SEISMOLOGY
RESEARCH
CENTRE

EchoPro

KELUNJI SEISMOGRAPH

PRODUCT USER MANUAL

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Powered by an Embedded Linux Operating System

V2.43 / V3.01

Dear Customer,

Thank you for purchasing the Kelunji EchoPro seismic recorder. You'll soon be set up to record earthquakes, blasts and other ground vibrations using our latest generation of portable and permanent seismic monitoring instruments.

Within a few minutes, you will have your computer set up to communicate with the EchoPro through its Ethernet port using your favourite web browser. The interface has been tested with a variety of common web browsers, including Microsoft Internet Explorer, Apple Safari, and Mozilla Firefox, on Windows, Macintosh, and Linux platforms.

The web pages are the primary EchoPro interface, but there is the optional LCD interface which enables the setup of basic recording functions for quick changes in the field without the need for a laptop.

Included in your delivery you will find a CD containing an electronic version of this manual as well as our eqWave software package and its manual. eqWave is a software application that can be used to view seismograms recorded by your EchoPro recorder. Installation instructions can be found in the eqWave manual.

Happy recording!

From the development team at Environmental Systems & Services.

Table of Contents

Getting Started

EchoPro – Standard or Rugged case, or SMA

As you can see below, the EchoPro is available in a number of configurations. The standard model uses a smaller case with the option of an external LCD & keypad interface. The rugged model uses a larger case and includes an internal LCD & keypad as well as many other components sealed inside the case for increased weather resistance.

Both models come with a GPS aerial – the standard model comes with a GPS aerial with 5m cable, whereas the rugged version has a high-gain aerial mounted on the internal bezel. The standard case has an optional internal sealed battery that necessitates an external on/off switch and charger socket, whereas the rugged model includes a lighter internal high density battery, plus on-off switch and charger socket on the bezel.

Both models come standard with an Ethernet port and 6-channel sensor input interface, although the rugged model has the option to be supplied as a dedicated 4-channel blast monitoring system with protected sensor connectors. The EchoPro can be expanded with a second 6-channel sensor input interface board for a total of 12 sensor channels. An internal triaxial accelerometer is an option on models without internal batteries, which is connected to three of the sensor input channels internally, meaning only a single triaxial sensor connector is visible externally from that interface board.

Both versions of the case have an internal USB socket for data storage media, but an external USB socket is available as an option. An internal modem is as an option on the standard case model, which adds an external telephone socket connector to the case.

Finally, a three-channel strong motion accelerograph (SMA) model is available which has an internal accelerometer and no external sensor connectors.

Powering your recorder

An EchoPro without an internal battery is provided with a power cable with bare wire ends. These can be connected to a 12V DC battery or a regulated 12V DC power supply. Ensure the black wire is connected to the negative terminal on your battery or power supply, and then connect the red wire to the positive terminal. The EchoPro will operate on 7 to 18 Volts DC. If the power is removed then restored, the EchoPro will restart using its previously saved settings.

The EchoPro operating system takes about one minute to boot up after power is applied. If you have specified the LCD panel option, the panel will display the instrument logo while the operating system starts up, and will then display the home screen when ready to operate. If your instrument does not have an LCD panel, an LED on the sensor input board (inside the case) will begin to flash after the boot sequence is complete.

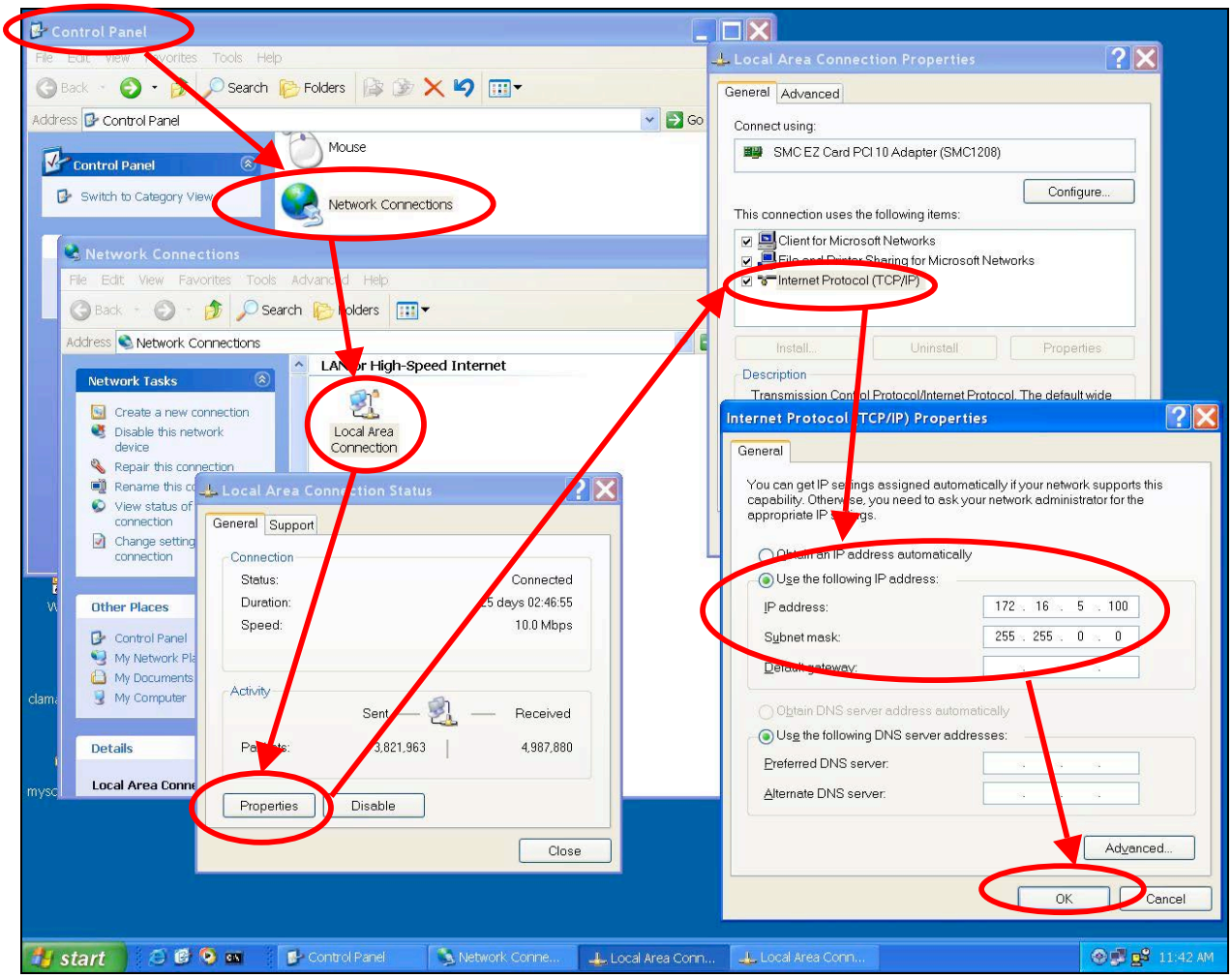
Communicating with the EchoPro

The normal method of communicating with the EchoPro is to use a web browser via the recorder's Ethernet port. If you are connecting directly from your computer's Ethernet port to the Ethernet port on the Echo, you will need to use the supplied red Ethernet **Crossover** cable.

By default, the EchoPro has an IP address of 172.16.5.120. You will need to change your computer's IP address to be in this network address range, but it cannot use the same IP address. The procedure for doing this is detailed on the following pages.

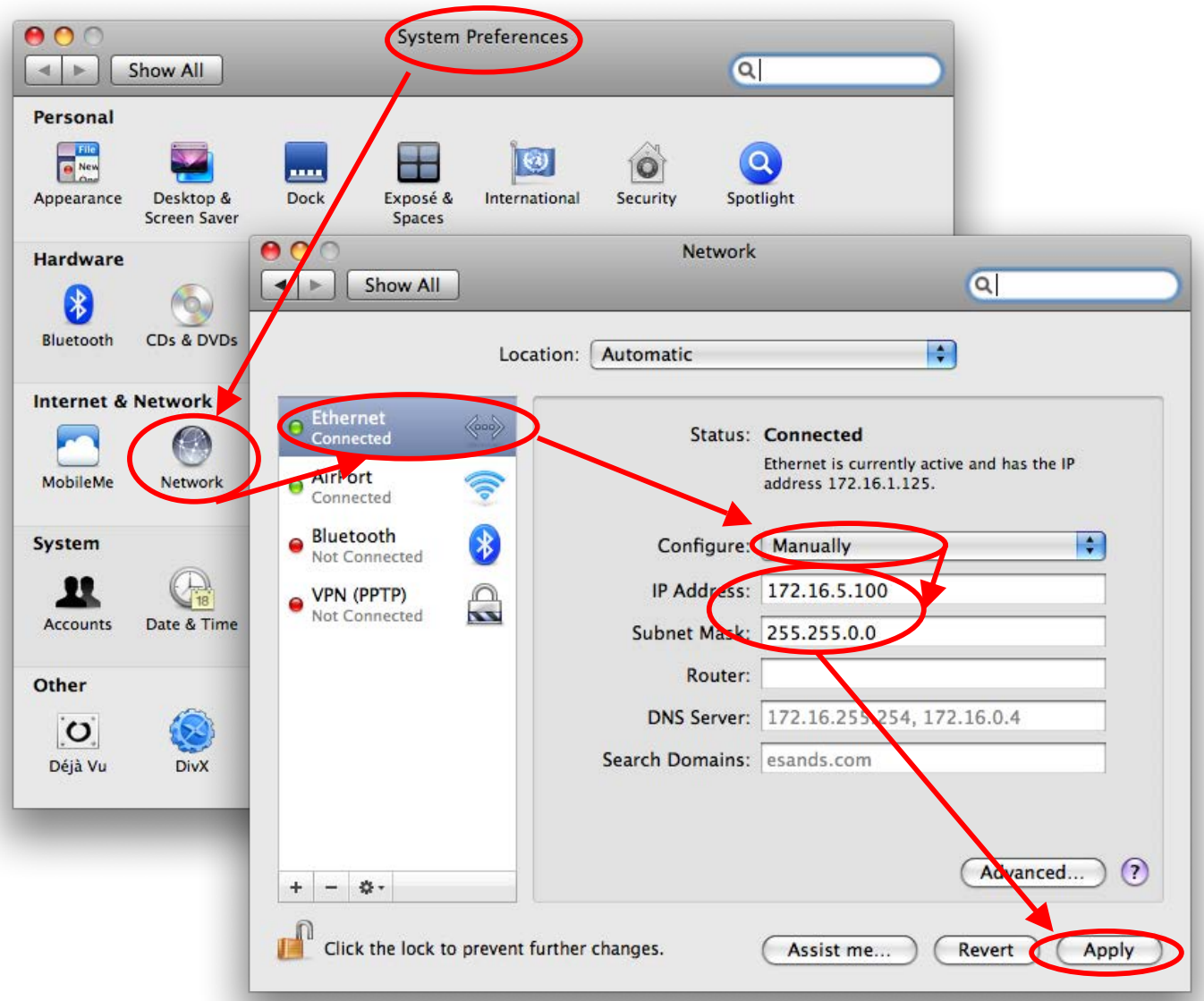
If you are connecting the EchoPro to an existing Ethernet network (to which your computer is also connected), simply plug a standard Ethernet cable (not included) from the Ethernet port on the EchoPro to the network hub. You will need to check with your System Administrator whether or not you can access the EchoPro over your network using its standard IP address. Instruction on how to change the EchoPro's IP address so that it can operate on your network is detailed later in the manual, but it will require that you first connect the EchoPro directly to your laptop using the cross-over Ethernet cable provided and using the following instructions.

Changing your computer's IP address (Windows XP Pro)



1) From the Start menu, go to "Settings…" then "Control Panel"
2) Double-click on "Network Connections"
3) If a "Local Area Connection" exists (it should if you are on a network), double-click on it. If not, create a new connection and follow the setup wizard to set up your IP address manually
4) Under the General tab, click on the Properties button
5) In the new window you will see Internet Protocol (TCP/IP). Click once on this to highlight it, then click on the Properties button
6) Select the radio button "Use the following IP address" and enter 172.16.5.100 as the IP address and set the Subnet Mask to 255.255.0.0
7) Click OK to save these changes and then type the recorder's IP address (http://172.16.5.120) into your web browser. You should now be connected to the EchoPro and prompted for a login and password

Changing your computer's IP address (Mac OS X)



1) Click on the Apple menu in the top left hand corner of your screen and select "System Preferences…" from the menu

2) Under Internet and Network, select "Network"

3) Select Show: "Ethernet" from the menu

4) In the Configure menu: "Manually"

5) Set your computer's IP address to 172.16.5.100 and the Subnet Mask to 255.255.0.0

6) Apply these changes and then type the recorder's IP address (http://172.16.5.120) into your web browser. You should now be connected to the EchoPro and prompted for a login and password

Troubleshooting connecting via web browser

If you can't connect to the EchoPro using your web browser, check that:

- You are not using a proxy server (common on Internet Explorer > Internet Options)
- You are not running a firewall on your PC that blocks this IP address range
- You have not set the IP address of your PC to 172.16.5.120 (being used by EchoPro)

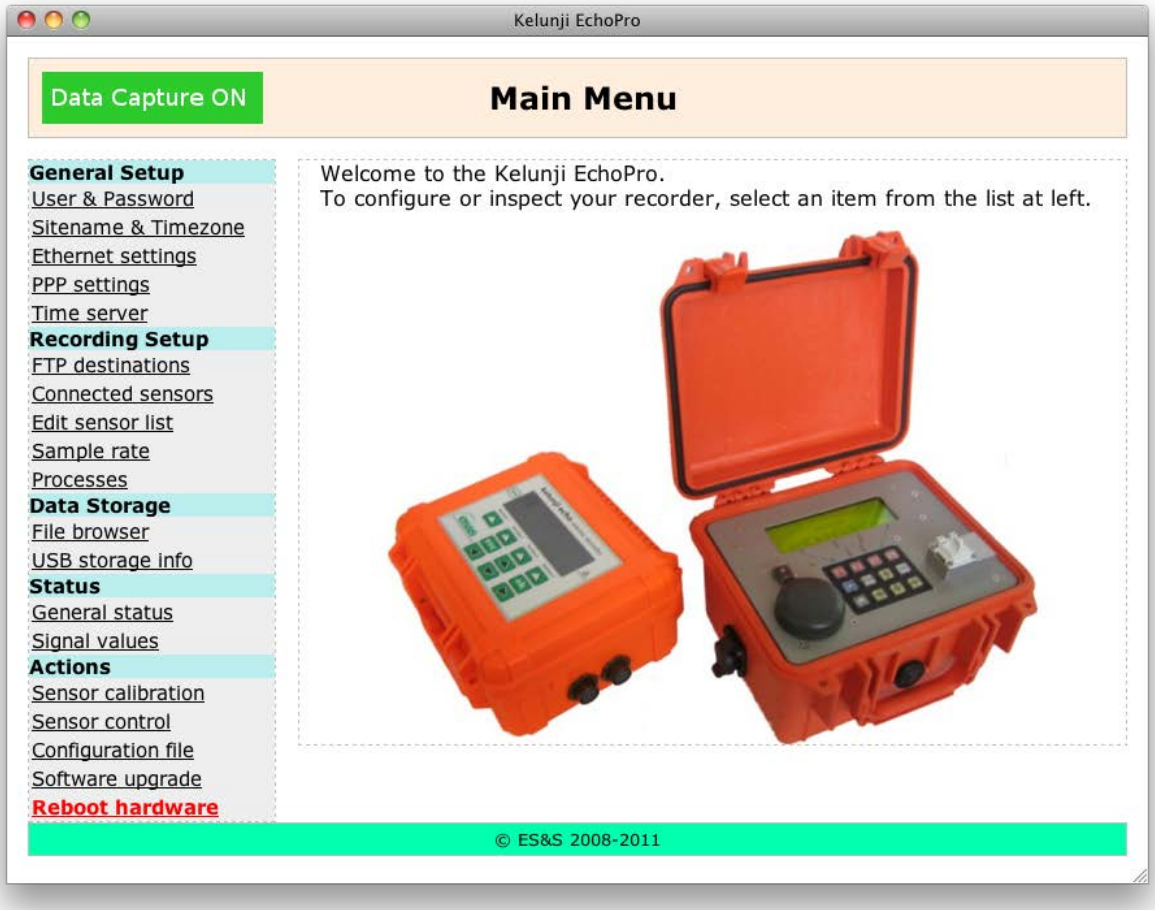
If you are still having trouble, contact the ES&S Kelunji EchoPro support team.

Logging In

When you first try to access the EchoPro through your web browser, it will ask you for a user name and password. As it comes from the factory, the **user name** defined is 'kelunji' with the **password** 'secret'. Note that both the user name and password are case sensitive and the defaults are all lower case.

For security reasons you may wish is to change this user name and/or password, which is explained in the **General Setup** section of this manual.

After successfully logging in, you will be greeted by the home page, which is shown below.



Setting up your EchoPro

Settings Requiring Hardware Reboot

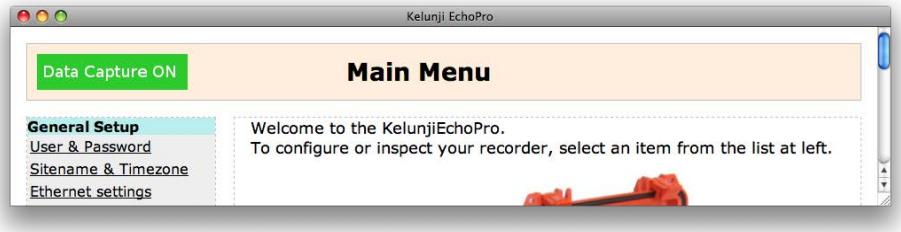
The web page interface of the Kelunji EchoPro allows you to change all of the settings on the recorder, but not all of these setting changes take effect right away. For instance, if you change the IP address of the recorder, you need to restart the recorder and then reconnect to it using the new address. Rather than immediately requiring you to restart the recorder, we allow you to make other settings changes that may also require a restart, which will save you time when you need to make many settings changes. These settings include:

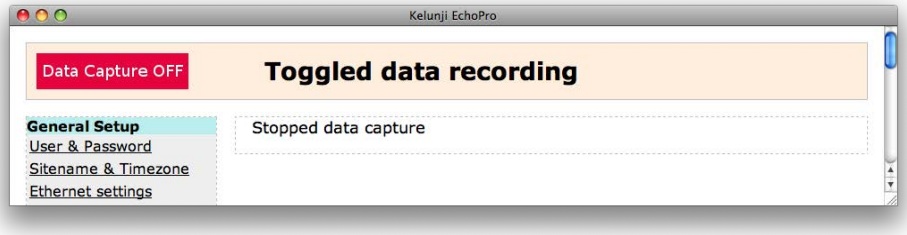
Sitename & Timezone	Reboot required if Timezone changed
Ethernet settings	Reboot required if any setting changed
Connected sensors	Reboot required if Gain changed
Sample rate	Reboot required if any setting changed
Configuration file	Reboot required to apply new configuration
Software upgrade	Reboot required to apply firmware update

Data Capture ON/OFF

At the top of the EchoPro web page is an indicator to show whether or not the "Data Capture" process is running. Data Capture effectively switches on and off the analogue to digital converters. While Data Capture is OFF, no data will be stored to memory, but networking operations (such as web and file browsing) will be much faster. When Data Capture is ON, all enabled recording processes will start accumulating data to storage.

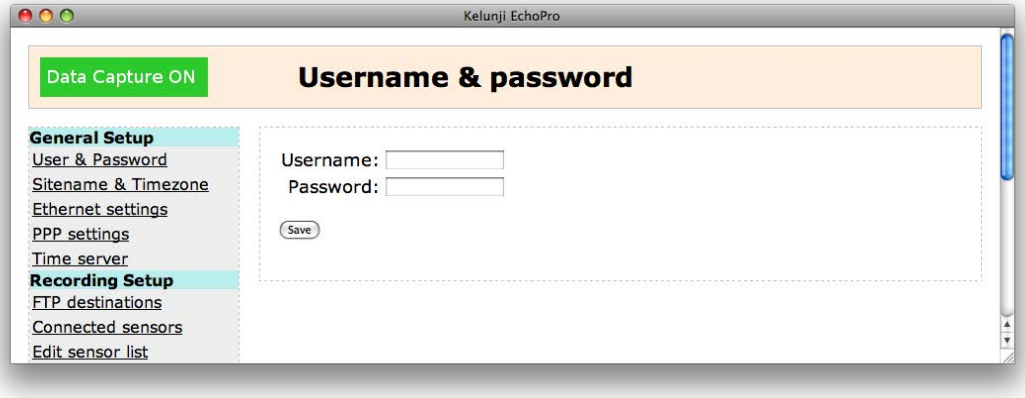
You can toggle the status of Data Capture by clicking on the **Data Capture ON/OFF** button. Once changed, a message will be displayed and the button will change colour.





General Setup

User & Password



The default user name and password are "kelunji" and "secret" respectively. If the EchoPro is to be connected to a network, particularly the Internet, this user name must be changed to avoid unauthorised access to your recorder. Only use characters A-Z, a-z and 0-9 in both the username and password. Use of special characters may cause you to be locked out of your recorder.

If you change the **User & Password** setting, the existing connection will remain open, but new web browser connections will require the new username/password.

Tip: The main need for password security is to block unauthorised access to your instrument over the Internet. If you have purchased a rugged case EchoPro or standard EchoPro without an LCD panel, you will notice that there is an area on the lid decal to write notes. If you change the "kelunji" user, we suggest you note down the new user name and password on the lid. This can be written in the decal notes area using a pencil so that it can be changed or removed at a later point using an eraser. For external LCD-equipped EchoPro recorders, we suggest writing the new username and password on a label or tag.

IMPORTANT! If you change the default user and password, make sure you note down the username and password. Without it you'll be locked out of the EchoPro. If this happens, please contact ES&S for emergency recovery instructions. A console connection may be required to recover from a lock-out.

Site Name & Time Zone

This settings screen allows you to set a unique identifying code for your instrument, which can be based on its permanently installed location, its asset number, or any other code relevant to your application. The **site name** can be any combination of one to five alphanumeric characters (uppercase A-Z, 0-9, and space).

System Log Files

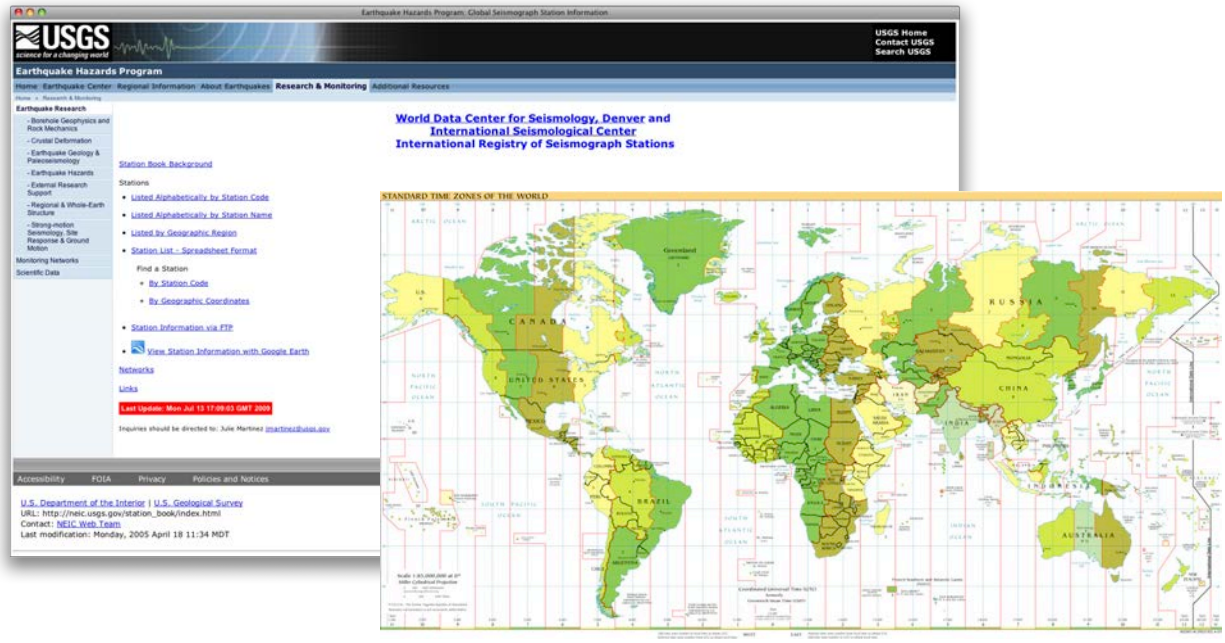
Users now have the ability to view daily log files as generated by the EchoPro's Operating System, as well as daily FTP log files. If the **Save system log files** option is enabled, files are generated daily at 0000 UT and stored in the Logs folder on the USB storage device. After the daily file is written, the log is reset so that the next file contains only new entries.

The files are named by date followed by either _sys.log or _ftp.log depending on their type (eg. 2010-07-16_sys.log). These files can be downloaded using the **File browser** menu and viewed with any text editor on your PC.

Sitename and Time Zone tips

Permanent earthquake monitoring stations should be unique around the world. A good reference to see what site codes are already used can be found in the USGS Station Book:

http://neic.usgs.gov/neis/station_book/

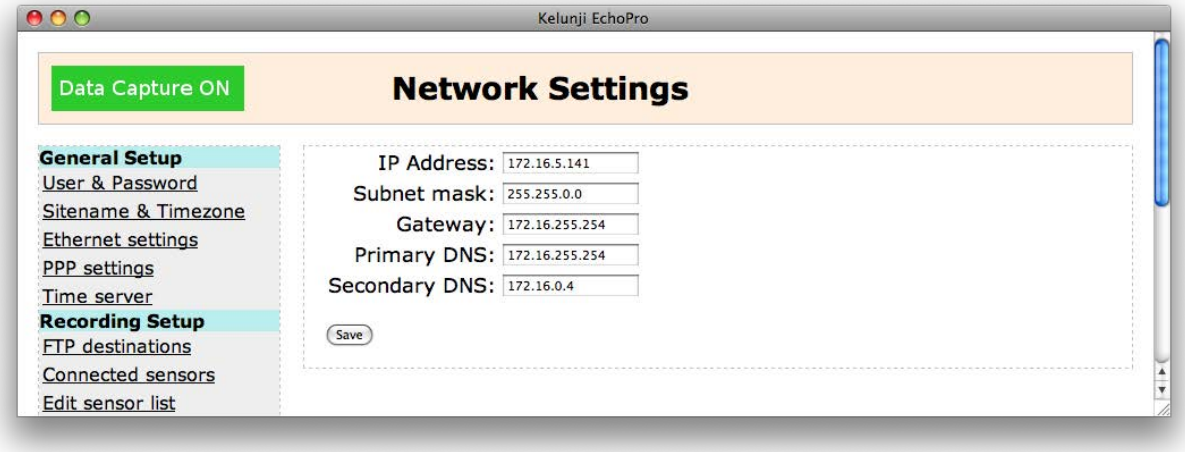


Data is always stored using the UTC (Universal Time Coordinated) as the time base. This time base is used globally in earthquake seismology, but if recording files showing local time is more relevant for your application, a local time offset can be entered on this screen. If you are unsure of your local time difference from UTC, you can check this value at various web sites. For reference, here are a few time zones (during non-daylight-savings periods):

+00:00 London, Lisbon (GMT)	+10:00 Melbourne, Sydney, ACT (Australia)
+02:00 Cairo, Kiev, Athens, Istanbul	+12:00 New Zealand
+03:00 Moscow, Kuwait, Baghdad, Nairobi	-10:00 Hawaii
+05:30 India	-09:00 Alaska
+07:00 Bangkok, Hanoi, Jakarta	-08:00 Pacific US, Tijuana
+08:00 Perth (Australia)	-06:00 Central America, US and Canada
+09:00 Japan, Korea	-05:00 Eastern US and Canada, Lima
+09:30 Adelaide, Darwin (Australia)	-04:00 Atlantic Canada, Santiago

Ethernet Settings

If you need to change the recorder's Ethernet settings to operate on your local network or when connecting to a VSAT or terrestrial broadband Internet service, you can do so easily.



To change the EchoPro's **IP address**, enter the new IP address in the first text field. Note this new IP address somewhere on the EchoPro box. It must take the form X.X.X.X, where X is an integer number between 0 and 255.

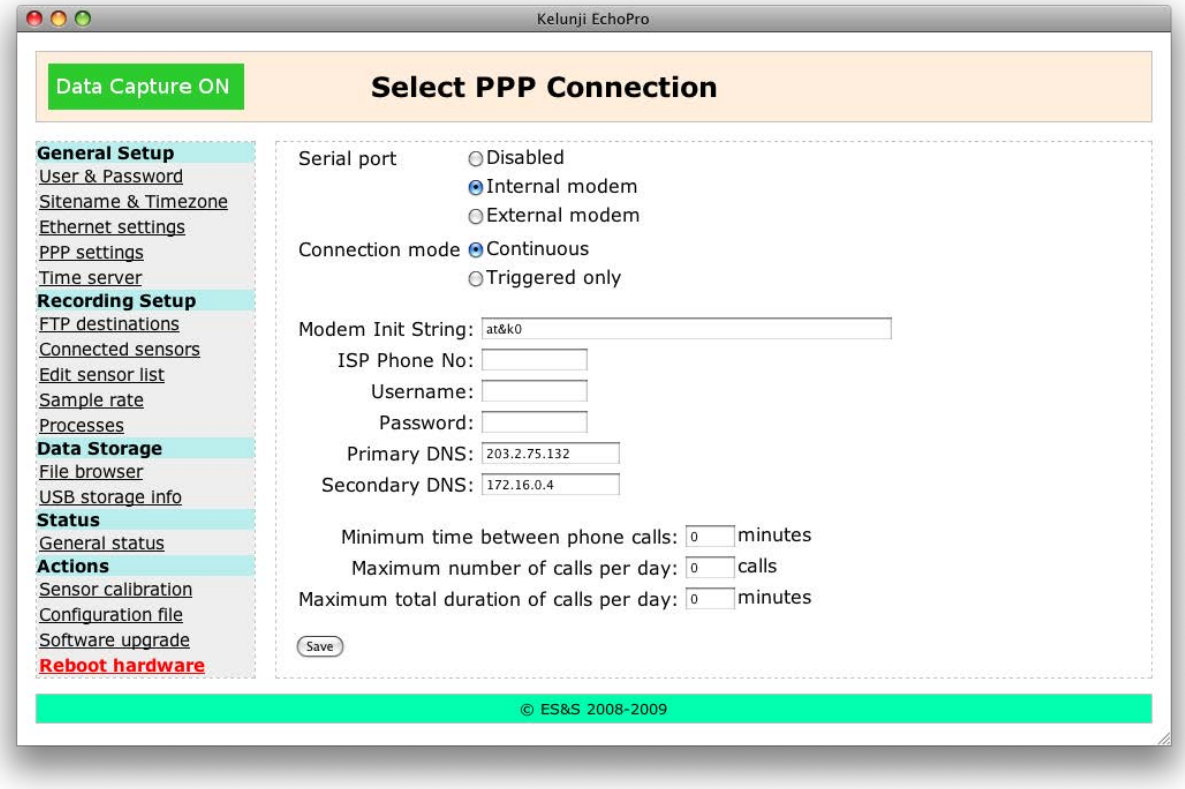
If you are changing the IP address, you may also need to change the **Subnet Mask**, **Gateway** address and **DNS** entries. Again, the format of the entry should be in the form X.X.X.X, where X is an integer number between 0 and 255.

To save the settings you have changed, click the **Save** button.

Note: If you have changed the IP address, you will need to reboot the recorder before the new settings take effect. This allows you to make further settings changes that may also require a recorder restart without re-booting multiple times. After you reboot the recorder, re-connect to the recorder using the new IP address you entered.

PPP Settings

A point-to-point protocol link is a network connection usually made over a telephone line to an Internet Service Provider (ISP). The EchoPro is designed to be used with an optional internal or external modem to connect to the Internet via an ISP.



By default the EchoPro has PPP **Disabled**, but you can enable this connection mode by selecting to use the **Internal Modem** (if installed) or an **External Modem**.

The EchoPro can make a connection with the Internet Service Provider (ISP) in two ways: continuously, or triggered (which sends only one file at a time). For telephone line service providers that charge based on the PPP connection time, we recommend that PPP only be used for triggered data telemetry. If the telephone line service provider only charges a call connection fee, then continuous PPP may be cost a effective data telemetry solution.

After the PPP connection is set up, the EchoPro will only start its first dial-up attempt if there is data queued up to be sent. If **Continuous** is selected, the connection will remain open until terminated by the ISP or if the telephone line drops out. If **Triggered** is selected, the PPP connection will open, one file will be sent, then the PPP connection will close.

The ISP that your EchoPro dials up should have provided you with connection information which includes the dial-in **Phone Number**, your **Username,** your **Password**. Enter these into the appropriate text fields.

Some modems require an initialisation string before they will establish a connection, so there is a field where you can enter the **modem init string**, which is sent to the modem before dialling. For the standard ES&S internal modem module, enter the string "**at&k0**".

If your dial-up account has a fixed IP address, you will be able to communicate with your EchoPro over the Internet by typing that address into your web browser. This IP address is automatically assigned to the EchoPro by the ISP upon connection. If your dial-up account does not have a fixed IP address, your ISP will assign the EchoPro a dynamic IP address that will likely change each time a connection is established.

IMPORTANT! Do not set the Ethernet IP address to the PPP connection's fixed IP address. This will cause an address conflict error.

The EchoPro has a number of settings that can be customised to suit the call cost rates of your PPP connection. These include:

Minimum time between phone calls

This setting will cause the EchoPro to wait some number of minutes after closing (or losing) a connection to the ISP before trying again. For immediate retries, enter a value of zero.

Maximum number of calls per day

You can set the maximum number of telephone calls you wish the EchoPro to make for any particular day. A value of zero gives the EchoPro an unlimited number of calls per day. The number of calls made for the day is reset at 0000 UTC. If the EchoPro had run out of calls on the previous day, calls will resume after 0000 UTC.

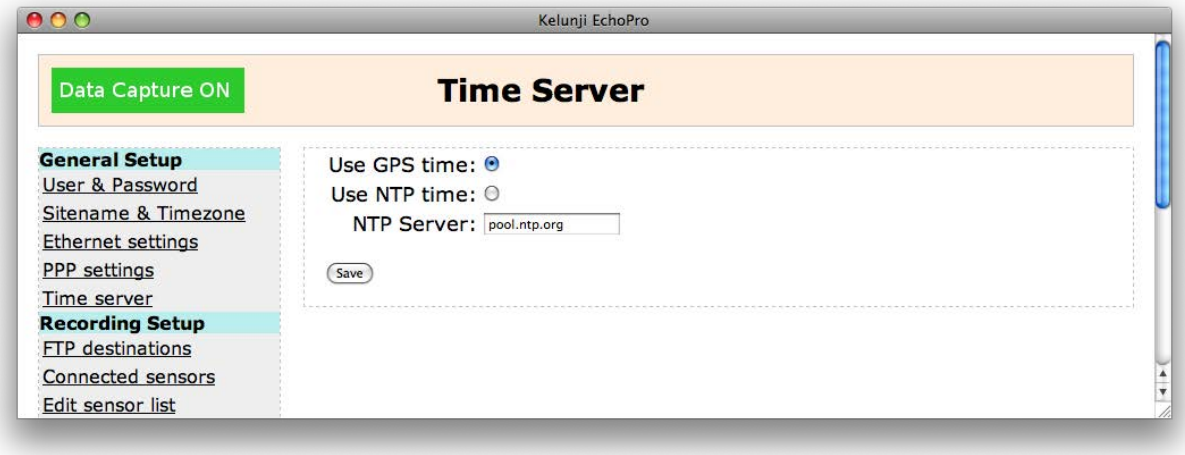
Maximum total duration of calls

As many types of telephone calls are timed and charged accordingly, this option ensures the EchoPro is not connected for unexpected lengths of time. Once the maximum number of minutes has been reached, the EchoPro will disconnect and not try again until 0000 UTC the following day. A value of zero will allow calls of unlimited duration.

IMPORTANT! If you change any of these settings that determine whether or not the PPP connection should remain active, the recorder may close the connection. The connection conditions are tested each time a file is prepared for sending, so for example if you have just set the maximum duration of calls to be shorter than the current connection has been active, when the next file is prepared for sending the connection will close.

If you change any of the PPP connection settings, such as the telephone number, username or password, these new settings will be applied the next time the EchoPro attempts to make a new connection. The current connection will remain open as long as the call connection rules allow.

Time Server



The EchoPro uses an internal clock to retain its time in between GPS time checks. The EchoPro will **Use GPS Time** by default, but there may be occasions where this is not possible, such as a break in the GPS aerial cable, or when there is poor GPS reception.

Without an external time source for reference, the internal clock will drift over time and become less accurate, but when a time source becomes available again it will correct its clock and continue operation.

The normal time source for an EchoPro is the GPS time system, but the recorder can also check the time if it has a connection to the Internet, or to a Network Time Server on its local network.

NTP, or Network Time Protocol, is a system whereby a device can check and correct its clock based on a query to an NTP server on a network. The delays associated with the time query over the network are compensated and the calculated time is as accurate as the time on the server. If enabled, the time is checked using NTP once every 10 minutes.

If your EchoPro is inside a building and does not have access to GPS signal, you can set it to use NTP time by connecting it to a network via Ethernet and selecting **Use NTP Time**, then nominating an NTP server IP address or domain name (eg. **pool.ntp.org**).

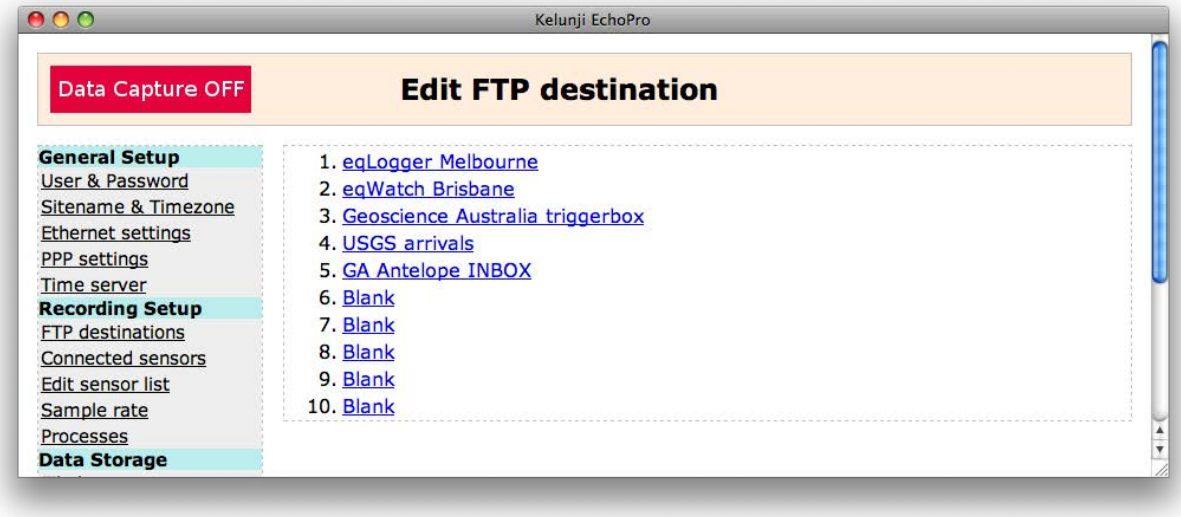
If NTP is enabled and you are using a PPP link to send triggered or continuous data files, when the PPP connection is established the EchoPro will check time using NTP immediately, and then check according to the 10 minute schedule thereafter.

The drift of the internal clock is such that it will change by less than the highest sample rate between regular 10-minute NTP checks. Daily time drift could be up to a few seconds without some form of regular time correction.

Recording Setup

FTP Destinations

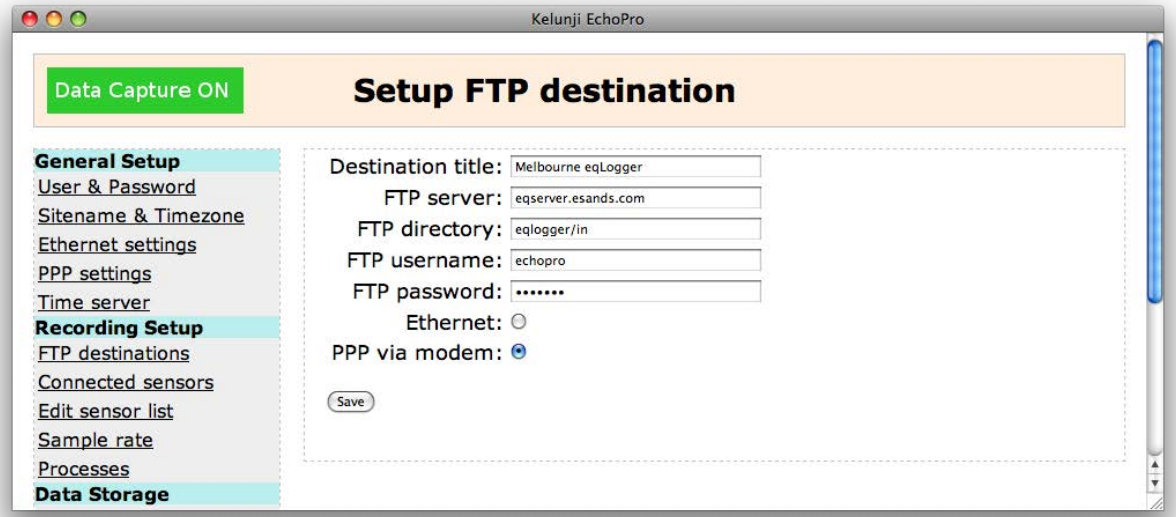
As pioneered in the original Kelunji Echo, the EchoPro can send data to a number of FTP servers (destinations). The difference in implementation in EchoPro is that you can define up to ten FTP destinations and then set a recording process to send data to one of these destinations without the need to type the FTP information into each recording process.



As supplied, the EchoPro will have no FTP destinations defined. By clicking on a blank entry, you will enter the settings screen to define a destination for your data.

You can also delete an existing FTP destination by clicking on it to edit, then using the **Delete** button instead of the **Save** button. Once deleted, it will no longer appear in the list of available destinations when defining a recording process.

Note: There is a limit to how much data can be telemetered as the process of sending data adds to the file system and CPU load. The EchoPro has been tested running one continuous recording process telemetering 6-channels of 100sps data via FTP. If the telemetry link is slow or more data is attempted to be telemetered, the communication tasks will cause the processor load to increase to a point where a watchdog reboot will be forced, resulting in the loss of some minutes of data.



Enter a **title** for your destination. This will be the name of the FTP Destination that you select in your recording process. Enter the IP address or domain name of the **FTP server** computer you'll be sending to. You may wish to write the files to a particular directory on the FTP server, which you enter into the field titled **FTP directory**. Directories may require the correct upper or lower case characters, so ensure your entry is correct.

The remote FTP server will request you to log in with an **FTP username** and will also request an **FTP password**. Enter those parameters into the appropriate text boxes, ensuring you use the correct upper or lower case characters.

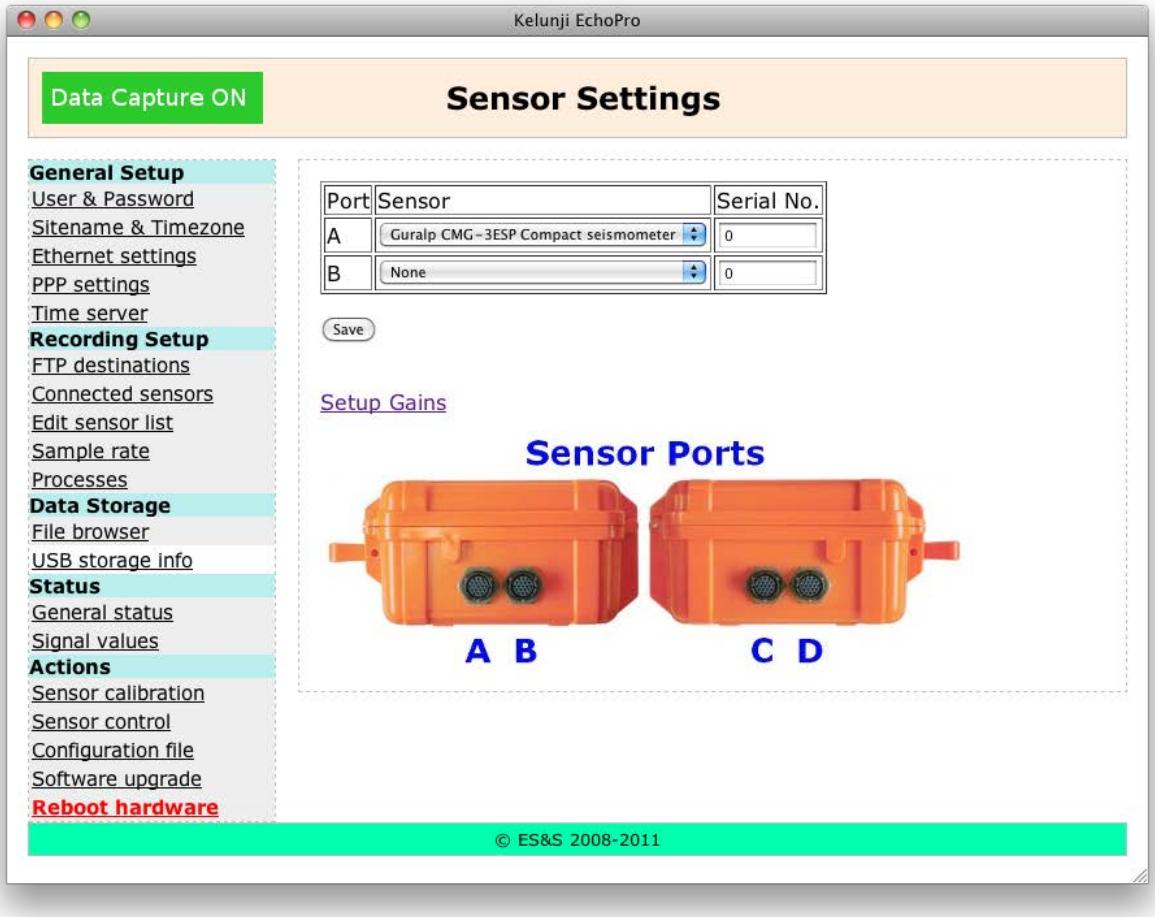
You can nominate whether this destination is accessed via a network connection established over the recorder's **Ethernet** connection, or if it should try to connect to this FTP server using a **PPP connection via modem**. PPP connections are used when you have the optional internal PSTN (land line) modem installed in your EchoPro.

To commit the settings you have changed, click the **Save** button.

If you have been editing an existing FTP destination, you can choose to **Delete** it. If you attempt to delete a new destination that has not yet been saved, an error will occur.

Connected Sensors

The standard EchoPro is supplied with a six-channel sensor interface, which is split over two external mil-spec connectors, with three channels on each connector. As most sensors are triaxial, you need to define what type of triaxial sensor is connected to each 3-ch input.



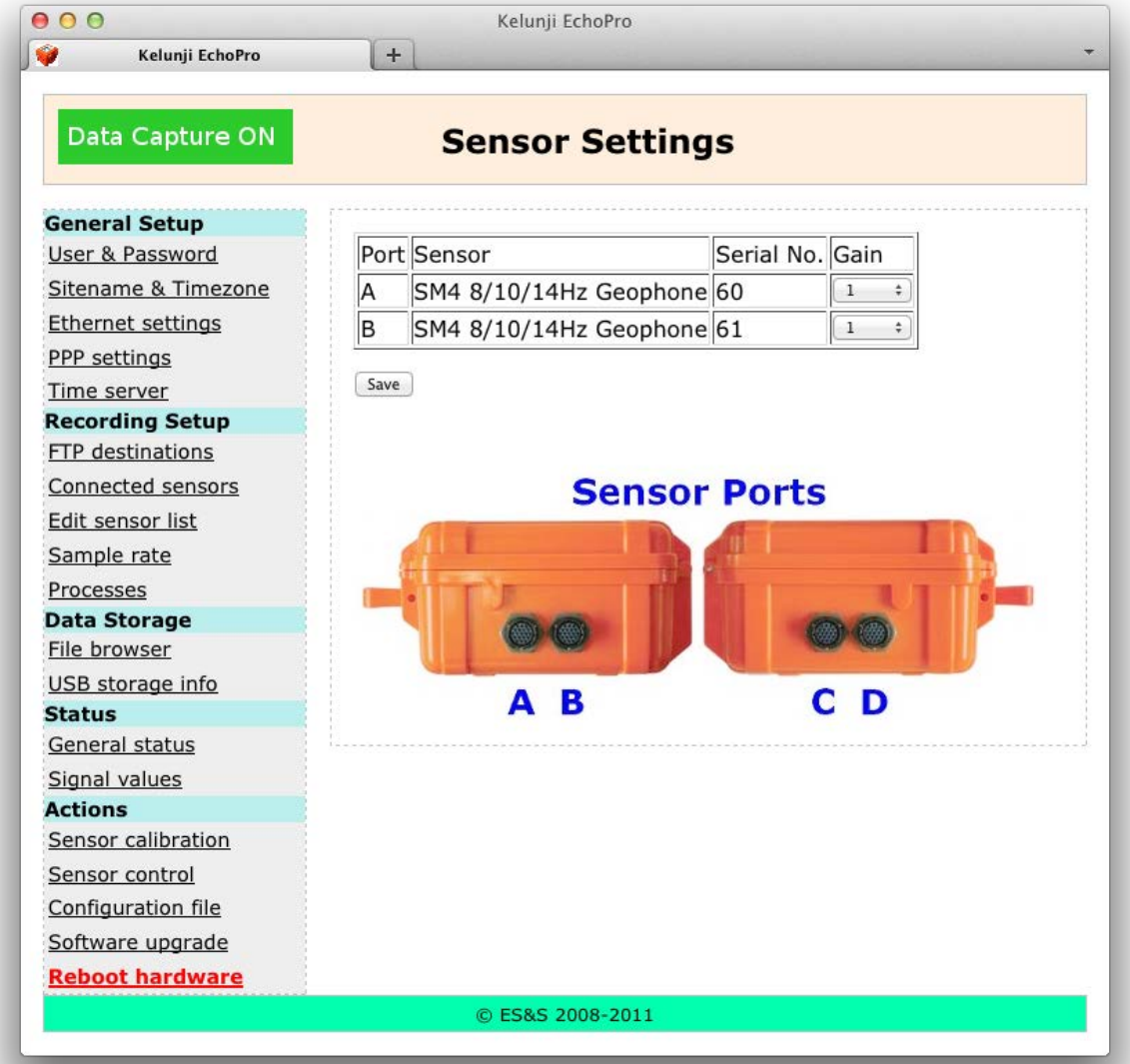
On a standard six channel EchoPro, the mil-spec connectors are located on the right-hand side of the case (when the handle of the case is facing you). If a second six channel sensor input board has been specified as an option, it will installed on the left-hand side of the box and the additional port settings will appear on the web page.

Select the sensor connected to each port from the drop-down list. If your sensor is not listed, see the next chapter which describes how to add or modify a sensor.

Enter the **serial number** of each sensor in the field provided.

Click on the **Setup Gains** link to select appropriates pre-amp gains for the saved sensors.

Setting the Gain



Voltage output sensors can be connected to the EchoPro in two ways, either single-ended or differentially. Previous to version 2.38 of the firmware, the input gain was fixed such that a single-ended sensor would use the full ±10V input range, which meant that differentially connected sensors would effectively have twice the gain. In firmware versions 2.38 and later, the sensors are defined as either "Differential" or not. If they are not differential, the available gains are 1, 2, 4, 8, 16 and 32. Differential sensors can be set with gains of 1, 2, 4, 8, 16, 32 and 64.

Important: In firmware older than v2.38, some predefined differential sensors were set with a sensitivity corresponding to the increased gain. For example, if a differential sensor was quoted as having 2x1000V/m/s response, the sensitivity was set to 2000V/m/s. When the sensor is now defined as a "Differential" sensor, the sensitivity for this sensor would be 1000V/m/s.

Using higher gains can be useful if your sensor output is less than ±10V and you wish to take advantage of the recorder's full 24-bit range, or if you are only looking at very small signals, such as during a micro-tremor survey, where you may be using ±10V sensors but are only interested in recording very small signal levels at higher resolution.

Note: Changing the gain will require you to reboot the recorder after saving

Internal Accelerometer

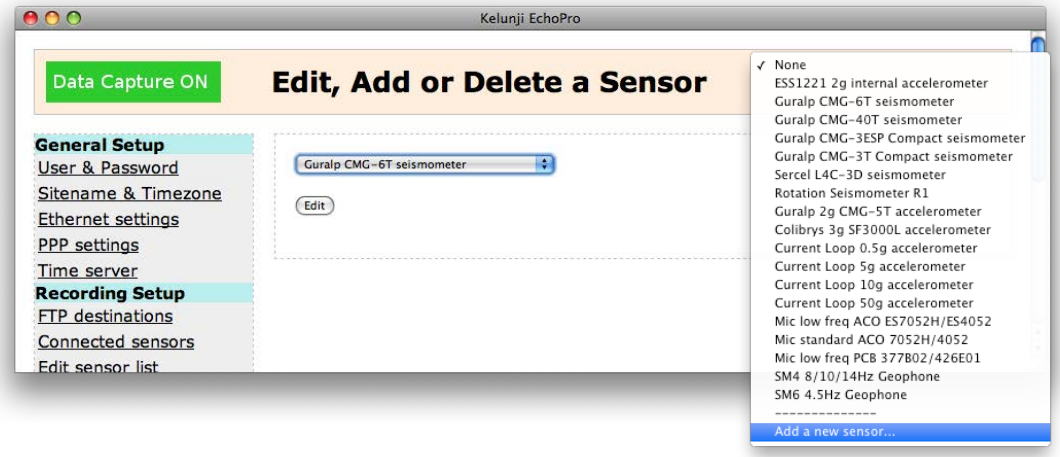
If you have purchased the **optional internal accelerometer** which is connected internally to the 6-channel sensor interface, it will be connected internally to Port B. In this configuration, only Port A will have a mil-spec external sensor connector.

If you have purchased an **EchoPro SMA** (strong motion accelerograph) there will be no external sensor connectors, and the accelerometer will be connected internally to Port A. You will need to select either the ESS-1221 ±2g 100dB internal accelerometer, or the Colibrys SF3000L ±3g 120dB (optionally internal) sensor from the sensor list, depending on the model of EchoPro SMA purchased.

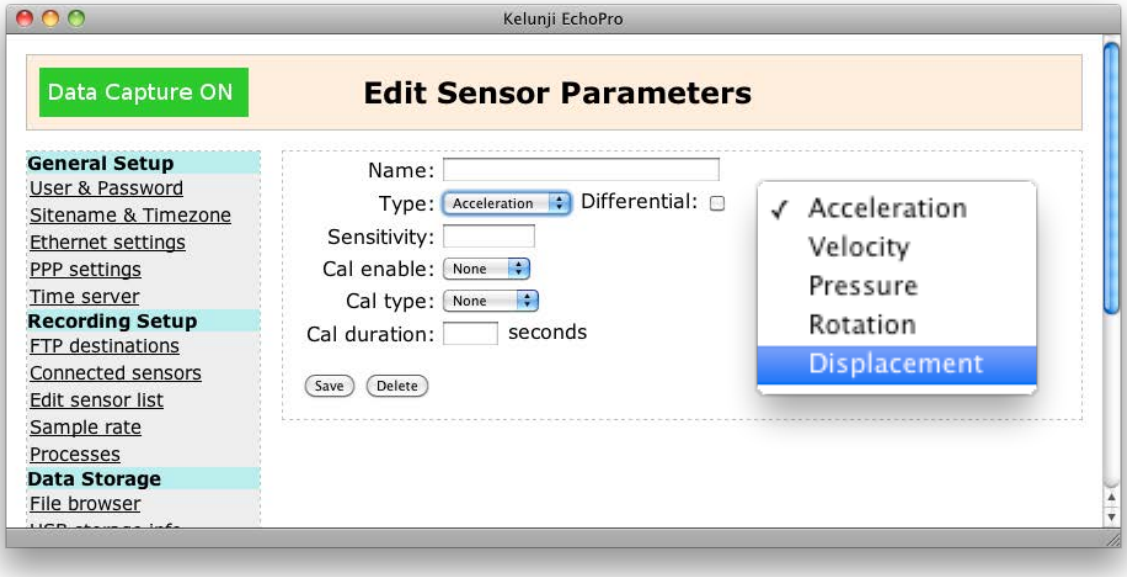
An EchoPro SMA can be bolted directly to a level mounting bracket, eg. inside a dam wall (as above)

Edit Sensor List

If you are using a sensor that is not shown in the Connected Sensor drop-down lists, you can edit the sensor list easily. You can also customise the settings of a listed sensor (eg. to specify an exact sensor output response) or delete a sensor using this page.



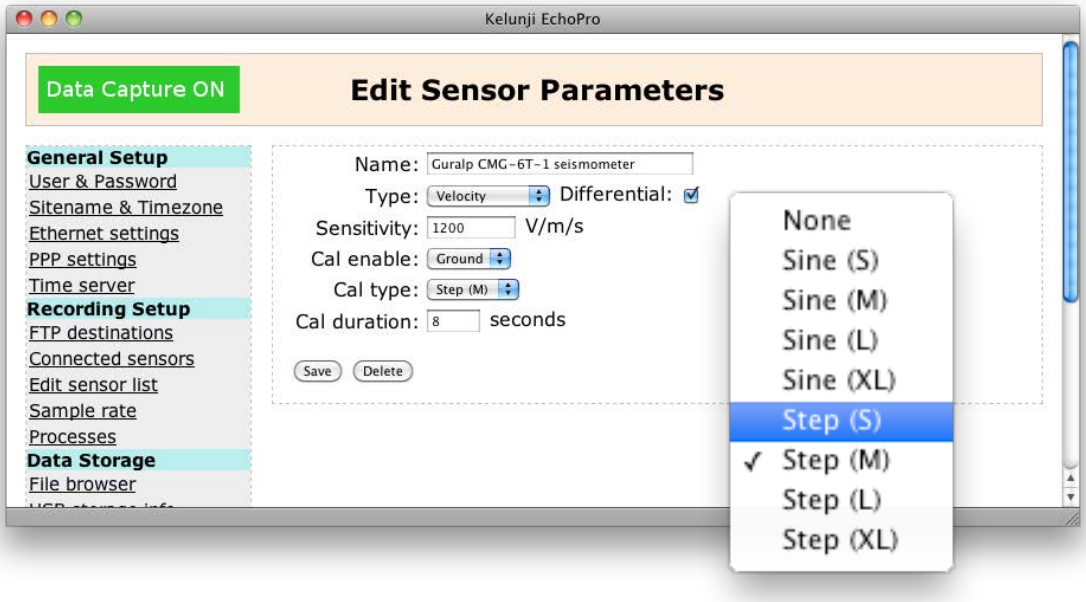
To edit a sensor's presets or delete a sensor, select it from the list and click on the **Edit** button. To add a sensor, select "**Add a new sensor...**" (bottom of list) then click **Edit**.



Enter the **Name** of the sensor in the field provided. The sensor **Type** can either be selected as velocity, acceleration, pressure (microphone), rotation, or displacement. If your sensor has a differential output and is wired to the EchoPro in this way, tick the **Differential** box. This is a new feature as of version 2.38 and allows an addition high gain setting. When this option is selected, the sensitivity should be set to the single ended response of the sensor, not the "double sized" sensitivity that was required in previous firmware. For example, previously the Guralp CMG-6T-1 with an output of 2x1200 V/m/s required a sensitivity 2400 to be entered. If the **Differential** box is checked, the sensitivity setting will be simply 1200.

The **Sensitivity** is a value provided by the sensor manufacturer that gives the sensor output response. This value is defined as Volts per metre per second (V/m/s) for velocity sensors, Volts per metre per second squared (V/m/s/s) for acceleration sensors, Volts per Pascal (V/Pa) for pressure sensors, Volts per radian per second (V/rad/s) for rotation sensors, and Volts per metre for displacement sensors (V/m).

Some sensors include calibration circuits to test the component response. In some cases active sensor needs to be told to enter calibrate mode, which is done by driving a **Cal enable** signal line to Ground or to 5V. Select the appropriate enable for your sensor if required (or None), which will be output to pin U of the sensor connector when the calibrate sequence is started.



The calibrate signal **Type** generated by the EchoPro can either be a **Step** Pulse or a **Sine** Wave of various size, output to pin J of the sensor connector. Prior to v2.38 of the firmware, the amplitude of the calibrate pulse was fixed at "XL", but now smaller signals are available for sensors with high sensitivity outputs.

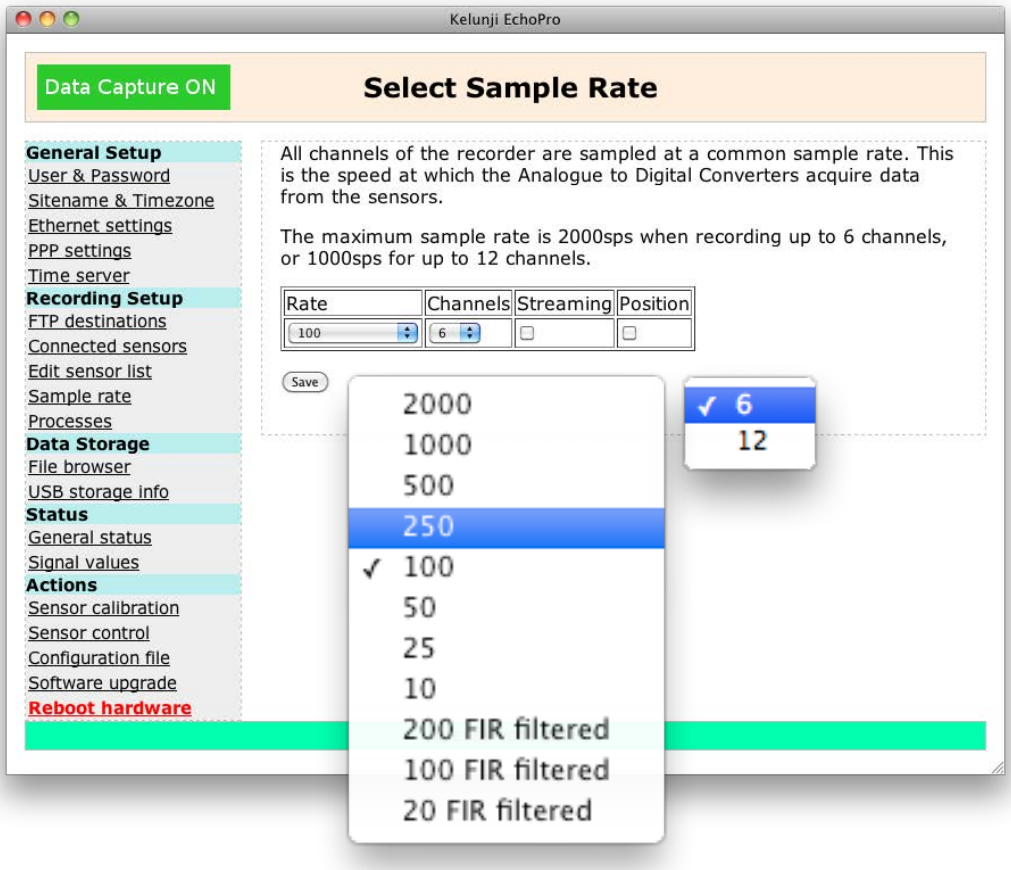
It is common to use a step pulse to check the response of a velocity sensor, and a sine wave for accelerometer component excitation. The **Duration** of this calibration signal will be determined by the period response of the sensor – for accelerometers or short period seismometers a few seconds is sufficient, whereas broadband sensors may need 30 or 60 seconds or more to see how the components respond to a step.

Click on **Save** to commit the changes. If you are adding a new sensor, it will not be added to the list until you click on Save. If you wish to abort, simply click on another EchoPro menu item. If you try to **Delete** a new sensor before it is saved an error message will be displayed. You can remove an existing sensor from the list by **Edit**ing the sensor, then clicking on the **Delete** button.

Sample Rate

All channels of the EchoPro are sampled at a common sample rate. This is the speed at which the Analogue to Digital Converters (ADCs) run to gather data from the sensors. There are two types of data sampling available – unfiltered and filtered. The selectable unfiltered sample rates are **2000, 1000, 500, 250, 100, 50, 25** and **10** samples per second. The selectable filtered sample rates are **200, 100,** and **20** samples per second.

If your recorder has two sensor interface boards (giving you up to 12 channels), you may wish to enable only one interface so that you can record at a higher sample rate. Select **6** or **12** channel operation from the drop-down list. If you select 6-channel operation, only sensor ports A & B will be sampled. See following pages for info on Streaming and Position.



If you have enabled both 6-channel sensor interface boards for 12-channel operation, selecting the 2000sps option will flag an error. The maximum sample rate for up to 12 channels is 1000sps.

If you select 12 channels, a number of the other menus will display additional settings. For example, the "Connected Sensors" menu will show four sensor ports, and the Process menus will display channels 7-12 to select for triggering and/or recording.

Note: You must restart the recorder before the new sample rate will come into effect

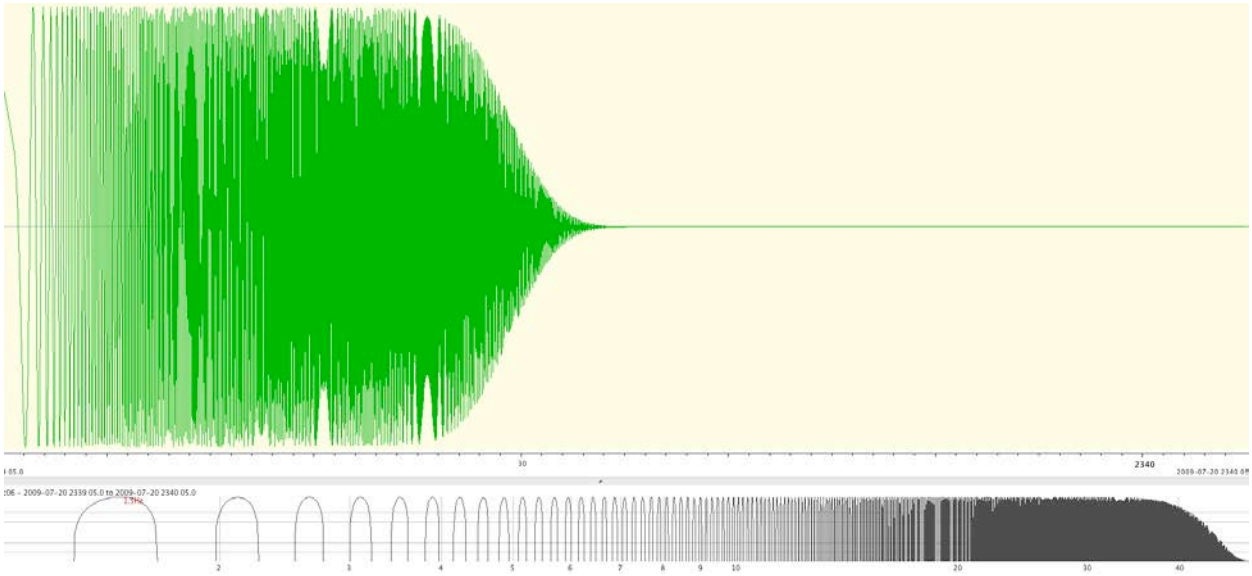
Filtered Sample Rates

A common practice in earthquake monitoring is to filter the pre-recorded data using an FIR filter to attenuate signals above the Nyquist frequency, or half the sampling rate frequency. If filtering is not used, it is possible to get aliases of above-Nyquist frequencies appearing in the sub-Nyquist range.

For example, there may be a 60Hz noise source near a recorder that is sampling at 100sps, where the Nyquist frequency is 50Hz. On an unfiltered recording, you would see some trace of the 60Hz noise folded back around the Nyquist point and appearing at 40Hz.

By using FIR filtering, all frequencies above Nyquist are effectively attenuated to a tiny fraction of the signal amplitude before they can affect the sub-Nyquist signal. The FIR filter design means that the attenuation starts at a frequency below Nyquist and rolls down to maximum attenuation at the Nyquist frequency.

The image below shows a time domain plot **(green trace)** of an EchoPro recording a fixed amplitude sweeping frequency from 0.1Hz to 100Hz. Half way through the sweep, at 50Hz, the signal has been attenuated by over 99.99%.



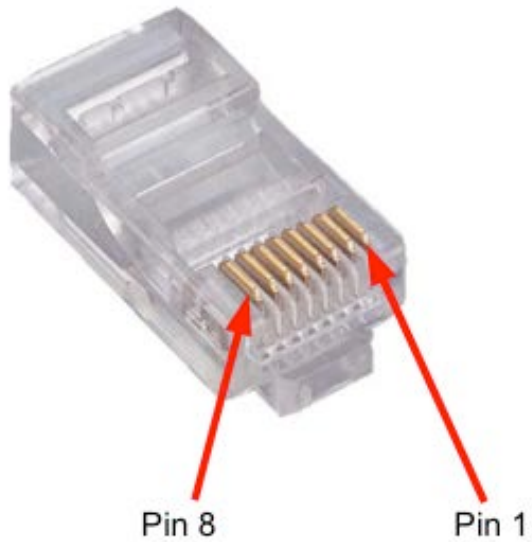
The logarithmic frequency domain plot above **(black trace)** shows the signal power at the various frequencies from 1Hz to 50Hz. The cut-off frequency (the point where the signal is 3dB down from the maximum amplitude occurs at 40.5Hz (for this 100sps recording example), and is all but eliminated at the Nyquist frequency of 50Hz.

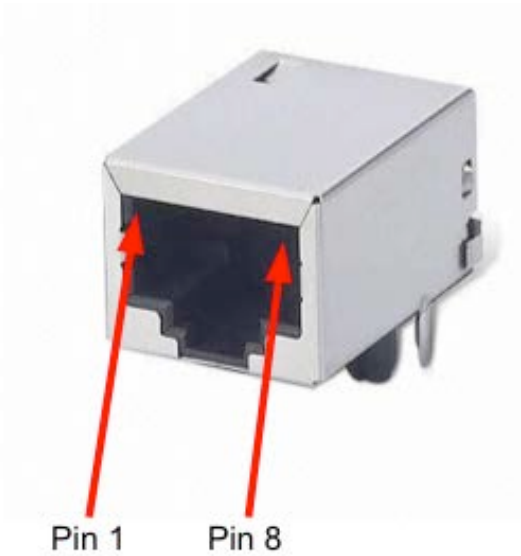
Real-Time Serial Data Streaming

If the **Streaming** checkbox is ticked on the sample rate screen, serial data from all 6 channels on Port A and Port B will be streamed at up to 100 samples per second in the format detailed below. If the **Position** checkbox is ticked the GPS information is included.

The EchoPro has an internal serial port that is either used to establish a PPP connection using an internal modem, wired to an external connector for PPP via an external modem, or used to stream out serial data. If the internal modem is being used to transfer data via a PPP link, real-time serial data streaming is not possible. Unless your EchoPro was specified with an external serial port at the time of manufacture, the internal and external hardware required will not be fitted to your recorder, but it can be added at any stage by returning it to the factory.

The external serial port is accessed through J16, a RJ45 socket as shown below:





Pin	Signal	Description
1	+12V	Power supply from the EK board to the external device
2	RxD	Received data flowing into the EK board from the external device
3	CTS	Clear to send, from the external device into the EK
4	DCD	Data carrier detect, from the external device into the EK
5	RTS	Ready to send, from the EK board to the external device
6	DTR	Data terminal ready, from the EK board to the external device
7	TxD	Transmitted data flowing from the EK board to the external device
8	GND	Ground

There are two pins required for serial data streaming, these being pins 7 and 8.

Once serial data streaming is enabled through the web interface, raw ADC data will be sent via the external serial port at 57600, N, 8, 1. This is fixed in the FPGA, and is not user configurable. The maximum sampling rate supported is 100sps. Trying to stream data at more than 100sps will result in intermittent loss of data.

The EchoPro uses the same serial formatting protocol as the Echo. This is described below:

Real-Time Serial Streaming Protocol

The serial port is set up as a standard RS232 port, at 57600 baud, 1 start bit, 8 data bits, no parity, 1 stop bit, no flow control. Data is sent as plain ASCII text, and can be recorded using a simple terminal emulator such as HyperTerminal or Minicom.

Data from each ADC is represented by a two's-complement, 24-bit hexadecimal number. This is raw data, and is not scaled in any way. Each channel is separated by a space character, and each line is terminated with a CR/LF.

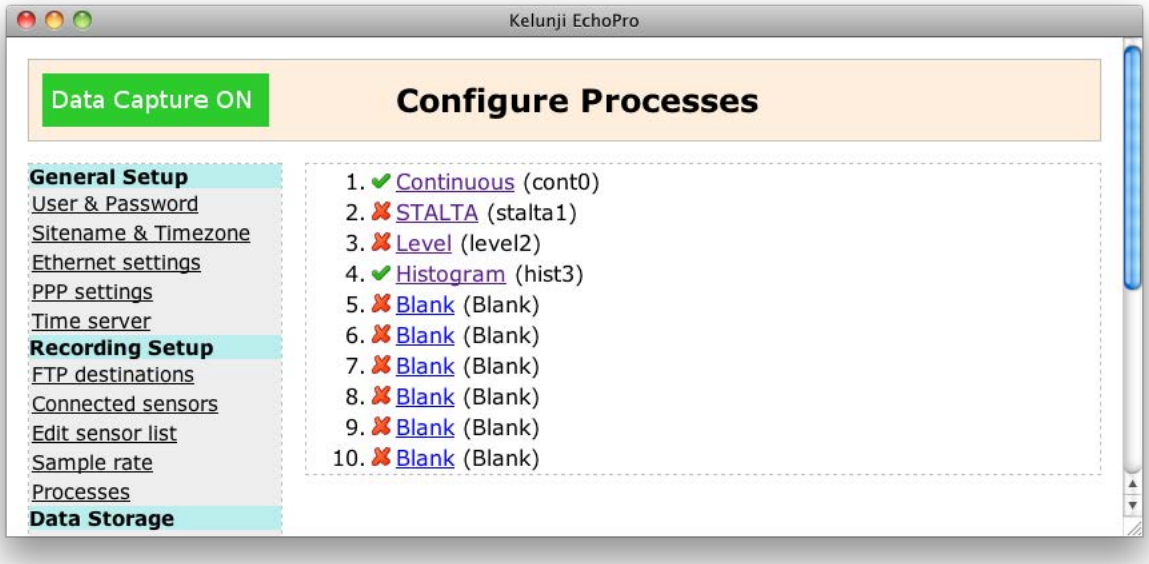
A time packet is inserted into the data at each second. This string is formatted according to: YYYY-MM-DD HH:MM:SS and optionally has the GPS position appended to this line if that option is selected. This line is both preceded and terminated with a CR/LF. This means there is a blank line before each second of data. A typical example is shown below:

```
...
...
00772e ff2b6f 00508e
00792f ff2d12 005146
007adb ff2dca 005245
007bab ff2c30 005287

2009-12-07 21:42:50
007a02 ff2b5e 00520f
0077ac ff2ca6 005075
007427 ff2d41 004a75
0075ea ff3293 005a43
007cb8 ff36d0 006fc4
...
...
007451 ff3016 0059f4
006fd5 ff2a09 00456d
0076e3 ff2bea 00504d
007be5 ff2d62 0059cb

2009-12-07 21:42:51
0076a4 ff2b84 004d39
00776d ff2cac 004ee8
0079ef ff31ce 005b8f
007ca0 ff31a5 006151
0075f0 ff2c25 00509f
...
...
```

Processes



The processes are the most important part of the EchoPro's data recording setup. In this context, "Process" is short for "data recording process", which is a set of instructions that defines what data is stored and where it is stored. Up to ten processes can be running in the EchoPro at any one time. Processes can be edited, enabled or disabled by selecting them from the list. There are three types of waveform recording processes in the EchoPro.

Continuous Recording

The EchoPro can record continuous data from any number of input channels. The data is compiled into one-minute long files, which are recorded to storage and/or sent via FTP to remote locations.

STA/LTA Triggered Recording

The EchoPro can monitor a single data channel to see whether the average signal level exceeds a particular threshold. The signal average is calculated by comparing the signal level over a Short Time Average (STA, eg. 0.5 seconds) to the signal level over a Long Time Average (LTA, eg. 20 seconds). When the signal level ratio (STA divided by LTA) exceeds the threshold, a "trigger" is declared and the data is recorded to storage and/or sent via FTP to remote locations.

Level Triggered Recording

The EchoPro can monitor data channels to see whether the signal level exceeds a particular threshold. When it does, the signal is recorded to storage and/or sent via FTP to remote locations.

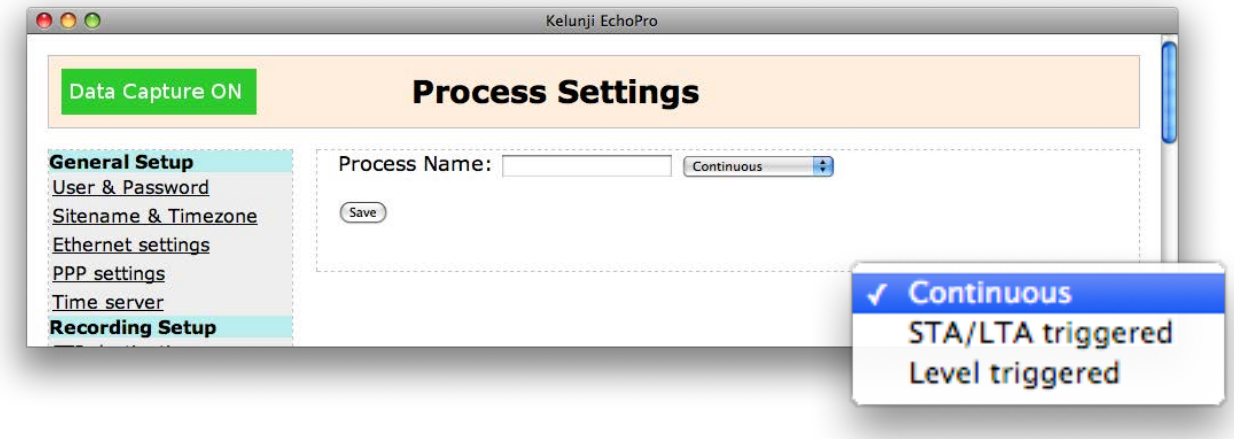
Pre-defined and Custom Processes

The first four process "slots" have fixed functions: slot 1 is a Continuous recording process, slot 2 is an STA/LTA trigger process, slot 3 is a Level trigger process, and slot 4 is a histogram recording process. These first four pre-defined processes cannot be deleted, but they can be renamed, modified, enabled or disabled.

Note: Any changes made to the Continuous, STA/LTA or Level trigger processes using the optional LCD interface will be reflected in these first three process slots, and vice versa

The remaining process slots are fully customisable. They can be set up as continuous or triggered process types, modified, enabled, disabled or deleted according to your requirements. By default, process slots 5 to 10 will be undefined and will read **Blank**. By default, all processes (including the pre-defined processes) will be disabled, as indicated by a red cross before the process name. Enabled recording processes are shown with a green tick.

To create a new recording process, click on a **Blank** slot and this screen will appear:



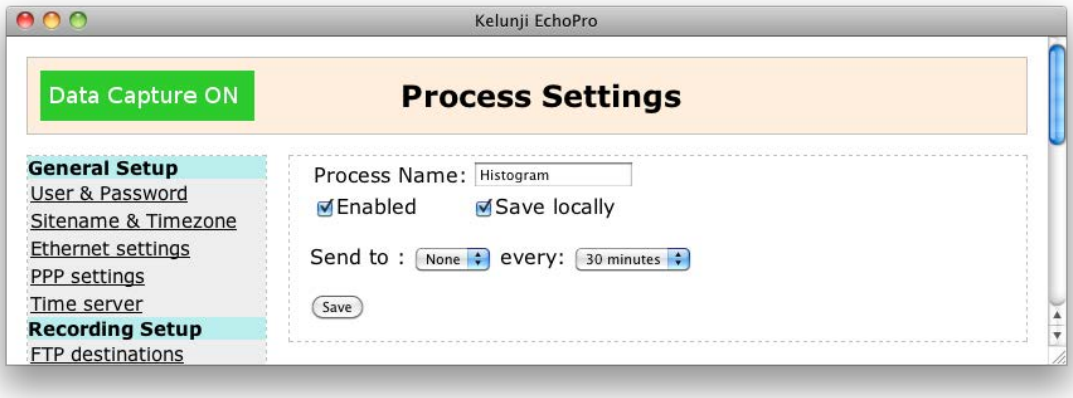
Enter a name for the process and select the type of recording process you want it to be.

Once you have created a new recording process, you will enter a screen that allows you to edit the settings of that recording process. This same screen will appear if you click on an existing process in the list to edit the recording process settings.

The only parameter that you cannot edit once a recording process is created is the recording process type (Level, STA/LTA, or Continuous) as this determines the settings that are available to that recording process. If you wish to change the process type you need to delete the process and create a new one in its place. Alternatively you can disable the process and start a new process in a different process slot.

Histogram Recording

A new feature is a fixed Process called "Histogram" that can be enabled to store daily log files that records the peak value for each minute on each channel.



These histogram files can be stored locally and/or sent to an FTP destination every 5, 10, 15, 30, or 60 minutes. A time-stamped entry is appended to the log file every minute showing the peak value on each channel in the previous minute. The daily files are stored in LocalArchive/hist3/ and a new file is created each day.

A header is inserted into the Histogram file when the process is started and in each new daily file. The header contains the response information for each channel in the format:

```
00,1,0.102000,a,838860.812500
```

Recorder constant {counts per Volt}

Sensor unit type {a=acceleration in m/s/s, v=velocity in m/s}

Sensor sensitivity {Volts per unit}

Gain

Channel Number

The data is in the format:

```
01:06:53,3595,3952,3369,380,893,24
```

etc…

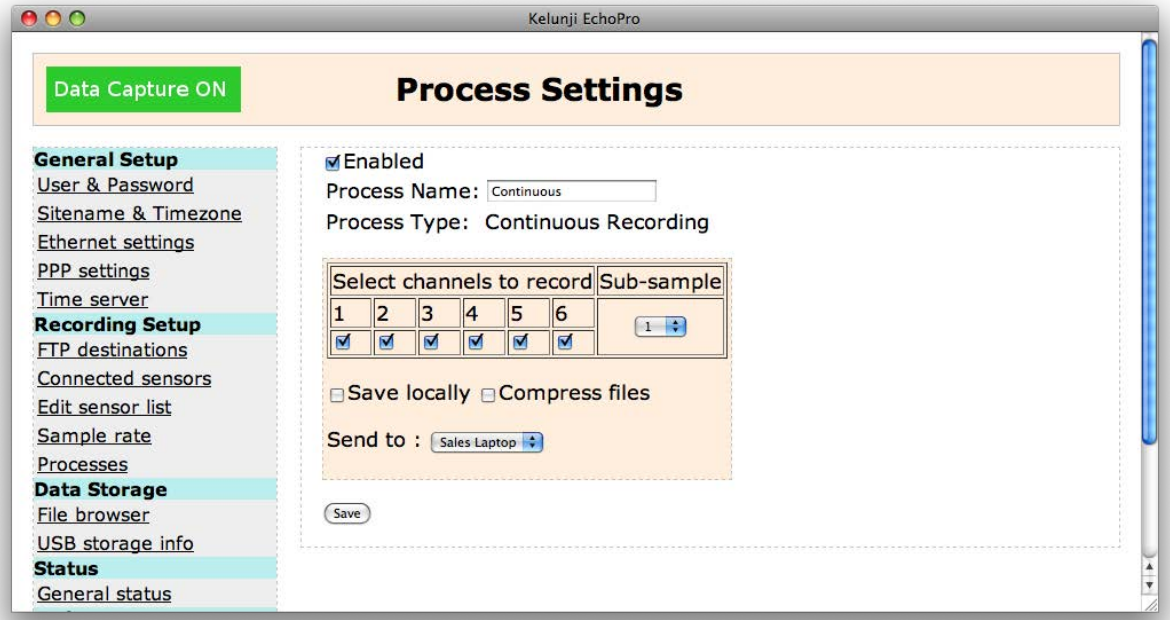
ch01 peak

ch00 peak

Timestamp

To work out the true value, take the data, divide it by the gain, divide it by the sensitivity, and divide it by the constant. Eg. if a geophone has a sensitivity of 28.8V/m/s, at a gain of 1, when the peak value is 1,000,000 counts it equates to 0.0414 m/s (41.4 mm/s).

Continuous Recording Process



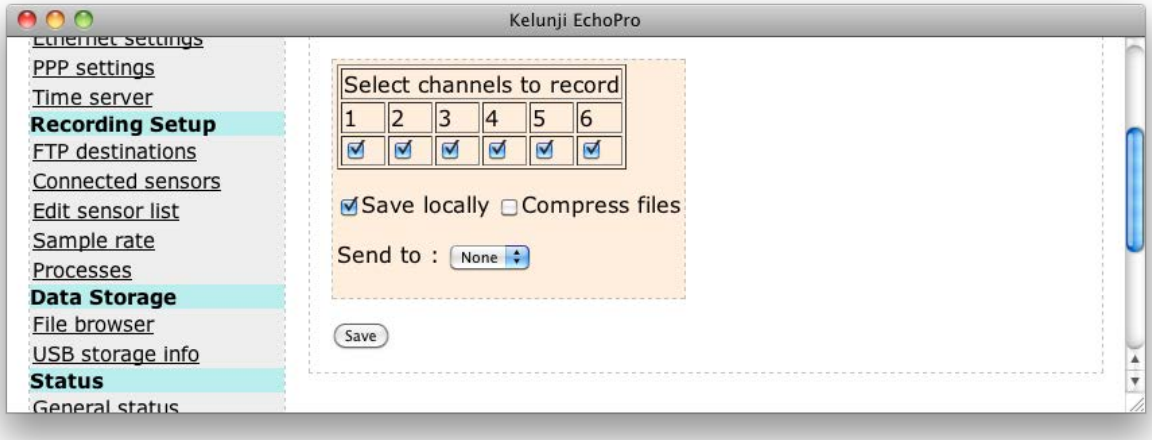
At the top of every process page is the **Enabled** checkbox which can be checked or unchecked to enable or disable a process. Below this is the **Process Name** which you can customise (using characters A-Z, 0-9, space, dash and underscore) and **Process Type**.

The continuous recording process itself does not have any settings to modify as it simply records data into one-minute long files that are stored on the USB memory storage for archiving or onward telemetry. The only settings that appear are the file storage and telemetry options (shown as a table with a pale orange background), which are common to all recording processes. The function of this table will be discussed in the next section below, and referenced from the other recording process descriptions that will follow.

Tip: Six channels of continuously recorded compressed data generates about 200MB per day at 500 samples-per-second. This estimate can be scaled proportionately by increasing or decreasing the sample rate and number of channels. For example, 3ch @ 1000sps yields around 200MB per day, 1ch @ 100sps produces less than 10MB daily.

Storing Files

Every recording process has a data storage and telemetry section, shown in a box with a pale orange background, that defines what data is stored and where it is to be stored.



A table of channels will appear under the heading "**Select channels to record**". Tick the boxes of the channels you wish to store in the data files created by this process.

Tick the **Save locally** box to save files to the LocalArchive folder on your USB storage device. If you plan to only send data to a remote computer, leave this box un-ticked.

If you wish to compress the data files to save space and allow for greater recording capacity, tick the **Compress files** box. This will apply a gzip compression algorithm to the data files as they are written to storage, saving 50% or more of the original file size. eqWave, the software package supplied with the EchoPro for waveform viewing, will read compressed files directly (without the need to uncompress them first).

Sending Files via FTP

The final setting in the file storage section deals with sending a copy of the data to a remote computer via FTP. By default this is set to "None", but you may wish to select one of your pre-defined FTP destinations as a location where you want your data sent. Data is written to the USB device to a folder called "ftp1" into a sub-folder whose name reflects your recording process (eg "cont0"). After a data file has been sent to the FTP destination, the file will be deleted from the FTP folder.

How much data can I store and telemeter?

The EchoPro can manage a lot of data, but it is not without limitations. There are many factors that will affect how much you can get the EchoPro to do, including how much data is being stored locally, whether or not compression is being used, whether or not data is being sub-sampled to file, how much data is being sent via FTP, how many FTP destinations are being used, the speed of your communication link, and many more factors.

As such, it is difficult to define guidelines for the number of recording processes that can be used, or how many channels can be recorded or telemetered.

When recording only to the LocalArchive folder on the USB storage device, it is possible for the EchoPro to handle three Continuous processes each recording 6 channels of data at 2000sps. With compression enabled, the 500kB files are written with about five seconds to spare in each minute. With compression off, the 1.4MB files are written with about 10 seconds to spare. The compression process adds CPU time, but less time is required to write the files due to their smaller size, and overall it is an option that takes more time.

In practice, this is not a configuration that would be used as it is creating three copies of the same data, but it gives some indication of the data volume that can be written to the LocalArchive by the EchoPro.

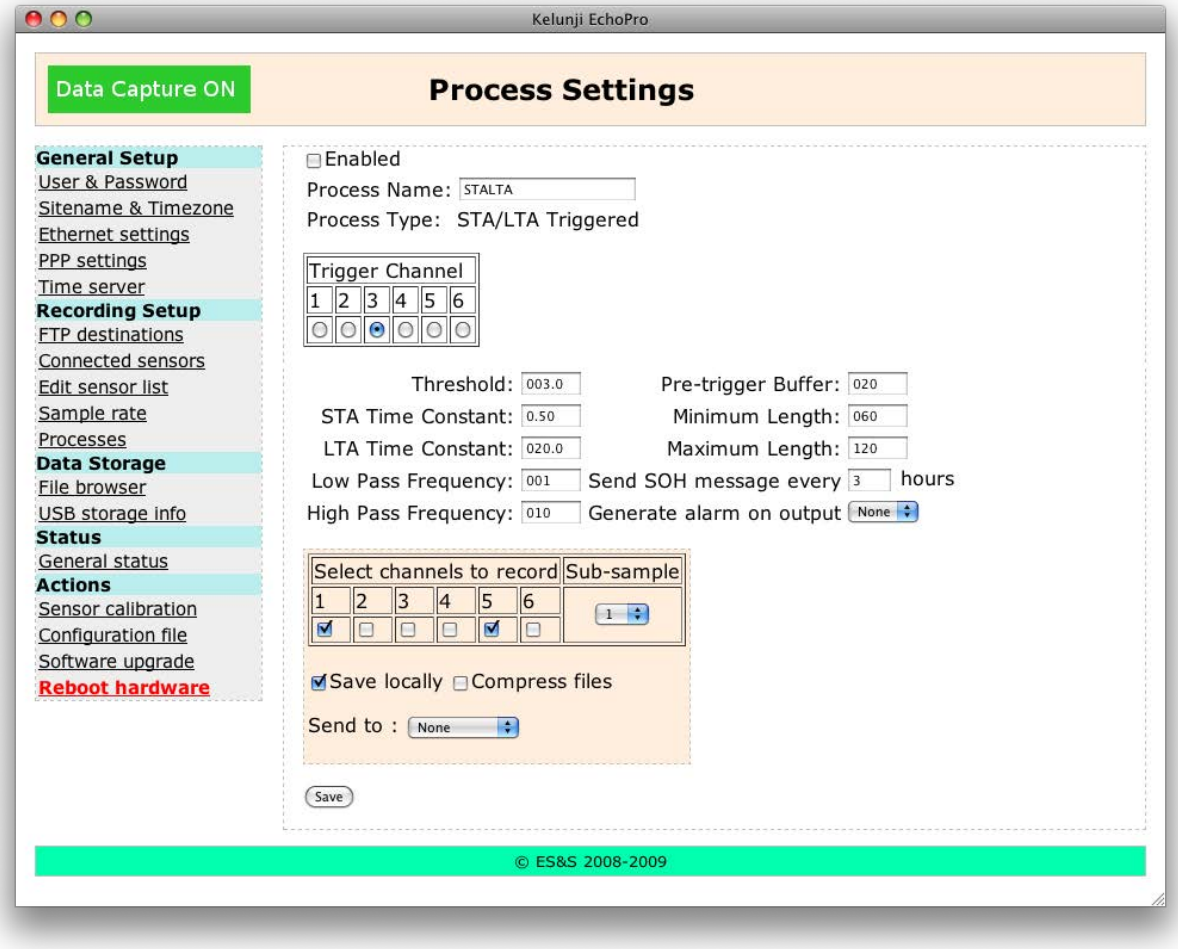
Sending data via FTP also takes up a portion of each minute. If any of the above three processes were expected to also send via FTP, there would have been no time to write the data to the FTP outbox, let alone spend time sending the data file during the minute.

Although 10 FTP destinations can be predefined, we recommend using only one or two at a time, depending on how much data is being sent each minute. Sending 6-channels of continuous 100sps data to an FTP destination is possible over a local network, but with a slower network connection the processes may fall behind and eventually lead to a watchdog restart.

Similarly, although 10 recording processes can be predefined, we recommend only using two or three at a time, again depending on the volume of data being recorded. The reason for having many processes defined is so that they can enabled and disabled as required without requiring repetitive data entry.

If you have pushed the recording/telemetry capabilities beyond their limits, you will eventually see an increase in the CPU load (see General Status screen) and the web/LCD interfaces will become less responsive. If the CPU load reaches 3, the recorder is operating outside of its processor abilities and a watchdog process will initiate a recorder restart. Unless the recording load is reduced, the recorder will continue to restart at regular intervals.

STA/LTA Triggered Recording Process



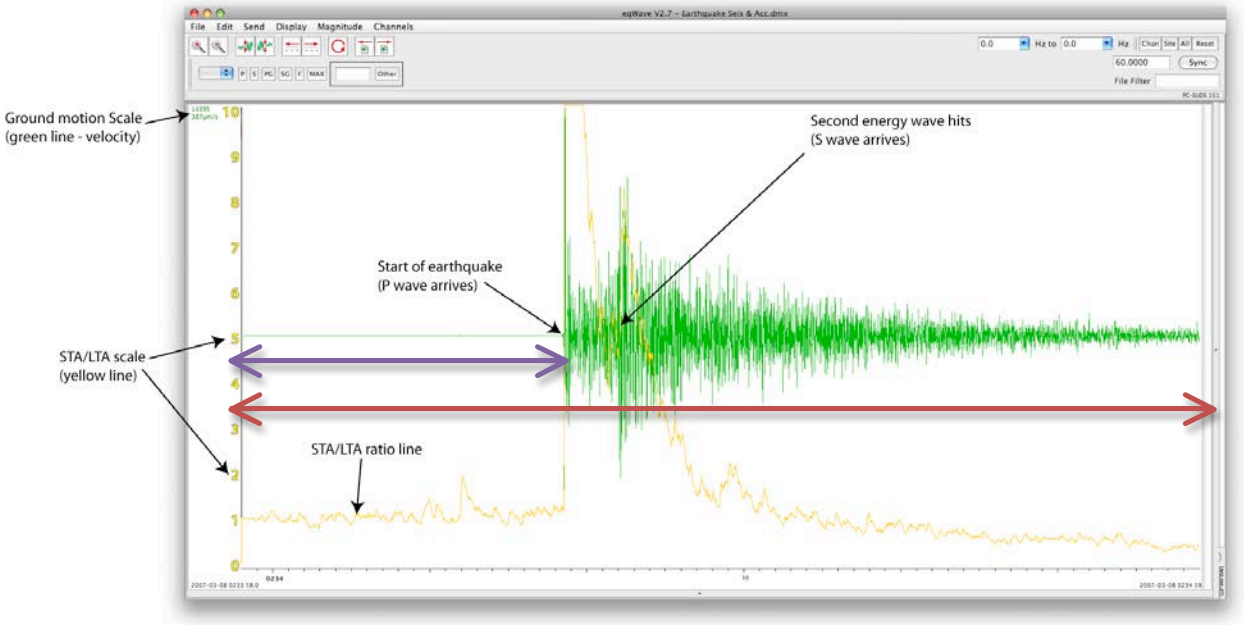
As with all recording processes, the Enable, Name and Type fields are shown at the top.

Select a **trigger channel** by clicking on one of the radio buttons. This is the data channel that will be compared against STA/LTA threshold.

The trigger **threshold** level is a floating-point number that relates to the ratio of STA to LTA. For example, if the short term average of the signal level is 30 counts and the long term average of the signal level is 30, the STA/LTA ratio is 1. If the short term average value suddenly increases to 300 counts while the long term average value is still 30, the STA/LTA ratio will be 10, which more than likely indicates an earthquake has occurred. For a quiet seismic station a typical value is 2 or 3, and noisier sites may need a higher threshold. A threshold value of 1 would make the recorder trigger continuously, so the valid range of values for this field is nominally 1.1 to 100.0.

Tip: The lower the threshold value, the more sensitive the triggering.

The signal ratio is calculated by comparing the **STA Time Constant** to the **LTA time Constant**, which are specified in seconds. Valid STA values are between 0.01 and 10.0 seconds, and valid LTA values are between 0.1 and 1000.0 seconds.



Shown above is a representation of the STA/LTA ratio (yellow line) during an earthquake (green line)
Also shown above are the pre-trigger buffer (purple line) and minimum record length (red line)

Note: The LTA setting must be higher than the STA setting, otherwise the ratio will mostly be 1 (or less) and the recorder will trigger continuously. Typically, the LTA is 10 to 20 times the STA setting to achieve reasonable signal level comparisons

The EchoPro will record all data from its sensors without filtering the signal, but you can filter what range of frequencies are looked at by the STA/LTA trigger routine. You can define the **Low Pass** and **High Pass Frequency** to specify the range of frequencies you wish to trigger on. For example, if the EchoPro is set to trigger only on signal content between 1Hz and 10Hz, signal with frequencies below 1Hz and above 10Hz will be ignored. This can be useful if your EchoPro is near a constant noise source (such as 50Hz or 60Hz from mains power, or a constant frequency from a generator or pump operating nearby) or to minimise recordings of low frequency teleseisms when you are performing microseismic surveys.

There are three different settings to define the length of the recorded file. The amount of data stored before the trigger time is known as the **pre-trigger buffer**, which must be an integer value between zero and 60 seconds. The EchoPro will stop recording an STA/LTA trigger after the **minimum length** of recording time, but not until the signal has returned to a level of twice that before the trigger was declared (or the **maximum length** record length is reached). This minimum and maximum record lengths must be greater than (or equal to) the pre-trigger buffer length.

The EchoPro buffers data to RAM while awaiting the end of the recording before writing the waveform to the USB storage. This buffer is shared by all recording processes. With only the STA/LTA trigger process running, at 2000sps the EchoPro can buffer 6 channels for 180 seconds. At up to 1000sps it can buffer 6 channels for 360 seconds. DataCapture will restart if the buffer overflows. If this happens, try reducing the amount of data being buffered.

If you have set up your recorder to send triggered data to you via FTP, you may wish to know its state of health (SOH) even if it hasn't triggered for some period. You can force the EchoPro to **Send SOH message every** so often as a sign that the recorder is still online even if it hasn't triggered. The default value is 24 hours, but you can turn off this feature by setting it to zero. You can enter any integer value up to 999 in this field.

The final setting before defining the data storage location is to select the alarm output function. There are two alarm outputs that can be triggered by an STA/LTA Trigger process, and this function is described below.

Alarm Output from triggered events

Both triggering processes (STA/LTA and Level) have the ability to generate an alarm when a trigger is declared. For example, if you wish to control a warning light or siren when a certain level of ground motion is exceeded, you could use an alarm output with a Level trigger process.

The EchoPro has two alarm outputs, and each recording process can drive one alarm output. Multiple recording processes can drive the same alarm output.

The alarm output is on whilst the process is triggered, and turns off when the maximum record length is reached.

The alarm outputs are FET drivers, open-drain outputs, low-side switch, capable of switching loads up to 2A at 40V.

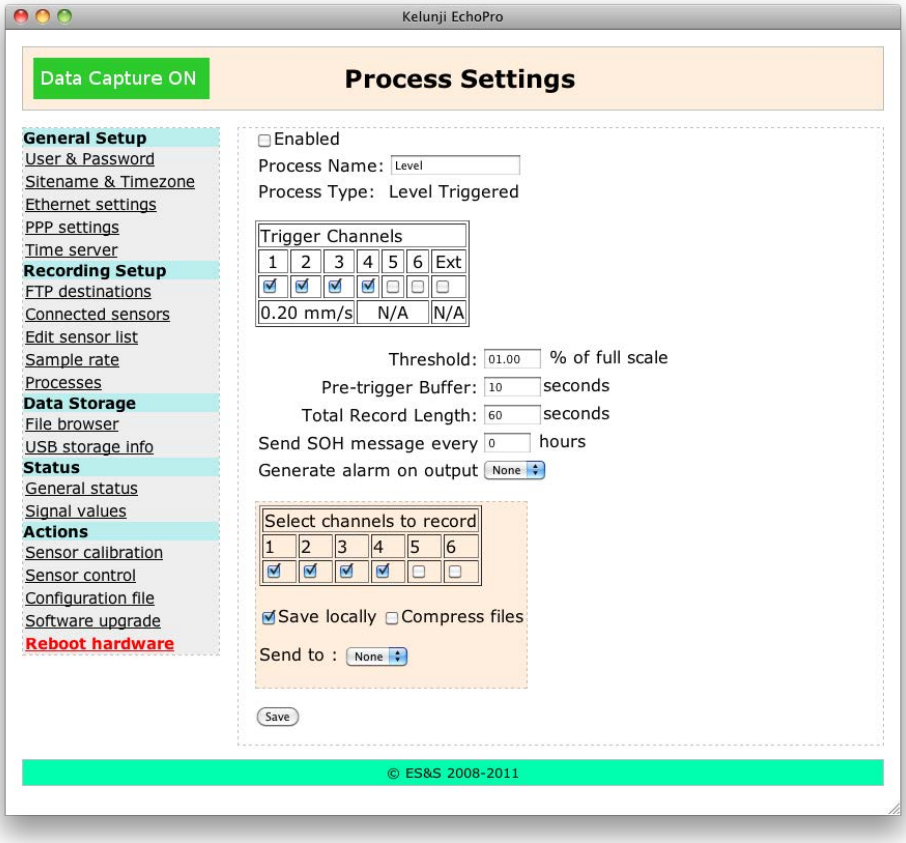
The alarm output is an 8 pin header socket on the main PCB, and the alarm signals are wired as follows:

Alarm output 1: pin 4, ground on pin 3

Alarm output 2: pin 2, ground on pin 1

To complete the STA/LTA process settings, you need to tell the EchoPro how you wish to store the data. See the previous section on "**Storing Files**" for further information.

Level Trigger Process



As with all waveform recording processes, the Enable, Name and Type fields are shown at the top. Select one or more **trigger channels** by ticking the channel boxes that will be compared against the trigger threshold. The last-saved trigger threshold for each sensor port is displayed in sensor units (m, m/s, g, Pa, or rad/s) below each three-channel group, so you can use this figure to refine your trigger threshold percentage.

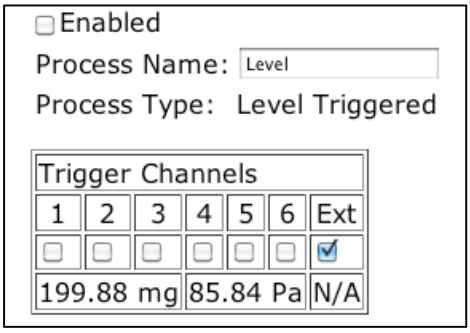
The trigger **threshold** is specified as a percentage of the full scale range of the input port. This applies to any sensor that you are checking against the threshold, regardless if it is measuring ground motion, air pressure, or some other parameter.

The time in the **Pre-trigger buffer** (up to 60 seconds) is part of the **Total Record Length**, which is an integer value giving the number of seconds of data that will be recorded in the file. The total record length needs to be at least the length of the pre-trigger buffer, and can be up to 360 secs when recording 6-ch at up to 1000sps (or 180 secs for 6ch at 2000sps).

As described in the STA/LTA trigger settings section, you may also **Send SOH message every** so often and **Generate an alarm output** on alarm ports 1 or 2 . The alarm will stay active from the trigger time until the end of the record.

To complete the Level process settings, you need to tell the EchoPro how you wish to store the data. See the prior section on "**Storing Files**" for further information.

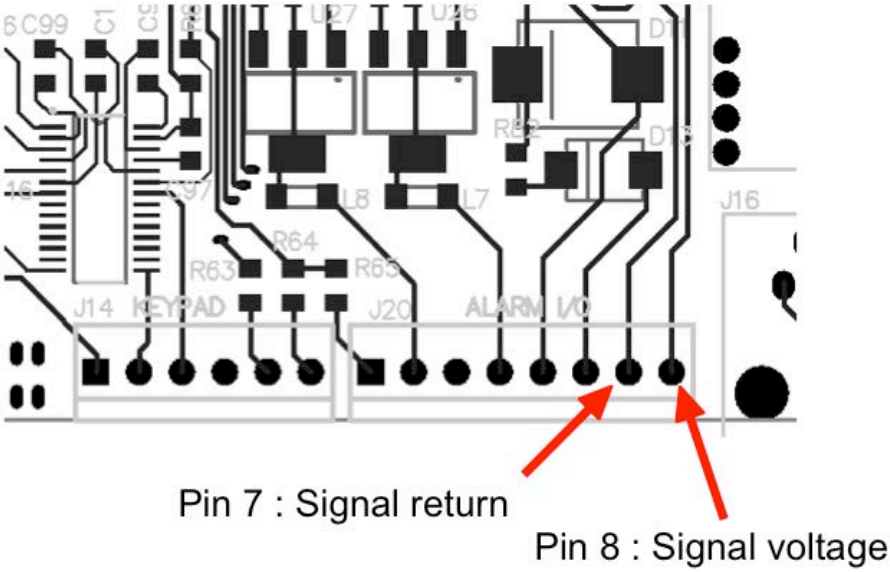
External input triggering



Level triggered processes now have the option of being triggered by an external event. This allows third-party equipment to be used to initiate recording. Such an event could be the closure of a relay, or the digital alarm output from some other hardware. The external input channel cannot be recorded. It is used solely to initiate recording on real data channels.

To enable external triggering, tick the **Ext** trigger channel box in a Level trigger process.

The external level triggered input is optically isolated, and requires two connections to be made to pins 7 and 8 of J20 on the main (EK) circuit board as shown below.



In order to initiate recording, a voltage must be applied between pins 7 (-ve) and 8 (+ve). This voltage must be greater than 3V, and less than 50V. The return path is not connected to ground on the EK board, and must be connected to ground at the external source.

Once the external voltage exceeds the threshold, the process will be triggered and recording will commence. Note that this input is not precisely timed, and should not be used as an accurate indication of the time the event occurred. A pre-trigger buffer should be configured if using an external level triggered source.

An external alarm input connector can be factory fitted to the EchoPro case as an extra cost option and can be retro-fitted to existing recorders. EK boards of version 2.01 and earlier require additional hardware modifications that must be done by factory-trained technicians.

Data Storage

This group of web pages deals with the USB data storage. You can browse through your recorded data and see information about the USB memory device.

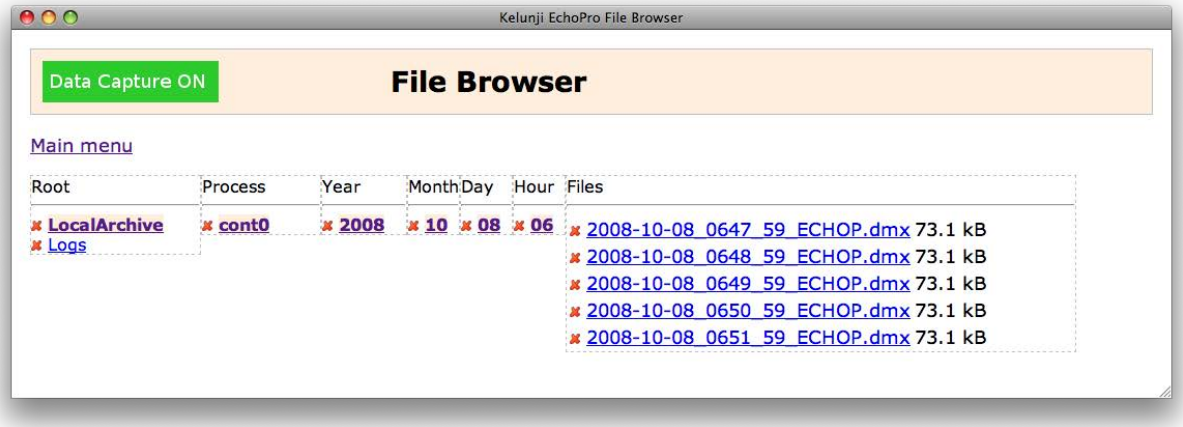
File Browser

Data is stored on the USB storage device in a cascading file hierarchy.

A folder at the top level of the hierarchy is called **Logs** and contains a number of files that record various information, such as a list of triggers (for display to the LCD), the GPS position strings, and telephone connection information.

Another folder at this top level contain will be your **LocalArchive** folder, and enclosed folders are named according to their function and process slot number: eg. **cont0** is the first slot which is a continuous recording process, **stalta1** is the second process slot which is an STA/LTA recording process, **level2** is the third slot which is a level trigger recording process, etc.

Within each of these process folders, data will be organised into nested folders by **Year**, **Month**, **Day**, and in the case of continuous data, **Hour**.



As you click on a folder, it will open its subdirectory and become bold to show the folder trail to the current folder. Files will be shown as links with their file size displayed in bytes.

The other folders to appear at the top level will be the FTP folder. If an FTP destination is enabled and a recording process is sending data, a folder called **ftp1** will be created. Within this folder will be a folder named after the recording process (eg cont0, stalta1, etc) which contains the data generated by that process that is to be telemetered via FTP.

Clicking on a red cross ✘ will delete that file or folder (and the folder's contents).

Click on the **Main menu** link to exit the file browser.

Data Retrieval

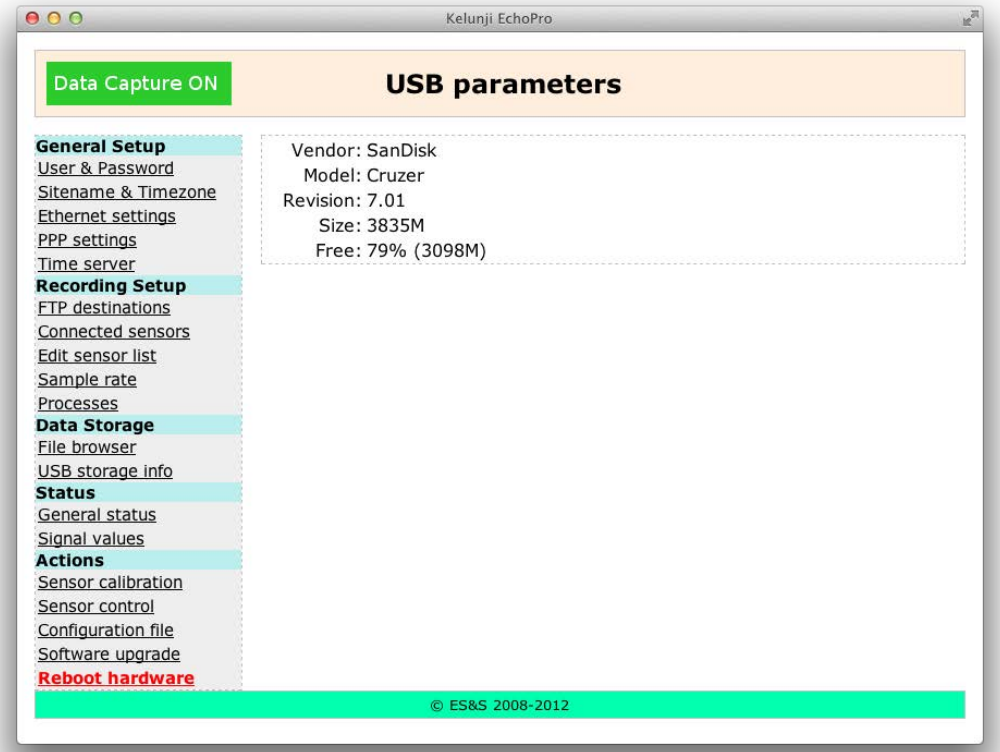
Clicking on a filename using the File Browser will cause the file to be downloaded to your computer. You can then use the eqWave software application to view the waveform.

To download entire data folders or multiple files, you can connect to the EchoPro using an FTP Client software package (such as FileZilla Client) and connect to the recorder's IP address using the login "root" and password "secretSEIS".

The other method of data retrieval involves physically removing the USB storage device from the EchoPro and inserting it into a computer's USB socket. The USB device will appear as removable hard drive. When you open this drive, you will see the **LocalArchive** folder, which contains the **Process** folders, and within these are the **Year, Month, Day** and (for continuous processes) **Hour** folders, which will take you to the individual data files. Navigate through to the folder or file you wish to retrieve, and copy it to your computer.

USB Storage Info

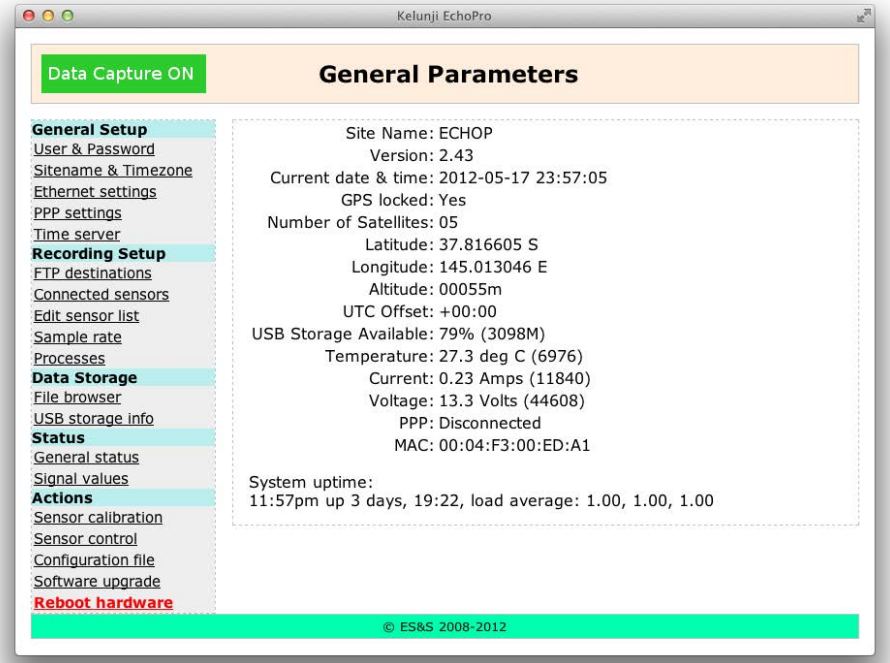
You can check the manufacturer, capacity and other information about your USB storage device using this information page. Importantly, it also shows the free memory as a percentage of the total capacity as well as the number of megabytes remaining.



Status

General Status

This web page presents some general information about your EchoPro seismic recorder. This summary includes the **Site Name**, software **Version** number, the **date and time** of the recorder when this web page loaded, whether or not the clock is **locked to GPS** time, the number of GPS satellites visible by the GPS aerial, the GPS position (**latitude**, **longitude** and **altitude**) and the current **UTC Offset** setting.



The amount of free memory on the **USB storage** is shown as a percentage of total capacity and in megabytes. The value read from the **Temperature** sensor on the main PCB is displayed. This sensor is located near some power circuitry, so the temperature can be significantly higher than the ambient temperature outside the EchoPro. Other sensors on the board read the power consumption of the EchoPro in **Amps** and the input **Voltage**.

The status of the **PPP** connection is also displayed, which can be useful when setting up your recorder to use PPP in the field to check whether or not a connection has been made.

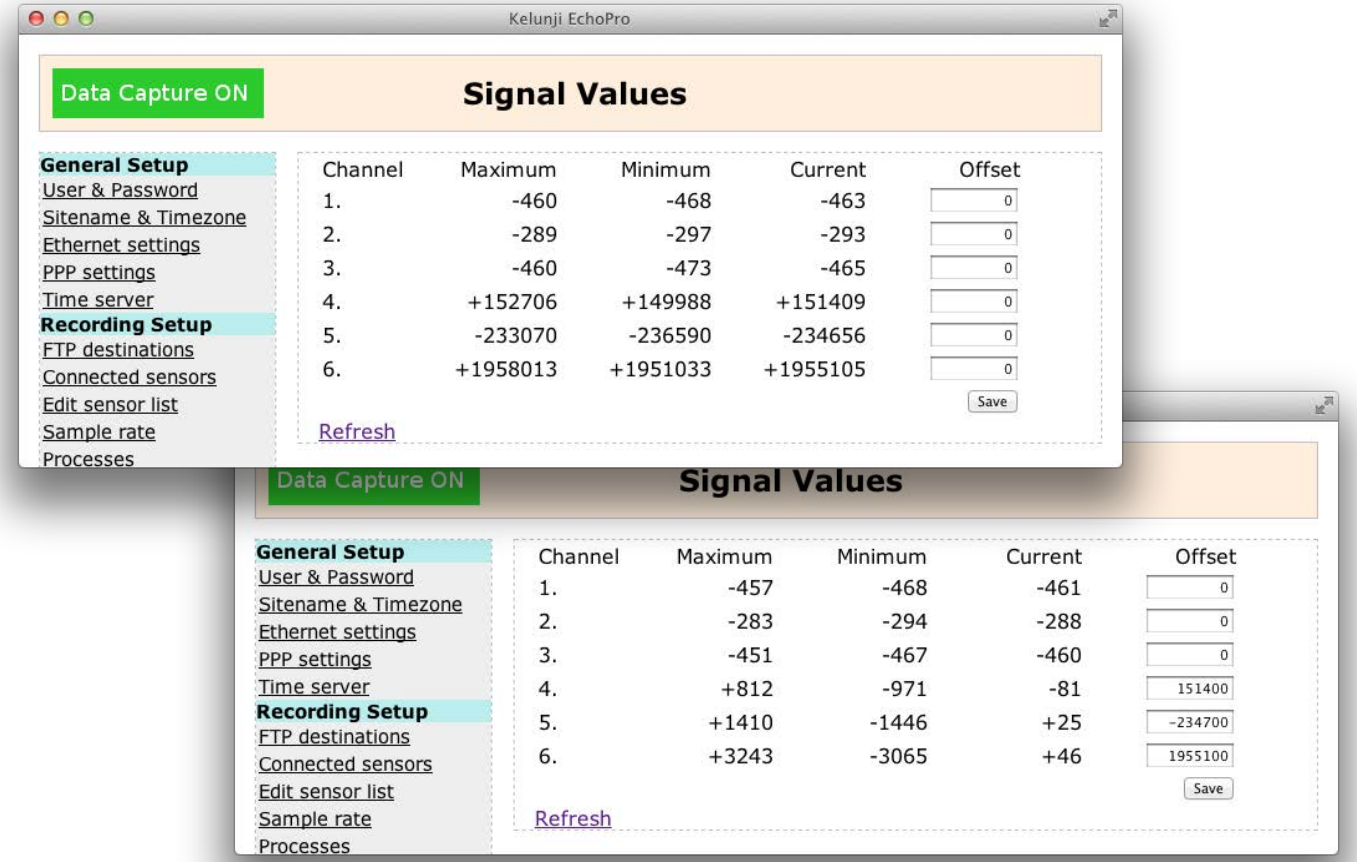
The **MAC** address of the device's Ethernet port is also displayed.

The last line shows the **system uptime** and the average CPU workload for the past 1, 5 and 15 minutes. Without DataCapture running the load will be close to zero, but in normal operating conditions the load will be between 1 and 2. If the load exceeds a value of 3, an electronic watchdog will restart the recorder to avoid system lock-up.

Signal Values

To check that all of the channels of your sensors are working as expected, you could start a continuous recording process for all channels and wait a minute for some sample data, but by clicking on Signal Levels under the Status section you can see a quick snapshot of the input levels for each channel. The Maximum and Minimum signal level in the last second is displayed, as is the Current signal level at the time the page was loaded (or refreshed).

The table displays the raw signal level from the Analogue to Digital Converter (ADC) which has a range of ±8,388,608 counts. To display the current values, click on the "Refresh" button on the screen or in your web browser.

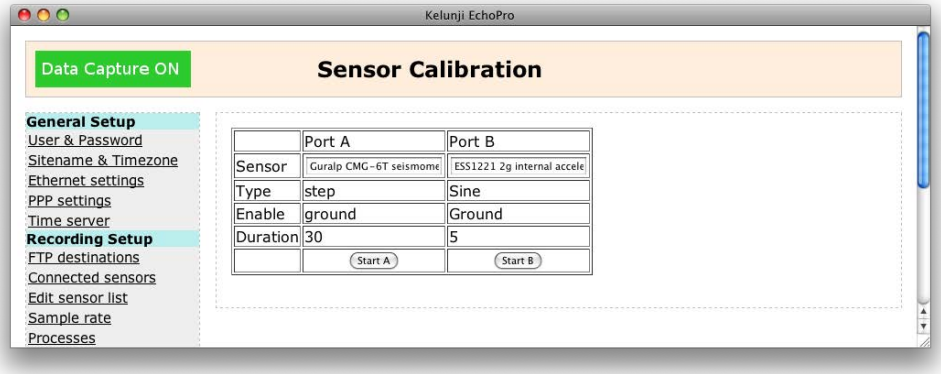


If your sensor is not perfectly level, or if you are using an accelerometer that does not compensate for gravity (such as the ESS1221 internal accelerometer), the Current values may not be close to zero. By typing in the amount of Offset you are seeing, the recorder will remove the offset from the raw data. This is particularly useful when using Level triggering with sensors that have large offsets that would otherwise continuous trigger the system.

Actions

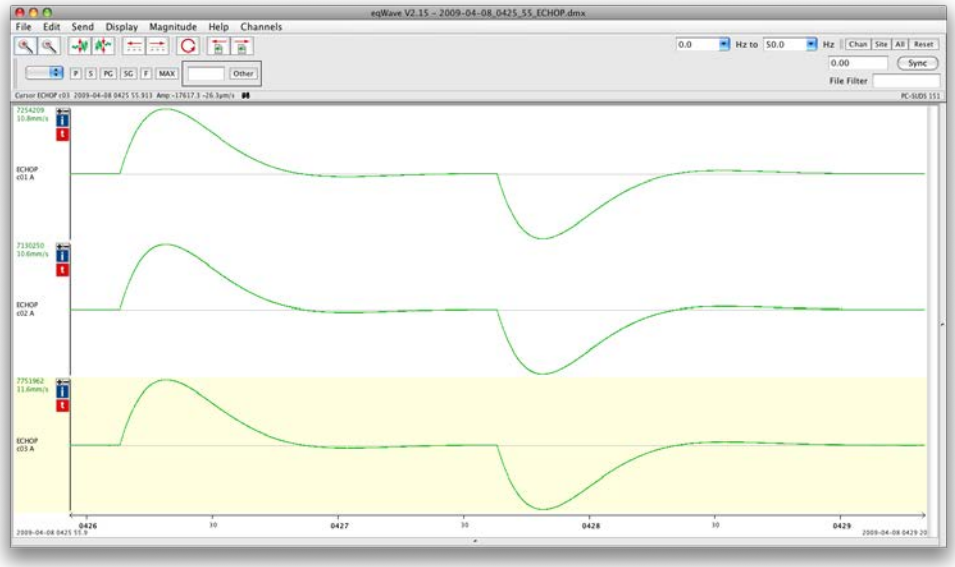
Sensor Calibration

The EchoPro can generate a calibration pulse to be sent to your sensor. This pulse is usually a step signal for seismometers and a sine wave for accelerometers. The EchoPro will generate one of two **types** of signal: a 1V step pulse or 1V 1Hz sine wave, for the **duration** specified in the sensor setup, after which time the signal will cease.



When you click the Start button to send a calibrate signal to your sensor, pin U on the sensor connector will be set to either Ground, 5V, or left open, depending on the cal **enable** setting in your sensor definition. The cal enable will remain set for twice the duration of the calibrate signal to allow for post-calibrate-signal component response.

When the calibrate signal is on, the EchoPro will output the voltage step or sine wave to pin J on the sensor connector.



A sample calibration recording is shown above. This is the result of a XL step being sent to a Guralp CMG-40T 30-second period seismometer The calibrate step duration in this case was 90 seconds

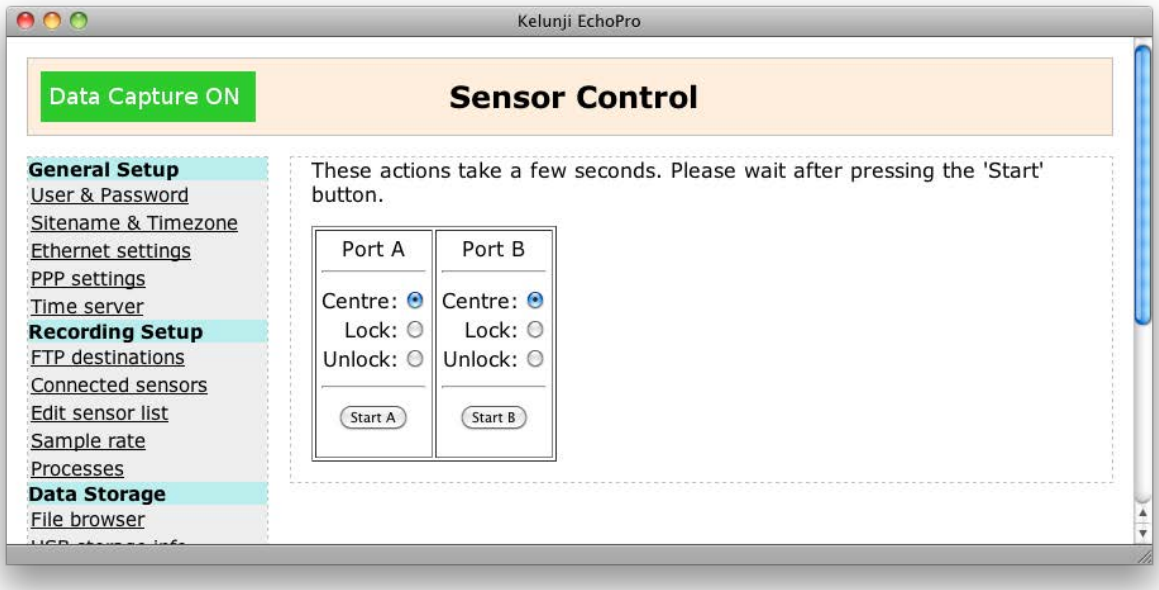
Where the Calibration File is stored

The EchoPro will record the calibration signal using the active recording processes. A continuous recording process will record data in 1-minute files, and the triggered processes will record the data according to their pre-trigger buffers and total recording lengths. You must have a recording process running if you wish to record your calibration response.

We suggest setting up a Level Trigger recording process with a threshold of 1%, pre-trigger buffer of 5 seconds, and total record of two to three times the calibrate duration. Every calibration recording will then be stored into this process folder.

It would be equally simple to enable a continuous recording process before you initiate the calibration sequence, then disable it after the recording duration you require.

Sensor Control



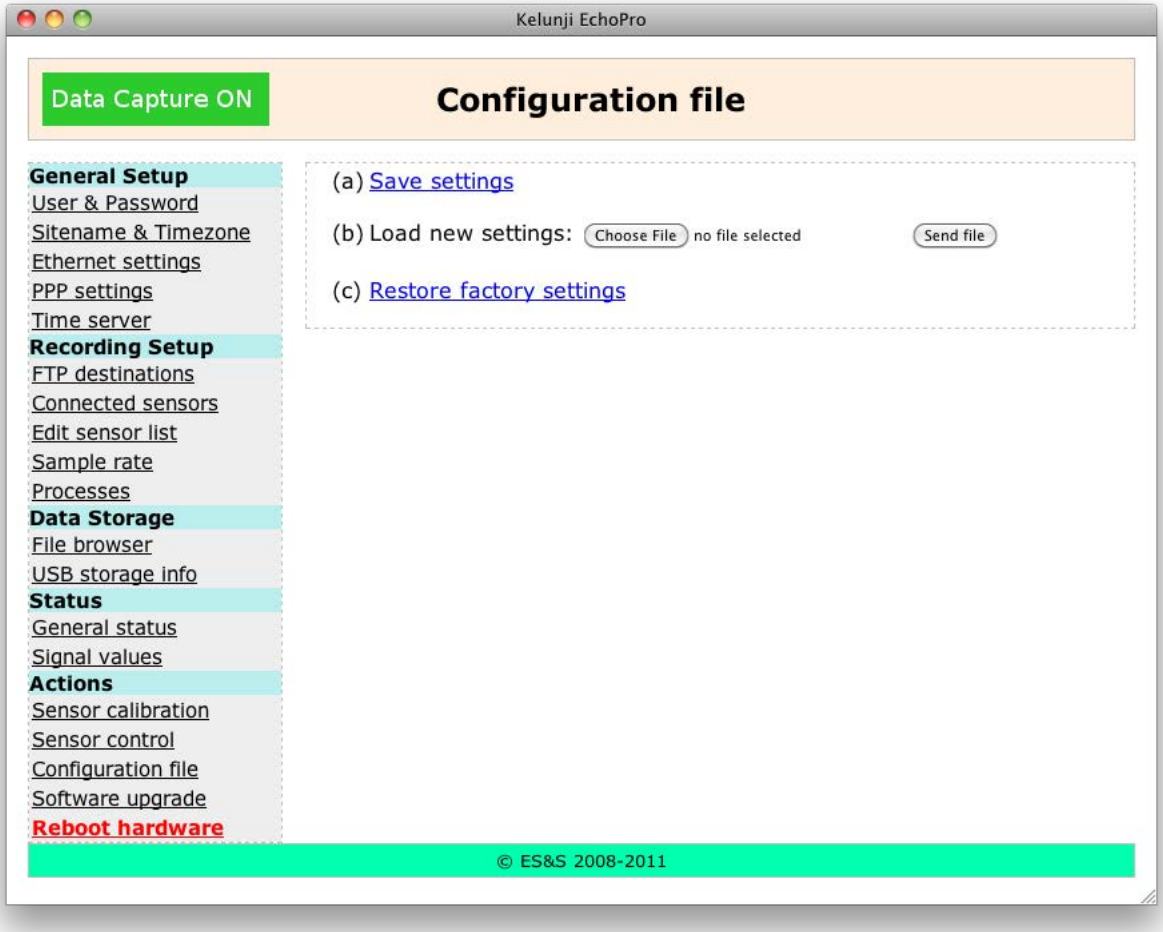
A new menu item on the main user interface screen appears under **Actions** and allows the user to remotely lock, unlock, an re-centre the mass of a Guralp CMG3-ESP or CMG-3T seismometer. This feature is only available on sensor interface boards manufactured after September 2010. The commands connect the relevant control line (pins N, P or R) to power ground (pin B) for 7 seconds. As a guide, the sensor locking process takes just a few seconds, but the unlocking and mass centering process can take up to several minutes to complete as the sensor automatically refines its mass positions.

To check that the masses are locked, go to the **Signal Values** screen and check that the components are at full scale.

Configuration File

All of the settings you've entered into the EchoPro are saved in a single Configuration File. This file can be downloaded and reloaded into the recorder at a later time. This function enables you to have a number of preset instrument configurations on stand-by, which you can then load into an EchoPro for immediate configuration.

Note: Configuration files generated by versions of the firmware prior to v2.38 cannot be used in version 2.38 or later.



To download the current configuration file, click on the **Save Settings** link. A file called "**echopro.ini**" will be saved to your computer's browser download folder.

To load a configuration file into the EchoPro, click the **Choose File** button, then browse your computer's file system until you find the Configuration file you wish to use (it doesn't need to be named "echopro.ini" – it can be named anything you like, eg. "aftershock setup.ini"). When you are returned to the web browser window, click on **Send**. The file will be uploaded to the EchoPro and all settings will be changed immediately. You will need to restart the EchoPro for these settings to take effect.

Finally, you may wish to **Restore Original Factory Settings** by clicking on the link. All of your custom settings will be lost, including FTP destinations and Processes. Importantly the Ethernet settings will also revert to factory default, so if you have been communicating with the EchoPro on a different IP address you will need to reconnect using the default IP address (172.16.5.120). The factory settings will be put into effect when the EchoPro is next rebooted, although some settings may take effect if you restart Data Capture.

Warning: **If you restore original factory settings** when you are communicating with the EchoPro over an Ethernet based remote communications link **you will need to change the Ethernet settings from the default values to your required Ethernet settings before restarting the EchoPro**. If you do not do this, you will probably not be able to communicate with the EchoPro after the recorder restarts as the EchoPro will otherwise use the default IP address upon reboot, which will no doubt have been changed to suit your communications link.

Restore Factory Defaults via USB

This feature has been in the firmware code since version 2.11. You have always been able to restore the factory defaults via the web interface, which is under the **Actions** section within the **Configuration File** menu. If for some reason you cannot access the web interface you now have a way to restore the EchoPro to its factory default settings by physically forcing the command using a file on the USB storage memory.

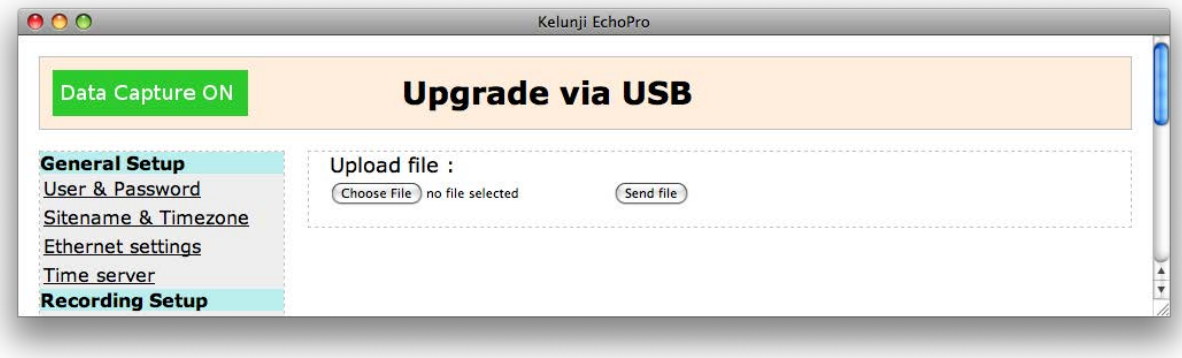
Using your PC, simply create a file (not a folder) with the file name **factorydefaults** (with no file extension) in the root directory of the USB device. While the recorder is not powered, insert the USB device and then power up the recorder. Upon start-up the recorder will look for this file, and if present it will restore the recorder to factory defaults and then delete the file from the USB device. It will then complete the boot process with the default settings.

WARNING! This will reset the network settings also, so you will need to reconnect using the IP address 172.16.5.120. The network settings are not affected when the "restore factory defaults" function is initiated via the web interface menu item.

Software Upgrade

You can upgrade the EchoPro software remotely via Ethernet or by placing the software upgrade file on a USB storage device and inserting it into the EchoPro. In the latter case, upon start-up the EchoPro will scan the top level folder of the USB storage device and if it detects that the software upgrade file is newer than its own software it will automatically perform the software upgrade and then automatically reboot the recorder when complete.

The procedure to upload the software upgrade onto the connected USB storage device over Ethernet using the web interface is detailed below.



Click on **Choose File** to open a file browser window. Navigate to the folder containing the software upgrade file, which will be called "**echopro-upgrade.zip**", and select it. When you are returned to the web browser, click on the **Send File** button to copy the file to the USB storage device. **Ensure the file is the original ZIP archive**, not an unpacked folder.

Once complete you will need to **Reboot Hardware**. Upon startup the EchoPro will check the USB device for new software, unpack and upgrade the firmware, delete the upgrade file, and then reboot again. This process takes a few minutes, after which you can reconnect using the previous IP address. Check that the firmware version number has incremented.

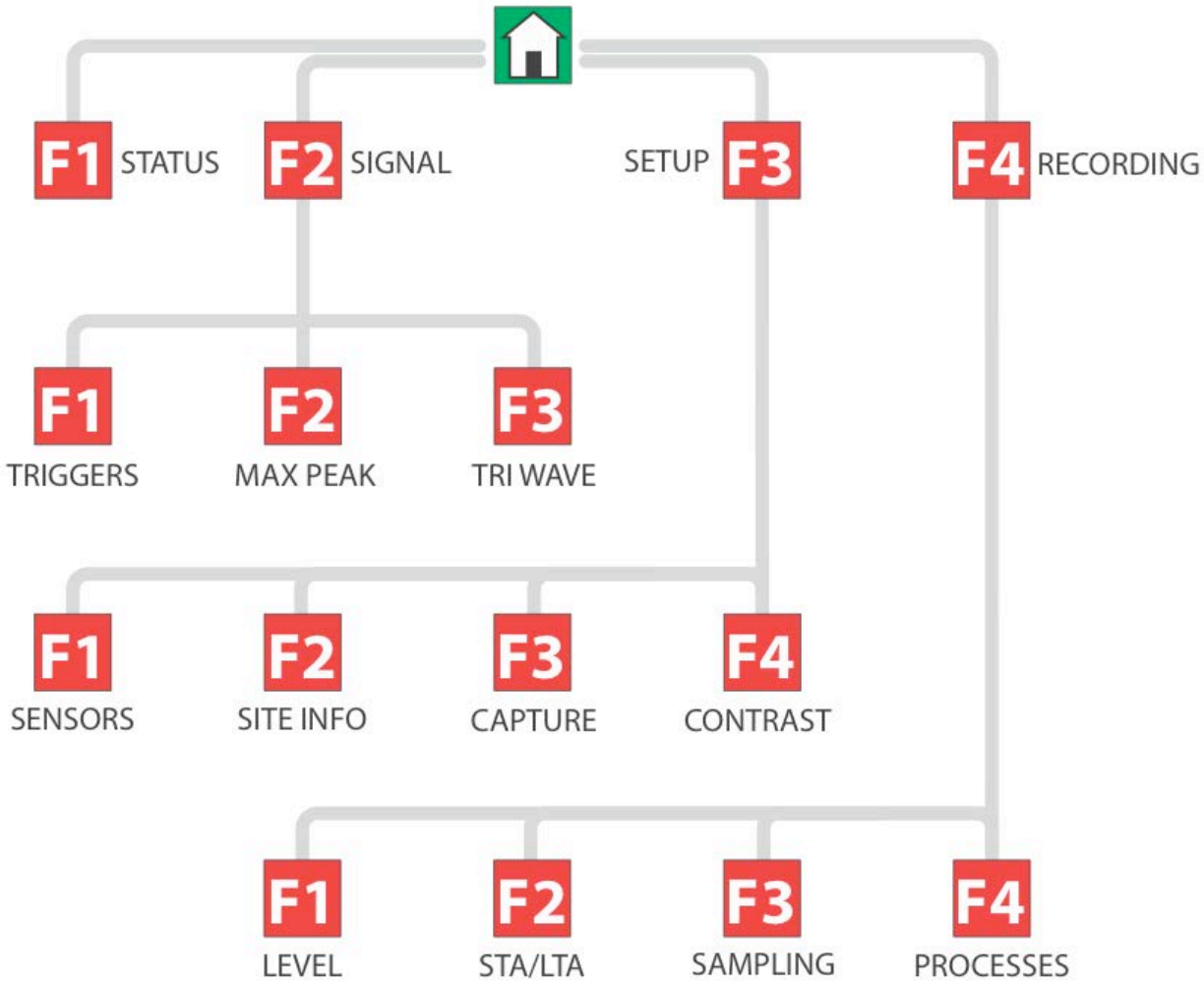
Note: Upon restart after a firmware upgrade, the **EchoPro will revert all settings to default values**, with the exception of the Ethernet settings, which will be retained so that a remotely upgraded EchoPro will still be able to be contacted after the upgrade.

WARNING! **Do not update to V2.24 (or later) over a PPP link.** Although the PPP settings are retained, when the EchoPro reboots the PPP session will end, and as there will be no processes using FTP enabled, and no FTP destinations defined in the default settings, the EchoPro will have no reason to establish a PPP connection and will be unreachable.

Kelunji EchoPro with LCD & keypad

The LCD interface is designed for use with a 6-channel recorder, and deals with sensor Ports A & B only. To setup the sensors connected to Ports C & D, and to add these sensors to recording processes, you will need to connect to the recorder via Ethernet and use the web interface to change the settings.

LCD Menu Map

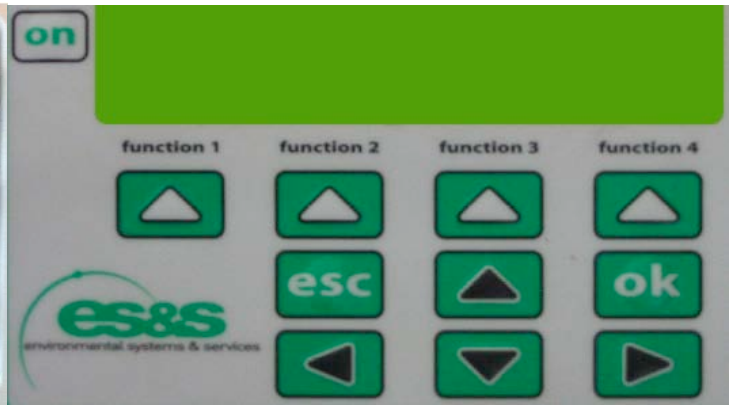


Using the Keypad

As a general rule, pressing the ESC key will take you back one menu level, and selectable menu items are listed across the bottom of the screen which should correspond to one of the Function keys (F1 to F4).

If you have an EchoPro with internal keypad, you will see the keypad shown below left. If you are using an external keypad, you will see the membrane keypad shown at right.

internal keypad



external keypad

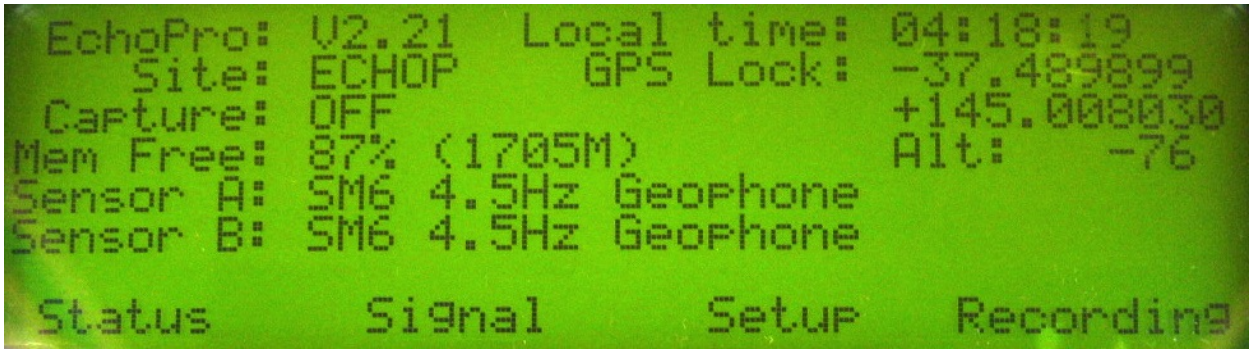
The main difference between the two is the addition of the green HOME key on the internal keypad, which takes you back to the home screen from any menu level.

The internal keypad LCD panel is always powered up. The LCD backlight dims after two minutes, but it can be reactivated by pressing the blue LIGHTBULB key.

The external keypad LCD panel will completely switch off after two minutes (unless you are on a waveform display screen). By holding down the ON key for a second you can power up the display again.

When you first switch on the EchoPro, the LCD will display the EchoPro logo for 45-60 seconds while the Linux operating system boots up and starts the recorder modules. Once start-up is complete, the home screen appears.

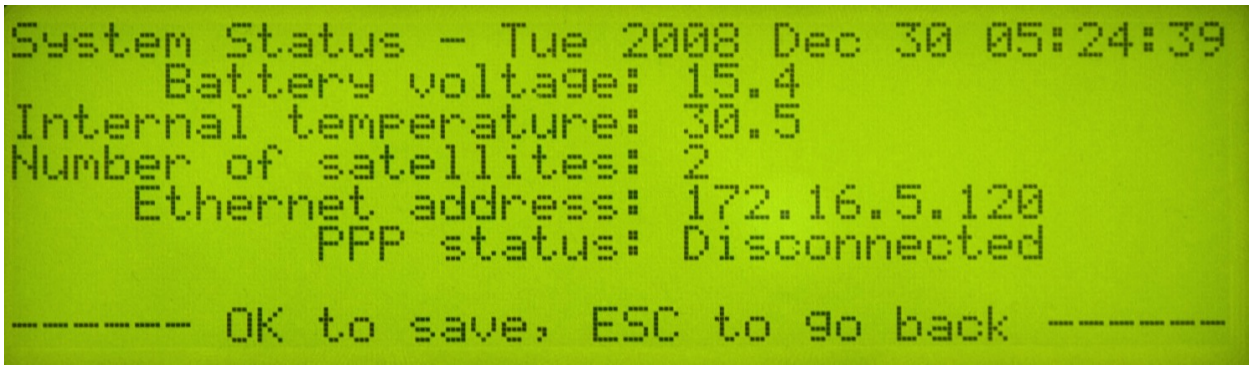
HOME



- At the top of the left column is the EchoPro firmware version number (eg V2.21)
- The next item down is the recorder's site code (default: ECHOP)
- "Capture" indicates whether or not Data Capture is running (ON or OFF). If ON, the current sample rate is displayed
- The amount of memory free on your USB drive is shown as a percentage (and in MB)
- The next line shows the sensor type connected to Port A (RHS of box, near handle)
- The next line shows the sensor type connected to Port B (RHS of box, near hinge)
- At the top of the right column the time is displayed and updated. By default this is UTC time, but if you have entered a local time offset it shows your local time
- GPS Lock will show "NONE" until locked, at which time it will show the GPS position of the instrument with latitude, longitude and altitude (in metres) shown in a column

Four menu items appear at the bottom of the screen, which correspond to each of the function keys (F1 – F4). The function of these menus are explained below.

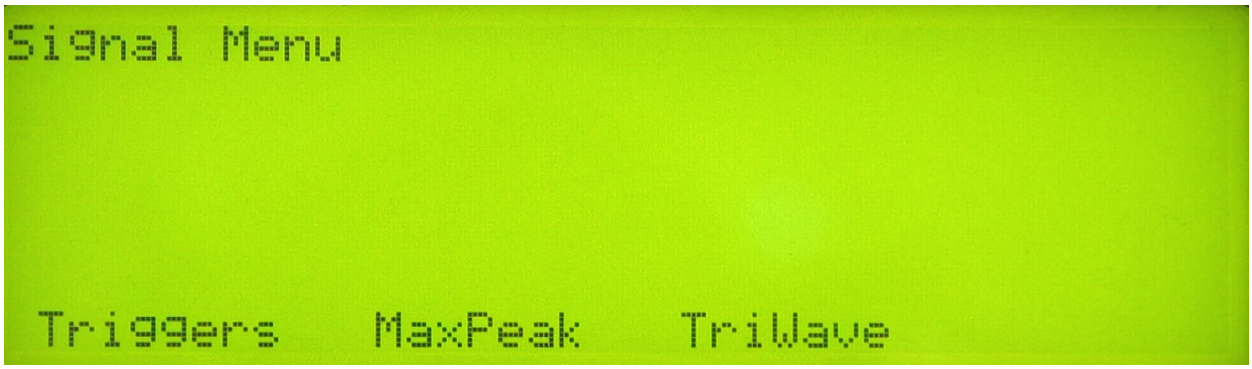
HOME > STATUS



In addition to the state of health information displayed on the home page, here you can view the recorder's battery voltage, temperature of the PCB, the number of satellites visible by the GPS, the Ethernet IP address, and the current status of the PPP connection.

HOME > SIGNAL

Hitting F2 from the home screen takes you to the Signal menu, which gives you three options: view a list of triggered event files; monitor the real time maximum peak value on each channel as well as a single channel of graphical waveform in real time; or view a three-channel waveform in real time from a sensor port.

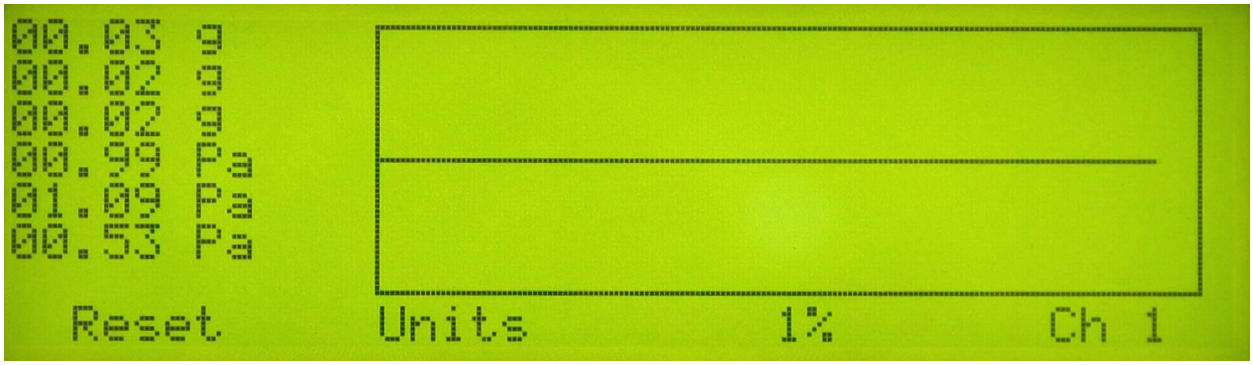


HOME > SIGNAL > TRIGGERS

The Triggers page shows a chronological list of triggered events (whether these have been triggered by the STA/LTA or Level trigger algorithms), with the peak amplitude recorded for each channel displayed. The UP/DOWN arrows scroll through the pages of the trigger list.

This display was implemented specifically for the blast monitoring application, where a three channel ground motion sensor and a single channel microphone is being used, hence the four channel value display. Channels 1, 2, 3 and 4 of the 6-channel digitiser are displayed and labelled to indicate **L**ongitudinal, **T**ransverse, and **V**ertical channels of the ground motion sensor, and the microphone signal **A**mplitude.

HOME > SIGNAL > MAX PEAK



This page displays a real time trace from one of the sensor channels, as well as the peak value recorded on channels 1 to 6 (sensor Port A & B) since the screen was entered.

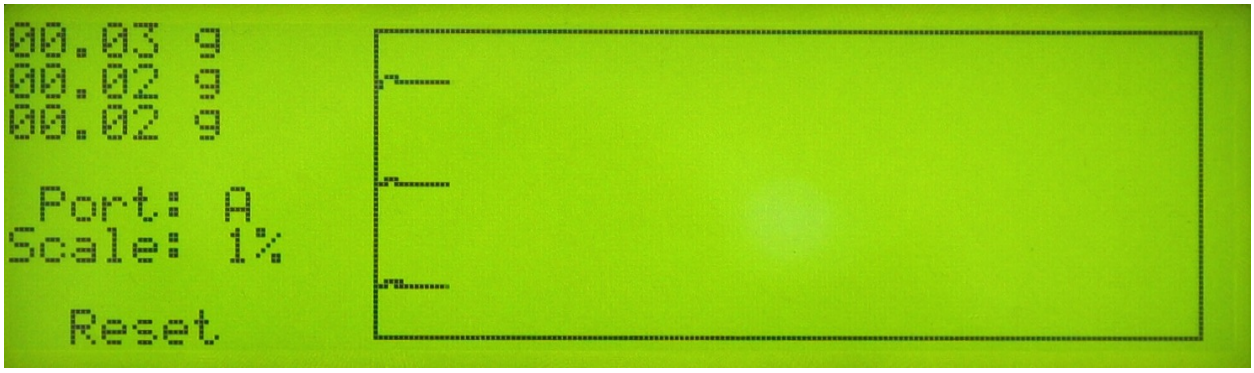
The F1 key will reset the peak values to zero.

The F2 key will toggle the acceleration units between m/s/s and g.

The F3 key or UP/DOWN arrow keys will change the scale of the waveform display, with the displayed scale (default 1%) indicating the percentage of the recorder's full scale input displayed in the waveform window.

The F4 key or LEFT/RIGHT arrow keys will change which channel is being displayed on the real time trace. Press ESC or HOME to exit this screen.

HOME > SIGNAL > TRI WAVE



The Tri Wave page is similar to the Max Peak page in that it displays the peak motion values and displays a realtime waveform, but in this case we deal with a single 3-channel sensor port, displaying all three channels of waveforms and the three peak channel values.

Again, the F1 key will reset the peak values to zero.

The F2 key will toggle the acceleration units between m/s/s and g.

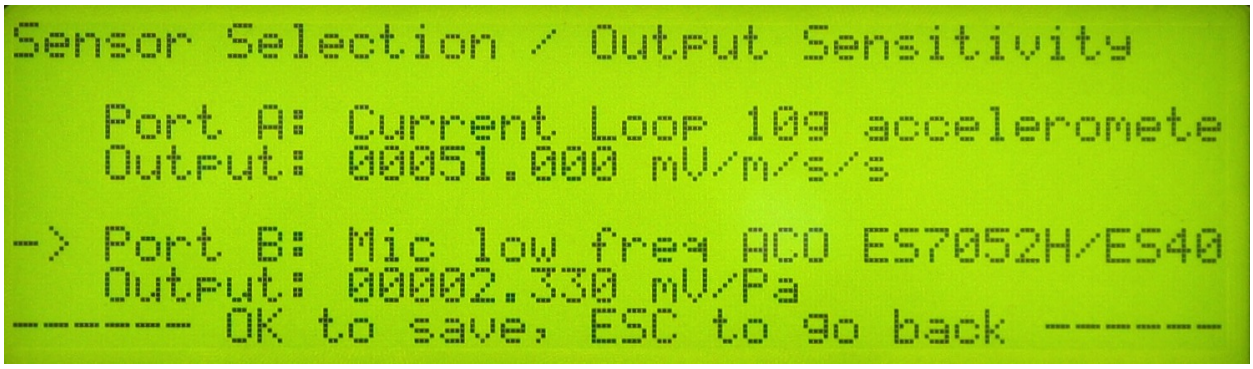
The F3 key or UP/DOWN arrow keys will change the scale of the waveform display.

The F4 key or LEFT/RIGHT arrow keys will swap the display between Port A and Port B.

HOME > SETUP

Pressing the F3 key from the HOME page will take you to the first settings menu. You can access the four settings screens shown across the bottom of the screen by pressing F1-F4. A description of the contents of each sub-menu is shown on the main screen.

HOME > SETUP > SENSORS



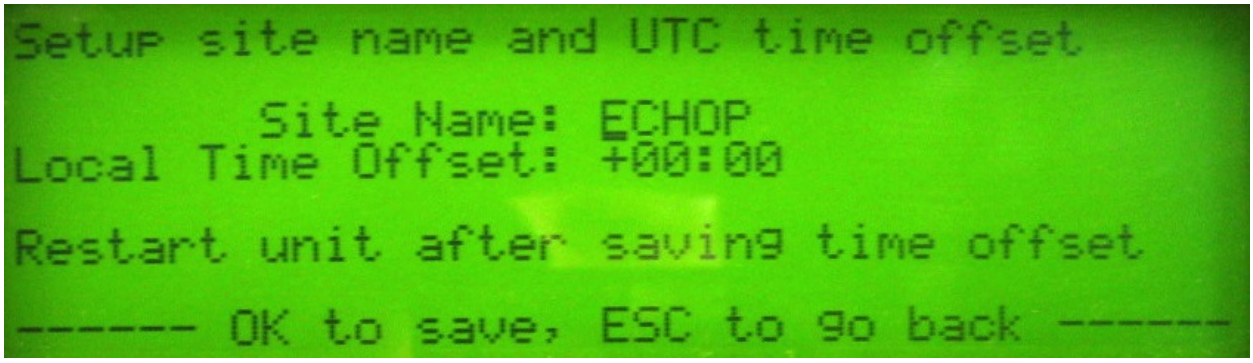
The sensors connected to Ports A and B can be selected and their sensitivities modified using the LCD interface. The arrow on the left side of the screen shows you which line your cursor is on. When your cursor is on **Port A** or **Port B**, you can scroll up and down through your pre-defined sensor list using the UP and DOWN arrow keys.

To move to the **Output** line, press the RIGHT arrow, and you will then see your cursor is under the first (left-most) digit of the sensitivity number field. You can change its value by using the UP and DOWN arrow keys, and you can move between digits by using the LEFT and RIGHT arrow keys. When you are on the right-most digit, pressing the RIGHT arrow key will take you to the next line. If the output value is greater than 999 mV per unit, the display will automatically display the value in V per unit and move the decimal point.

If you change the sensitivity value of a sensor, this change will also be reflected in the web interface, which you can check by going to Edit Sensor List and seeing the modified value.

To save any changes you must hit the OK button, otherwise ESC will take you back one menu level and leave the settings unchanged.

HOME > SETUP > SITE INFO



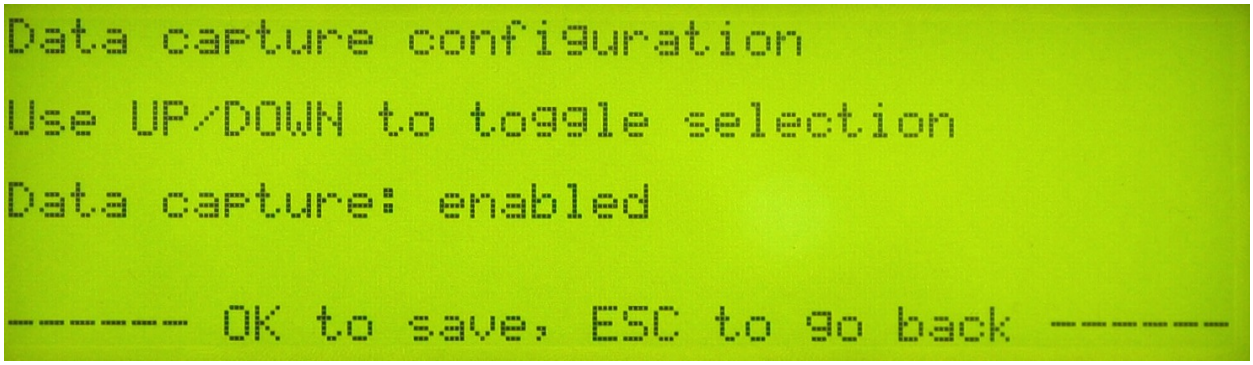
You can change the side code of the recorder by simply using the UP and DOWN arrow keys to scroll through characters A to Z, 0 to 9, and <SPACE>, and using the LEFT and RIGHT arrow keys to move between the five character positions available. When on the rightmost character position, pressing the RIGHT arrow will move the cursor to the next line to edit the local time offset.

By default, the local time offset is set to +00:00, which means that all data will be recorded using UTC (Universal Time Coordinated, as read from the GPS). If you wish to have data file names recorded with local time instead, enter your local time offset (from UTC) using the arrow keys in the same way as above. Time zone correction allows for 30-minute resolution.

Once saved, the new site name will appear at the end of each file name and be embedded in the recorded data files to enable to you track the location of your recorder.

IMPORTANT: After changing the local time offset, the EchoPro must be rebooted before this new setting will take effect

HOME > SETUP > CAPTURE



This screen is used to start and stop all data recording processes in the same way that clicking the Data Capture ON and OFF button stops ands starts all data recording. If you change the setting using the UP/DOWN arrows, you must hit OK to commit the change. If you hit ESC the setting will remain in its previous state.

HOME > SETUP > CONTRAST

You can change the LCD contrast by using the LEFT/RIGHT arrows. Values are from 20 to 240 in 20 unit steps. This change is effective immediately.

HOME > RECORDING

Pressing the F4 key from the HOME page will take you to the second settings menu. You can access the settings screens shown at the bottom of the screen by pressing F1 to F4. A description of the contents of each sub-menu is shown on the main screen.

HOME > RECORDING > LEVEL

Triggered event recording is based on storing data only if a certain threshold is exceeded. With Level Triggering the threshold is an absolute value of signal level.

Your cursor starts on the first line, which allows you to select which **Channels** are to be tested against the trigger threshold level. Use the UP and DOWN arrows to turn them on and off, and the LEFT/RIGHT arrows to change between channels. When you are at the end of the line, press the RIGHT arrow key to move to the next settings line.

The **Threshold** is defined as a percentage of the full scale input range of the input port, which may be greater than the full scale range of the sensor. Again, move between fields to define the percentage of full scale where you want to set your threshold.

As you change this value, you will see that the values shown on the next two lines will change. These values are the threshold values in real units, which are calculated based on which sensors (and sensitivity) you have defined as being connected to your recorder. If you have an accelerometer connected, the value will be shown in g, microphones will show their threshold in Pa, etc.

Pressing the RIGHT arrow key at the end of the threshold setting will take you to the **Pre-trigger buffer** length setting, which is the number of seconds of data to retain in the buffer before the trigger is declared.

The last line shows the **Total record length** in seconds, which includes the pre-trigger buffer time, so ensure this value is greater than the Pre-trigger value.

Press OK to save any changes.

Any changes you make in this menu will also be reflected in the first Level trigger process that can be viewed using the web interface.

HOME > RECORDING > STA/LTA

STA/LTA triggering uses an average signal level comparison for triggering rather than an absolute signal level.

On the first line you select which **Channel** you want to test for triggering. The STA/LTA process can only process the average signal level of one channel at a time. As you will have guessed by now, using the UP and DOWN arrow keys will change the value and the LEFT and RIGHT arrow keys will move your cursor between settings fields.

On the next line you will set the trigger **Threshold** ratio, followed by the length of the **Short Term Average** (STA) window and **Long Term Average** (LTA) window in seconds.

The short term signal level is divided by the long term signal level, and the resultant ratio is compared to the threshold. When nothing is happening the ratio is close to 1, but as an event occurs and the STA increases, the ratio will exceed the threshold and recorder will trigger.

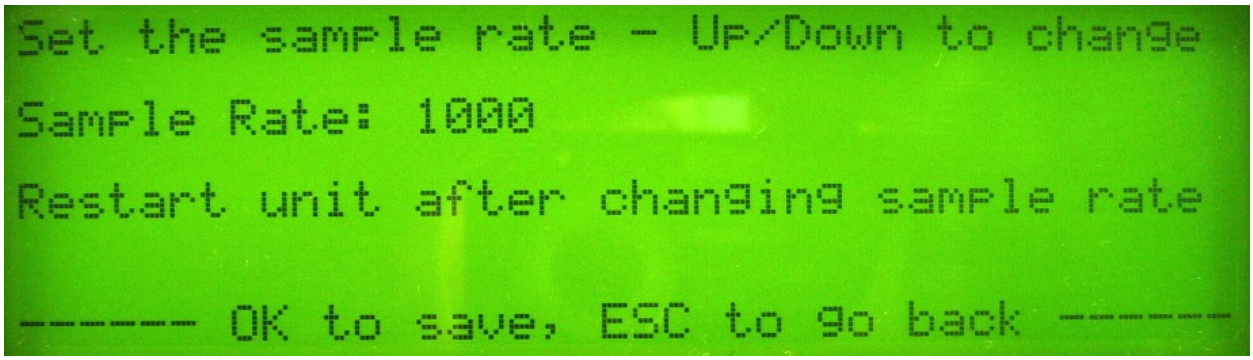
You can set the **Pre-trigger Buffer** in seconds, as well as a **Min**imum and **Max**imum file lengths. These latter settings include the pre-trigger buffer, so ensure they are at least as long as the Pre-trigger buffer. The recording will end some time after the minimum file length, either when the STA/LTA ratio drops to pre-event levels, or when the maximum file length is reached, whichever comes first.

You may wish to only trigger on signals within a certain frequency range. You can define that frequency range by specifying the **Low** frequency and **High** frequency cutoffs.

Press OK to save any changes.

Any changes you make in this menu will also be reflected in the first STA/LTA trigger process that can be viewed using the web interface.

HOME > RECORDING > SAMPLING



You can now change the sample rate of the recorder through the LCD interface. Use the UP/DOWN arrows to scroll through the available sample rates. Press OK to commit the change.

IMPORTANT: After changing the sample rate, the EchoPro must be rebooted before this new setting will take effect

HOME > RECORDING > PROCESSES

You can enable and disable the first three recording processes defined in the Process list, which as mentioned in the web-interface Recording Setup - Processes menu are: Continuous recording, Level triggering and STA/LTA triggering. Use the UP/DOWN arrow to select the process, and use the LEFT/RIGHT arrows to enable or disable the process. Press OK to commit the change.

Installing an EchoPro accelerograph

If you have purchased an EchoPro SMA (Strong Motion Accelerograph) or a 6-channel recorder with the internal accelerometer option, you will need to bolt down your recorder down to hard rock, concrete, or to the structure you are monitoring. ES&S supplies all of the parts you need to install the accelerograph mounting plate.

YOU WILL NEED

a bullseye spirit level

a hammer drill

a hammer

Mounting kit parts

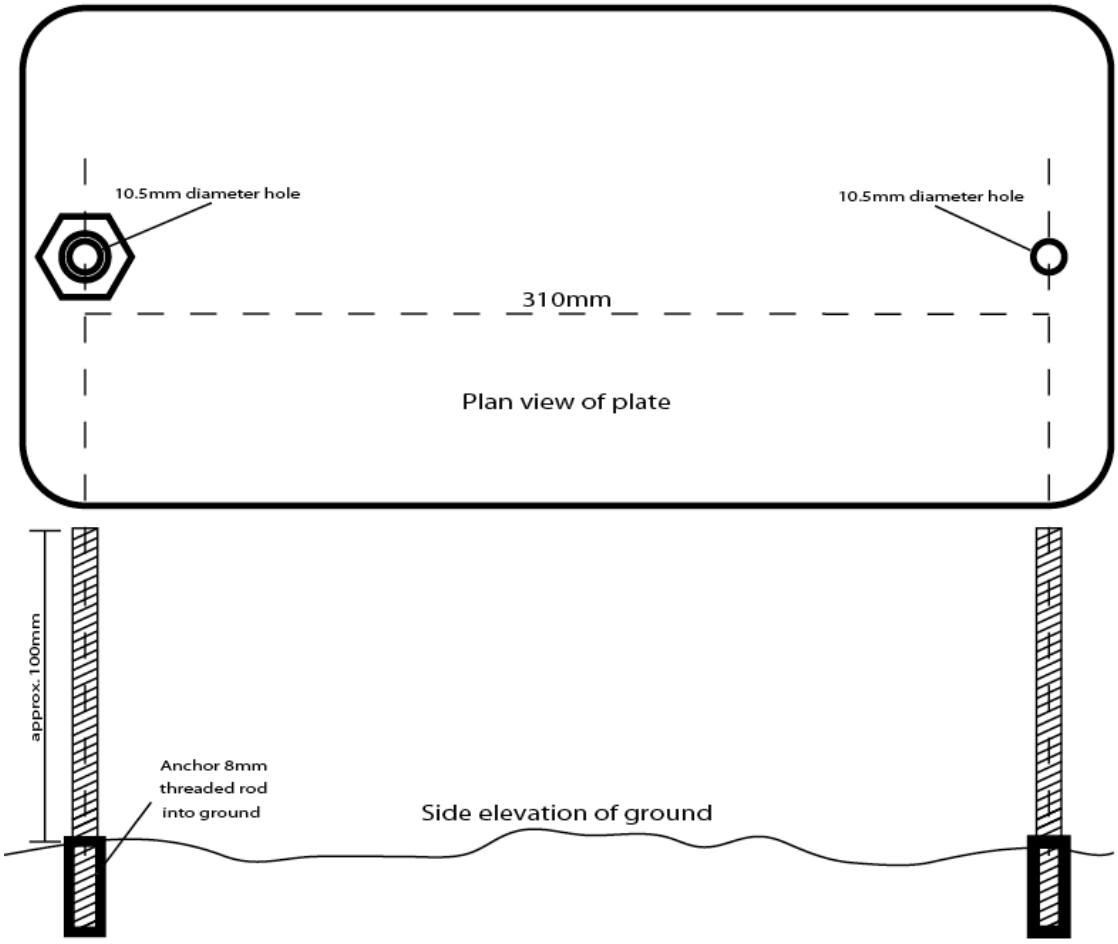
The items pictured below will be included in your shipment. A zip-lock bag will contain all parts except the base plate and the (longer) 30mm M6 bolts and two of the M6 washers. The bolts and washers will be in the EchoPro being used to secure the internal aluminium accelerometer mounting plate to the EchoPro case during transport. The M6 nuts that are being used for transport are not used in the installation process and can be discarded.

Plate installation

The accelerometer inside the EchoPro is oriented such that the handle of the EchoPro case should face North for a free-field installation. This means that you must install the long edge of the base plate in an East-West direction. If being installed in a structure (such as a dam) a good rule of thumb is to install the long edge of the plate in the longest dimension of the structure (eg. parallel with the dam wall). In the example, North would then represent the upstream-downstream motion of the dam wall.

Place your base plate on the ground in the desired location and orientation and mark the ground through the two holes that are at the short edges on the centreline of the base plate. Using the supplied masonry drill bit and your hammer drill, drill a vertical hole at each point to a depth just greater than the length of the rock anchors.

With the threaded hole on the anchor facing upward, drop the anchor into the hole. Insert the narrow end of the anchor-locking tool into the anchor. The base of the tool will stop at a nut, which when pushed down will flare out the lower section of the anchor, locking it into the hole. Using your hammer, hit the top of the locking tool to push down the locking nut.



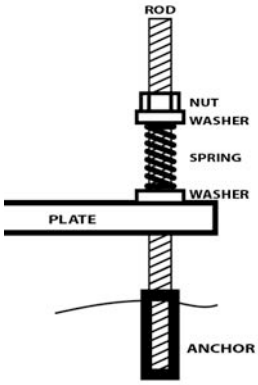
Remove the tool and screw the threaded rod into the anchor. You should not be able to remove the anchor from the hole by pulling firmly on the threaded rod.

Take the short hollow threaded rod and place it through the large hole in the base plate. Secure it in place using a washer and nut on either side of the plate. This rod will form one of the three adjustable legs of the plate, although you should only need to adjust the other two legs to get the base plate level.

Take the two pointed bolts and screw a nut onto each bolt until the bolt is about half way along the length of the bolt. Drop a washer behind each nut and then screw the pointed bolts into the corner threaded holes until the pointed ends are well clear of the threaded inserts. The nut and washer will be used to lock the legs in place once the plate is level.

Drop the base plate onto the threaded rods. The rods will thread through the hollow leg and through the hole in the plate at the opposite end. Each of the legs should be supporting the plate so that the threaded inserts that protrude below the plate are clear of the ground. Place your bubble level in the centre of the plate and adjust the legs in or out using the large hex key until the plate is level. Lock the legs in place by screwing down the lock nuts.

The final step is to lock the plate to the ground. As illustrated at right, drop one washer over the threaded rod, then drop the spring, another washer, and finally screw down the nut. The spring should be compressed by about 25%, which will allow for thermal expansion and contraction. Recheck your level and adjust accordingly.

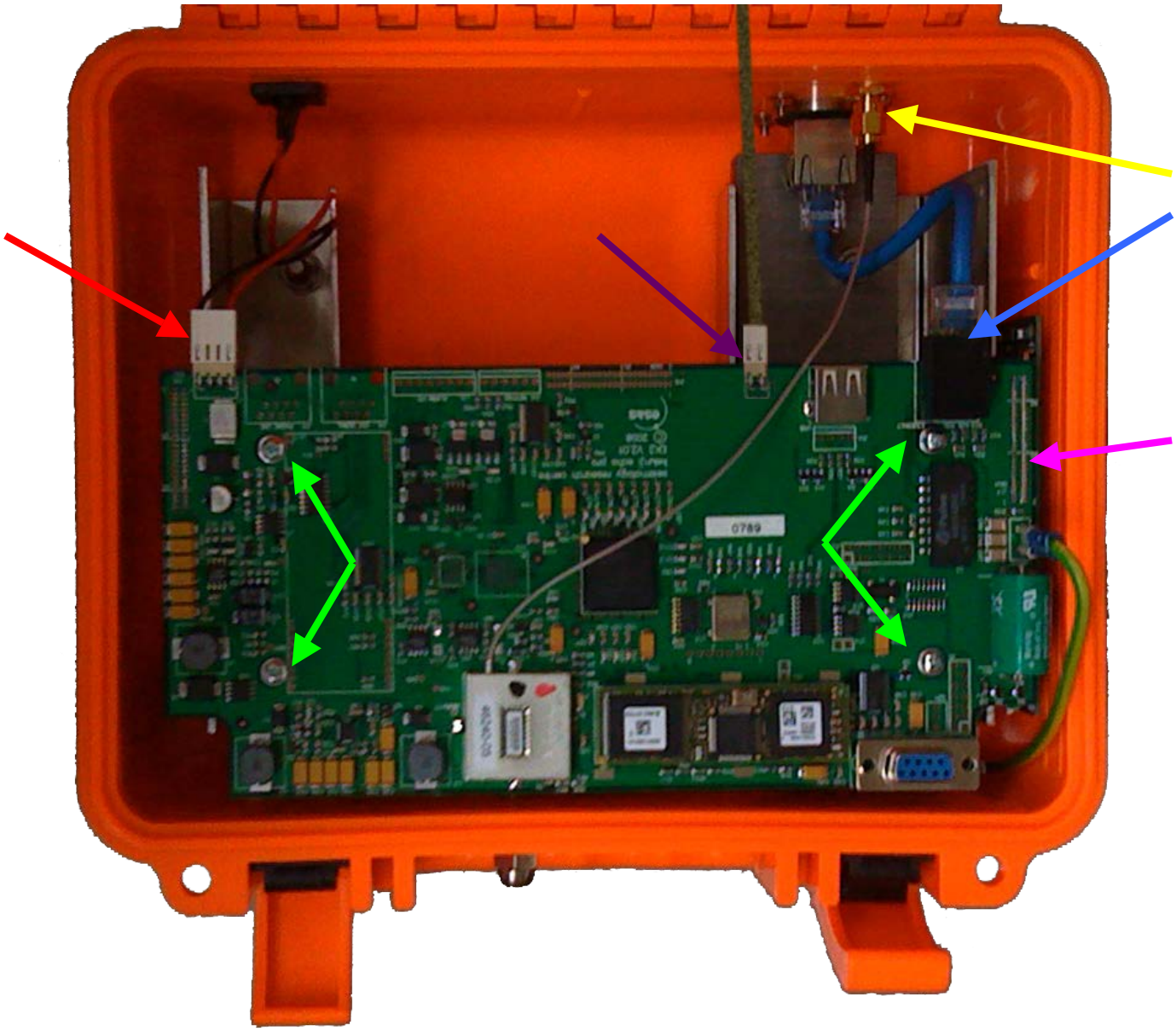


The final result will look like the image below, ready for the EchoPro to be bolted down to the remaining four threaded holes which align with the predrilled holes in the base of the EchoPro case.

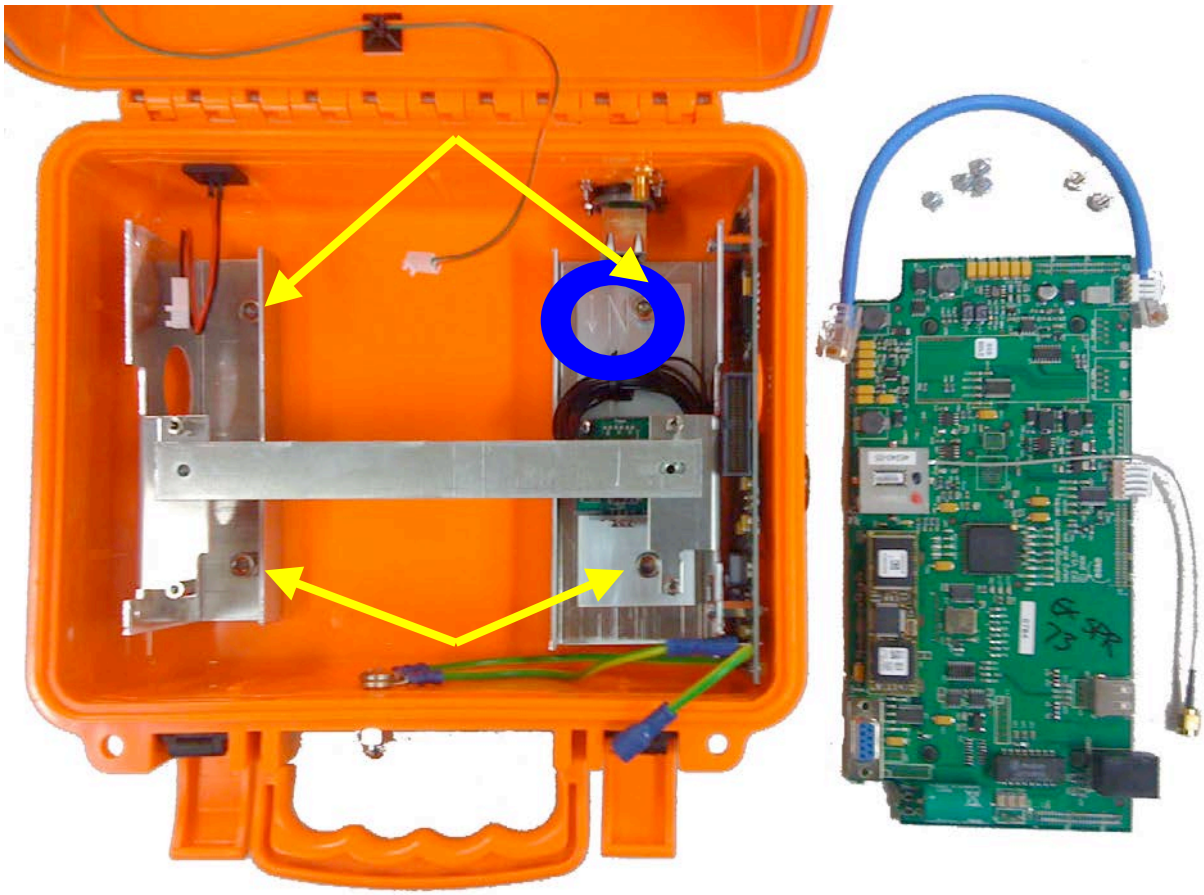
EchoPro installation

You will need to remove the main PCB from the EchoPro to gain access to the accelerometer mounting holes in the base of the case.

First, open the lid of the EchoPro and remove the screws on the that hold the PCB to the board support frame (marked by green arrows in the diagram below). Disconnect the power cable (red arrow), LED indicator cable (purple arrow) and Ethernet cable (blue arrow) from the ports on the main PCB, and unscrew the GPS aerial connector from the bulkhead (yellow arrow). It is a good idea to also remove the USB memory stick. Carefully disconnect the main PCB connector on the right hand side of the main PCB (pink arrow) from the vertical PCB that is rigidly connected to the case and frame. The board should be placed on a non-conductive surface while the installation procedure takes place.



Remove the four M6 bolts (yellow arrows) that are securing the internal mounting plate and frame components through the base to nuts recessed into the feet of the case. The nuts are only used for transportation of the unsecured instrument. Locate the case over the installed accelerometer base plate, aligning the four holes in the frame and base of the case with the four threaded holes in the base plate. Ensure the recorder is oriented correctly on the external plate using the arrow etched into the internal mounting plate (blue circle).



Re-use the M6 bolts and washers to attach the case to the base plate through the accelerometer mounting plate and frame (the longer bolts are for the RHS, through the accelerometer plate). Use the supplied hex key to tighten the bolts so that the sensor and recorder are securely fastened to the external base plate. Replace the main PCB by aligning the right-hand-side connector with the vertical PCB, screw the PCB down to the support frame, reconnect the Ethernet, GPS, LED and power wires, plug in your USB memory, then close the lid. Your installation is now complete.

Note: Before 2010, the EchoPro framing was assembled differently. See older versions of this manual for the relevant instructions.

Note: 6-channel (ET2) PCBs manufactured before September 2010 required the internal accelerometer to be hard-wired to Port B of the 6-channel PCB (while Port A is available to an external sensor). PCBs manufactured after this date allowed the accelerometer to plug in to the PCB, but it is still connected to Port B. The 3-channel EchoPro SMA uses a shorter PCB (ET3) with no external connectors, and in this case the accelerometer is connected internally to Port A.

Technical Data

EK2 – EchoPro Motherboard

Main Processor	ARM9 32-bit RISC processor, 180MHz processor, 16MB SDRAM
Operating System	Embedded Linux for UNC90 modules
Ethernet	10/100 Mbit
GPS	Trimble Lassen SQ
Data Storage	USB 1.1 single socket (compatible with USB 2.0 storage devices)
Power Input	7-18V DC

ET2 (and ET3) – High-resolution Sensor Interface

Channels	Six, external *(ET3 – three, internal only)*
Differential input	20V differential ±10V, AC or DC coupled *(ET3 – zero-to-5V, DC coupled)*
Constant current output	23V DC 4mA *(ET3 – none)*
Resolution	24-bits
Dynamic Range	143dB @ 100sps with FIR filter enabled 140dB @ 100sps unfiltered 133dB @ 1000sps unfiltered 130dB @ 2000sps unfiltered
Output:	838.8608 counts per millivolt
Frequency Filters:	permanent digital 5th order sinc filter, at 100sps: DC to 44.2Hz optional FIR filter, at 100sps: -3dB at 40.5Hz, -120dB attenuation

EA1 – Internal Model 1221 Accelerometer

Type	MEMS (Micro-ElectroMechanical Systems)
Channels	Three (orthogonally aligned)
Components	Silicon Designs model 1221-002 accelerometer chips
Full Scale Range	±2g (absolute)
Dynamic Range	100dB @ 100sps
Output	2000 mV/g (typical)
Frequency Response	DC to 400Hz

Warning

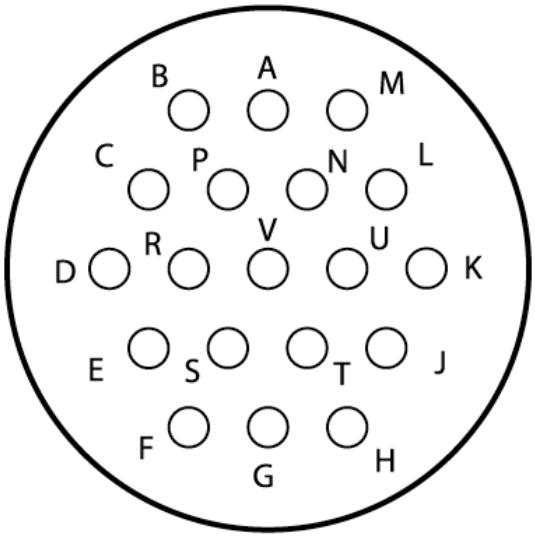
This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

N13014

Connector Wiring

EchoPro sensor port connector

Below is a diagram of the pin connections of the standard EchoPro input ports. Looking at the back of the supplied sensor connector shows the same pin configuration. The function of each pin is listed in the table below.



MS3116F14-19P
(rear view)

A	n/c
B	GROUND (battery ground)
C	X Signal
D	X Return
E	Y Signal
F	Y Return
G	Z Signal
H	Z Return
J	Voltage Calibrate Signal
K	Voltage Calibrate Ground (same as pin B)
L	n/c
M	POWER (battery voltage)
N	Mass Control – Centre
P	Mass Control – Lock
R	Mass Control – Unlock
S	n/c
T	Current Calibrate Signal
U	Current Calibrate Return / Calibrate Enable
V	SHIELD

Rugged 4-ch Blast Recorder case

Below is a photo of the input ports on a Kelunji EchoPro rugged case configured with dedicated 4-channel input for blast monitoring. When it has a constant current triaxial input for an IEPE accelerometer and a dedicated single-channel differential voltage microphone port, the wiring of the ports is as follows:

Sensor Port A (14-19P mil-spec)

Wiring for constant current accelerometer

B	GROUND (must be connected to pins D, F & H)
C	X Signal (east or radial)
D	X Return
E	Y Signal (north or transverse)
F	Y Return
G	Z Signal (vertical – up)
H	Z Return

SENSOR PORT B (8-4P mil-spec)

Wiring for microphone

A	Signal
B	Ground
C	(not connected)
D	Power

Warranty

Seismic equipment manufactured by Environmental Systems & Services is warranted to the original purchaser only, to be free of defects in material and workmanship at the time of shipment and for a period of one year from the delivery date. This warranty applies to equipment purchased from Environmental Systems & Services that has been properly installed and operated, but not to equipment which has been subject to neglect, accident, improper installation, misuse, misapplication, abuse or alteration. It does not apply to damage caused by factors beyond our control including fire, flood, lightning or vandalism.

Environmental Systems & Services will, at its own option, repair at its laboratory or replace equipment covered under this warranty. All costs of freight and insurance plus any applicable customs and clearance fees will be paid by the purchaser. All goods must be sent in original packaging with appropriate protection against damage including electrostatic charge.

It is the responsibility of the purchaser: to give prompt notice of any claim; to request a return authorisation before returning any equipment to Environmental Systems & Services; and to return the goods within the warranty period.

During the warranty period, should a new version of the Kelunji EchoPro operating software or eqWave seismic waveform analysis software be released, these will be available to the customer free of charge via the customer web site (customer.esands.com).

Some components of the Kelunji EchoPro seismic recorder are covered by the warranty of the original equipment manufacturer, which may be longer or shorter than 12 months, and are thereby excluded from the ES&S warranty. These items include:

- GPS receiver and antenna
- Internal modem
- USB storage devices
- LCD panel
- Internal keypad

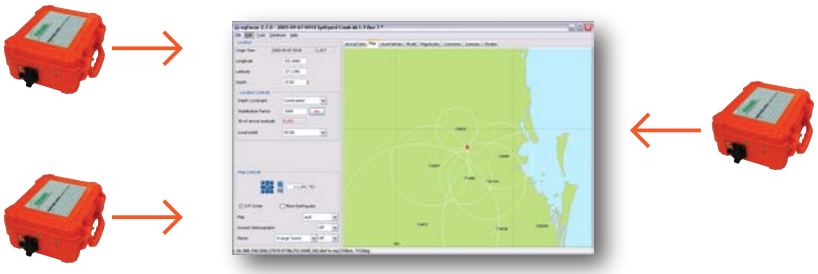
Extended warranty

Extensions to the standard 12 month warranty are available. These are available at the time of purchase of the Kelunji Echo, or at any time before the expiry of the original warranty. Extended warranties have the same conditions as the original warranty, including free EchoPro software and eqWave upgrades. Please contact ES&S for pricing information.

SOFTWARE TO COMPLEMENT YOUR ECHOPRO

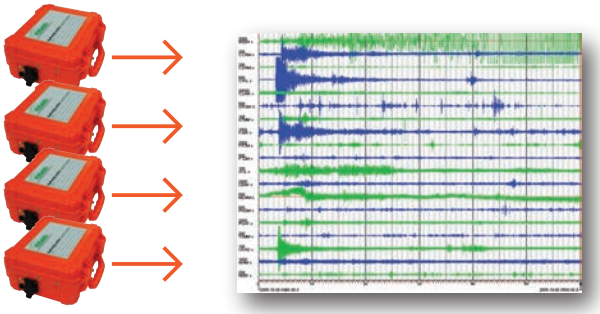
eqFocus

Calculate earthquake location & magnitude from your EchoPro seismic network



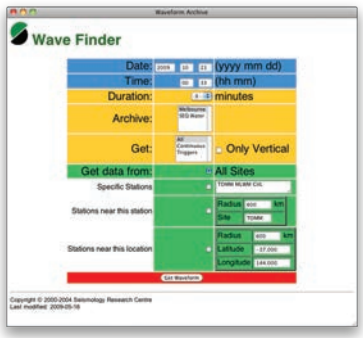
eqLogger

Display continuous data in real time and automatically store it in a data archive



eqServer

Data acquisition, archiving, alerting & network management



- **WEB BASED DATA MANAGEMENT SYSTEM**
- **DATA ARCHIVE & EARTHQUAKE DATABASE**
- **NETWORK HEALTH & MANAGEMENT TOOLS**
- **EARTHQUAKE ALARM FUNCTIONS**
- **DATA SHARING & NETWORK INTEGRATION**

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