

Gecko ERI-2G

EARTHQUAKE RECORDING INSTRUMENT with $\pm 2g$ ACCELEROMETER

PRODUCT USER MANUAL



Welcome to the world of simplified seismic recording with your new Kelunji Gecko seismograph. Within minutes you can be recording earthquakes, blasts and other ground vibrations using our latest generation instrument that makes high dynamic range, high sample rate, low power, continuous recording accessible to experts and novices alike.

In the Gecko, we have simplified the modern digital seismograph. The low cost of flash memory means you can save weeks, months, even years of continuous data on a single memory card. The Gecko can record everything continuously while logging trigger times for you to sort through back at the lab. Even if your trigger settings missed the event, you'll always be able to retrieve that chunk of time from the continuous archive.

An even more efficient way of managing your data is not to have to collect it at all, so we have included a simple telemetry protocol that streams data packets over the Internet via Ethernet. Data from all of your stations is then available in a single archive for you to access whenever you need it. Simply install our free "Streams" data reception software on your Windows, macOS or Ubuntu PC and watch your data live on screen while it is archived away to your PC. Streams is ideal for collating data from multiple network-connected structural monitoring instruments. Download it free today from the SRC website:

<https://www.src.com.au/downloads/streams/>

Our "Waves" waveform analysis application is available as a free download for Windows, macOS and Ubuntu from <http://www.src.com.au/downloads/waves/>. Each Gecko purchased is entitled to one Waves product key that will remove the advertisement that pops up for 10 seconds when you launch the program. You can email sales@src.com.au with your recorder serial number to obtain a product key. Each product key can only be used once and is not transferable to another computer.

Happy recording!

From the Gecko development team.

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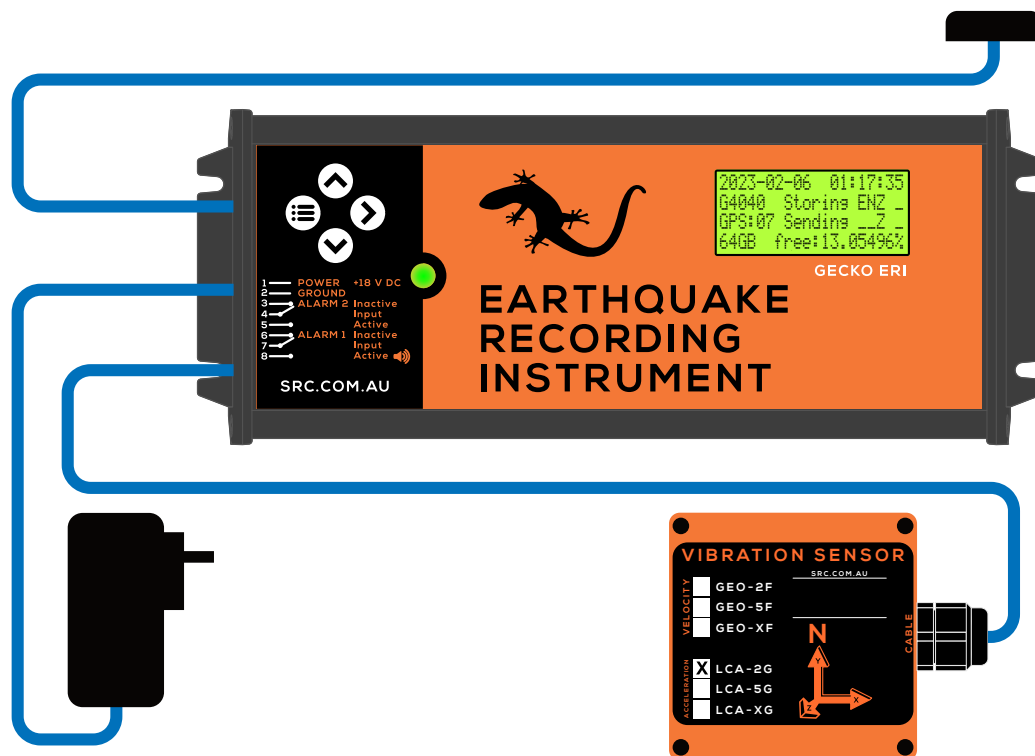
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Getting Started

The Gecko ERI is designed primarily as an all-in-one structural monitoring solution. It has an internal NiMH (Nickel Metal Hydride) battery pack that will ensure data continues to be stored in the event an earthquake causes external power interruption. When new, the battery should continue to record data for over 12 hours without external power.

Press the power button on the connector panel to start the data logger.



Connect the GPS cable to the small gold threaded coaxial connector on the end panel, and place the GPS antenna where it has a view of the sky, ideally outside but the GPS signal will generally get picked up through a window if outside cabling is not possible.

Backup Battery

When the AC-powered 18VDC plug pack is connected, the battery will start to be re-charged, and the Ethernet interface will power up. If AC power to the building is lost, the local network will likely go offline, so the Gecko ERI is designed to provide maximum recording backup time by not wasting power on the Ethernet functionality. You can use an external 18V battery to power the ERI to maintain data telemetry during an AC outage.

The battery/charge indicator LED only works when external power is connected. You can check the battery voltage on the Gecko status screen at any time. The Gecko will automatically turn off at around 11V to protect the battery from damage due to being over-discharged. The life of the battery depends on how often the battery is drained, but it should last for 3-4 years in normal conditions.

LED & buzzer status	Meaning	Notes
A single beep followed by LED flashing Red-Orange-Green, then LED off for 3 seconds	Power-up initialisation	Only after power-up
LED orange on	Fast Charging	Should take 3-4 hours if battery is completely flat
LED orange with a green flash	Fast Charging has been on for more than 3 hours	If this happens regularly it may indicate a degraded battery
LED green	Trickle Charging	Battery fully charged
LED red flashing	Battery voltage is between 10 and 11 Volts.	Battery discharged, very low, or degraded
LED red flashing with a beep every 10 seconds	Battery voltage is lower than 10 Volts.	Battery discharged, critically low, or degraded

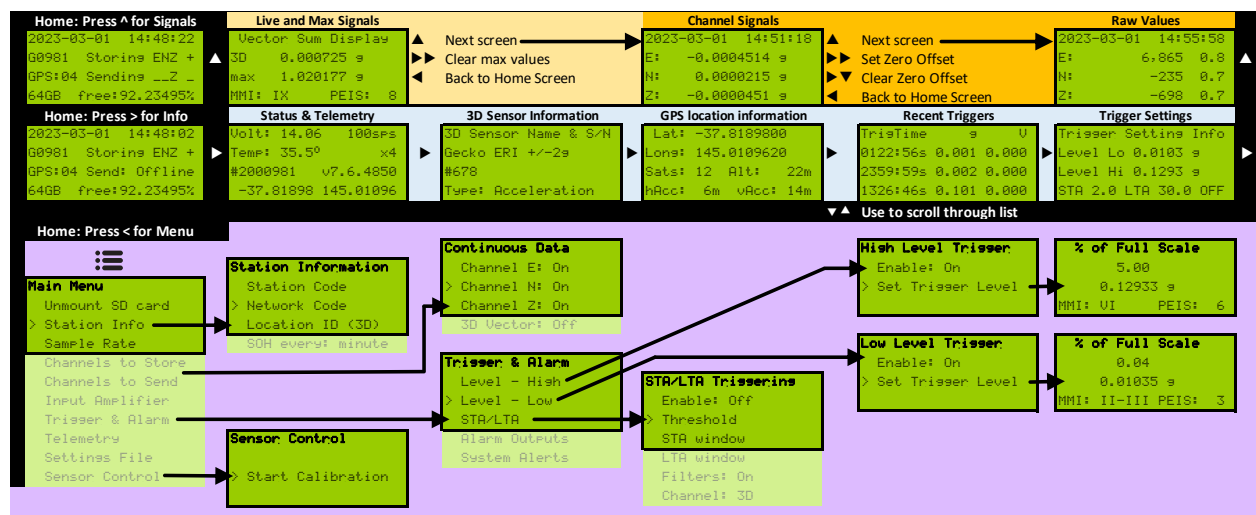
Setting up your recorder

The Gecko ERI is pre-configured for the attached sensor, so the default settings will record data continuously to the removable SD card. You can customise the data rate, alarm trigger levels, and more. You can configure the Ethernet interface to stream data to a particular computer on your local network, or to a remote server on the Internet.

The Gecko does not require a computer to configure recording settings – these are accessible through the LCD and are modified using the four control buttons. You do need a computer and web browser to configure the Ethernet port through its web interface.

Menu Map

After start-up, pressing the **Menu** button will toggle between the main menu and the home screen. The LCD backlight will stay on for 2 minutes after the last button press.



On most screens you can scroll **Up** and **Down** through a list and enter a menu item or toggle a setting by using the **Right** button. Pressing the **Menu** button will save the current setting and take you back one menu level. From the Home Screen, pressing **Up** screen shows signal level screens, and pressing the **Right** shows general information screens.

The Home Screen

```
2022-09-30 19:05:59
G0981 Storing ENZ +
GPS:04 Sending ___ +
64GB free:92.23495%
```

The four lines on the home screen show:

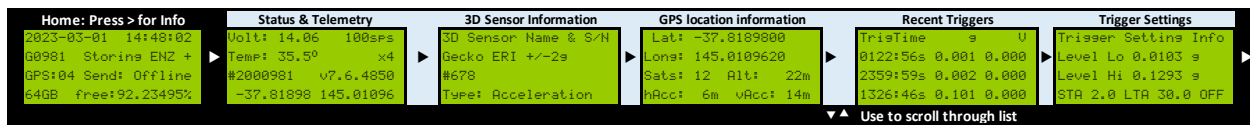
- the Gecko clock's date and time (in UTC – Universal Time Coordinated)
- the station code, and which channels are being stored to the SD card
- the number of GPS satellites visible; and what is being sent via Telemetry
- the SD card capacity and percentage of storage remaining

The "+" is the vector sum of channels ENZ (East-West, North-South, Up-Down), which gives the peak 3D acceleration. This is an absolute value. This can be streamed if network bandwidth is not sufficient to allow ENZ to be streamed individually.

The "Storing" word animates using ▼ down arrows to indicate packets of data are being written to the SD card. The "Sending" word animates using ▲ up arrows to indicate packets of data are being streamed "up" to a remote computer.

Status Screen Loop – Right Button

The Gecko has several status pages accessible from the Home screen. Press the **Right** button to scroll through them, or press the **Menu** button to return to the Home screen.



The first screen shows input power voltage and CPU temperature, the current sample rate and input amplifier (gain) setting, followed by the Gecko serial number and firmware version number. The bottom line shows the GPS latitude and longitude.

The next screen shows the name and serial number of the 3D sensor, with the sensor type (acceleration for the ERI $\pm 2g$) shown on the bottom line

Next is the GPS screen that shows the latitude, longitude, altitude, and other information.

"Sats" indicates how many satellites are currently visible in the sky to the GPS antenna. The "hAcc" value is the horizontal accuracy of the location in metres as read from the GPS receiver, and "vAcc" is the vertical accuracy.

The next screen shows the time of the last triggered events, followed by the peak amplitude in the 10 seconds after the trigger. An "s" after the time indicates it was an STA/LTA trigger, a ▲ indicates a Level-High trigger, and a ▼ indicates a Level-Low trigger. Use the **Down** button to scroll to older triggers, or **Up** to view the latest trigger.

The final screen shows the current trigger settings. If "OFF" appears at the end of the line, it indicates that the trigger process is currently not enabled.

Realtime Data Loop – Up Button

Press the **Up** button from the Home screen to view real time sensor data.

Vector Sum

```
Vector Sum Display
3D  0.002464 g
max 0.020267 g
MMI: IV    PEIS: 4
```

The first screen shows real-time peak acceleration output.

Tap the sensor to see the numbers change. It shows the live peak from the 3D sensor, and holds the peak acceleration (max), and the estimate of the peak Modified Mercalli

Intensity (MMI) and Philippine Earthquake Intensity Scale (PEIS). Press the **Right** button twice to clear the retained peak values.

Sensor Signal

```
2023-03-01 11:52:18
E:  -0.0043940 g
N:   0.0036001 g
Z:  -0.0011021 g
```

Press the **Up** button again to see the live acceleration values for each sensor axis. Pressing the **Right** button on this screen will prompt you to either press the **Right** button again to remove any signal offset (e.g. the 1g offset due to

gravity that affects the vertical channel), or press the **Down** button to clear the any existing offset correction. A drift correction feature will correct signal offset over time.

Raw Signal

Pressing **Up** again will display the raw numbers from the analogue-to-digital converter (ADC) in real time. The values shown are up to ± 8.4 million recorder counts, which represents a signed 24-bit range number.

```
2023-03-01 11:52:20
E:    -2,726  0.6
N:     4,326  0.8
Z:   -356  1.2
```

The zero level can be controlled in the same way as the Sensor Signal screen.

If STA/LTA triggering is enabled, the STA/LTA ratio is also displayed in real time at the end of each line. It is the ratio

of the average signal in the short term divided by the average signal in the long term. When nothing much is happening, this value will sit around 1.0, but a short burst of anomalous signal will increase the number. This ratio may assist you in determining at what level to set your STA/LTA trigger threshold.

The Main Menu

Pressing the **Menu** button from the home screen will show you a list of actions and settings for managing your recorder.

The main menu includes some or all of the following items:

If you change any settings, they are usually applied once you exit to the home screen. The settings are automatically saved to the recorder's configuration file.

```
Main Menu
  Unmount SD card
> Station Info
  Sample Rate
  Channels to Store
  Channels to Send
  Input Amplifier
  Trigger & Alarm
  Telemetry
  SD Storage
  Sensor Control
```

Unmount SD card

Data is being sampled at all times, whether an SD card is present or not, because data can be telemetered without an SD card. If there is no SD card, backfilling of unsent data will not be possible.

Before you remove the SD card, you should unmount the SD card so that the system does not try to write data to the card while it is being removed, an action that can corrupt the current file, the FAT file system, or the SD card.

When you insert an SD card, it will automatically be mounted.

Data Storage

The Gecko is supplied with a 64GB SD card, formatted with the FAT file system. Larger capacity SD cards can be used in the Gecko if they are pre-formatted as FAT (not exFAT).



To remove the card from a Gecko ERI, the SD card cover requires a quarter turn anti-clockwise before removal. The SD card faces the rear of the box. Press the card in and it will eject, ready for removal. Insert the SD card into your computer (directly if you have an SD card slot, or via a USB card reader) and you'll be able to browse your continuous data files.

To re-insert the card, **check you have the correct orientation and do not force the card if it does not insert easily**. Push the SD card down into the socket, ensuring you feel the card spring back from push-lock. The SD card will automatically mount and recording should resume. Check that the ▼ arrows are animating over the word "Storing" on the Home screen, which indicates data packets are being written "down" to the SD card.

Station Info

```
Station Information
  Station Code
> Network Code
  Location ID (3D)
SOH every: minute
```

Every seismic monitoring point needs to have a unique identifier. As part of the MiniSEED data format standard there are three tiers of identifier – Network, Station, and Location.

Station Code

This station code can be up to 5 characters long and can only contain uppercase letters and numbers. By default this is “G” followed by the last 4 numbers of the serial number. If you wish to use less than 5 characters, end the code with blank space character. Note that any characters after a blank space will be ignored (e.g. if you enter “ABC 1” the Gecko will truncate the station code to “ABC”).

```
Enter Station Code

G0981
```

A flashing block indicates the cursor position. Use the **Up** and **Down** buttons to scroll through letters and numbers, and use the **Right** button to move to the next character. Press the **Left/Menu** button when on the first character to

save and exit.

Network Code

The MiniSEED format allows you to include a two character network code. By default this is set to “SS” which is reserved for “single seismographs”. This is typically used by seismic observatories to store their FDSN code. For example, the Seismology Research Centre uses “OZ”, and Geoscience Australia uses “AU”. You can register for an FDSN code at fdsn.org, or you can use this text field for your own identification purposes.

Location ID

A seismic monitoring location may have multiple monitoring points, so rather than coming up with a different station code for each, they can all use the same station code with a unique Location ID. This field is any two character code, and the default value is 00. For example, if you are monitoring the basement, middle and top of a building you could use Location IDs of B1, M1, and T1; or simply 01, 02 and 03.

SOH frequency

The Gecko creates a CSV format histogram summarising some State-Of-Health (SOH) parameters. By default this is logged once per minute. You can increase the logging frequency to every 2 seconds or every 5 seconds with fewer parameters to save file size.

Sample Rate

```
Select Sample Rate
  50 sps
> 100 sps
  200 sps
  250 sps
...<more>
```

The standard ADC sample rates are 250, 500, 1000, 2000 and 4000 sps use a 4 stage FIR filter. The Gecko use an additional FIR filter and 5th-sample decimation to produce the following sample rates: 50, 100, 200, 400, and 800 sps.

Scroll to the sample rate you wish to use, then press the **Left/Menu** button to exit and apply the new sample rate.

Channel Naming

The naming of channels has been automated in the Gecko based on the selected sample rate and sensor type, with preset channel names.

The SEED standard states that each channel requires a 3-letter code, where the first letter indicates the Band Code, the second letter indicates the Instrument Code, and the third letter is the Orientation Code. Detailed information on this standard can be found here:

<https://ds.iris.edu/ds/nodes/dmc/data/formats/seed-channel-naming/>

The Gecko will set the first letter of the channel name based on the sample rate:

- B: 50 sps
- H: 100 & 200 sps
- C: 250, 400, 500, 800 sps
- F: 1000, 2000, 4000 sps

The Gecko will set the second letter of the channel name based on the sensor type, which in the case of an ERI $\pm 2g$ will be "N" to denote that the sensor is an accelerometer.

The Gecko will set the third letter of the channel name based on the channel number:

- E: channel 1, typically used for East, Transverse, or X
- N: channel 2, typically used for North, Radial, or Y
- Z: channel 3, typically used for Up, Vertical, or Z

For example, the vertical channel of a 100sps of an ERI $\pm 2g$ would be HNZ, or when running at 250sps the channel would be named CNZ.

The data stored as the vector sum of the 3D sensor uses channel code **SUM** and will use the same location ID as channels E, N, and Z to reinforce the association with those channels.

Channels to Store

You can turn off any unused channels to save storage space. Storing the vector sum is a waste of space if you are already storing ENZ. Toggle the channels on or off as required.

```
Save Continuous Data
  Channel E: On
> Channel N: On
  Channel Z: On
  3D Vector: Off
```

The 3D Vector channel should not be enabled unless it is required for data if telemetry bandwidth is limited. Note that if a channel is enabled for telemetry (see next setting below), it will automatically be stored to the SD card to ensure the data is available for backfill should the communication link drop out.

If all channels are accidentally turned off, the Z channel is automatically re-enabled to ensure at least one channel is being recorded. Note that if a channel is turned off here, it will also be turned off in the “Channels to Send” settings – see below.

Channels to Send

You can select which channels to send **continuously** to your remote server. For blast and structural vibration monitoring applications you may choose to send the 3D Vector sum channel continuously, storing the ENZ channels to be streamed only when a trigger process detects an event.

```
Send Continuous Data
  Channel E: Off
> Channel N: Off
  Channel Z: On
  3D Vector: Off
```

Toggle the channels that you want to send continuously on or off using the **Right** button.

Note that if a channel is enabled for telemetry, it will automatically be turned on in the “Channels to Store” settings. This is because the stored data is required for backfilling gaps in data telemetry. Disabling a channel in telemetry will not disable that channel in the “Channels to Store” settings.

Input Amplifier

The Gecko is, fundamentally, a high speed, high resolution voltage logger. It measures the voltage across each channel's pair of wires, and it can measure from -20V to +20V DC at 24-bit resolution. This 40V peak-to-peak range is converted into a 24-bit number, producing a value between 0 and 16,777,216 counts, which equates to 419,430 counts per volt.

Input Range
x2
> x4
x8
x16

Because the Gecko ERI uses $\pm 4\text{V}$ MEMS accelerometers, the default gain is set to x4 to shrink the $\pm 20\text{V}$ input range to $\pm 5\text{V}$ to record the signal at higher resolution.

We recommend leaving the Gecko ERI at a gain of x4 for optimal resolution and range. We discourage the use of x32

and higher gains as the offset due to gravity will place the vertical channel outside of the recording range most of the time.

The Gecko ERI $\pm 2\text{g}$ will clip at these accelerations when set to the listed amplifier gains:

Gain	Horizontal Clip Level	Vertical Clip Level
x1	$> \pm 2\text{ g}$	$> +3\text{g to } -1\text{g}$
x2	$> \pm 2\text{ g}$	$> +3\text{g to } -1\text{g}$
x4	$> \pm 2\text{ g}$	$> +3\text{g to } -1\text{g}$
x8	$\pm 1.6\text{g}$	$+1.6\text{g to } -0.6\text{g}$
x16	$\pm 0.8\text{ g}$	$+0.8\text{g, } -0.2\text{g}$

Trigger & Alarm

Trigger & Alarm
Level - High
> Level - Low
STA/LTA
Alarm Outputs
System Alerts

The primary function of the Gecko is to record data continuously, but triggering is still required to help detect events of interest and to control alarms. The Gecko has two Level trigger processes and an STA/LTA trigger process that can be enabled and disabled. The Gecko also monitors some system parameters that can generate an alarm.

The Gecko logs the trigger time to a text file that can be used to help you find the data in the continuous archive. This "trig.txt" file is located in the top level folder of the SD card.

We have developed a Windows application that can be copied to the Gecko SD card and run from a PC that will scan the trig.txt folder and then automatically extract the continuous data from the archive. The program will create a discreet file for each trigger time, stored in a folder called "reports" on the SD card. Each waveform file contains one minute of data before and after the trigger time. At the same time a PDF report is generated for the triggered event, with files named based on the local time in your PC. This app simplifies vibration monitoring reporting for non-technical users.

Level Triggering

By default each Level trigger process is OFF, but simply toggle this using the **Right** button.

```
Level Triggering
  Enable: On
> Set Trigger Level
```

The Gecko will trigger when the 3D vector sum of the accelerometer channels exceeds a predetermined level. Enter the menu to set the trigger level.

Use the **Up/Down** buttons to change the number values from 0.01% to 99.99% of the recorder's full scale range.

The line below will update with the acceleration based on the input amplifier gain range of your Gecko.

The Gecko ERI $\pm 2g$ will also display the estimated MMI and PEIS intensity that relates to this trigger threshold.

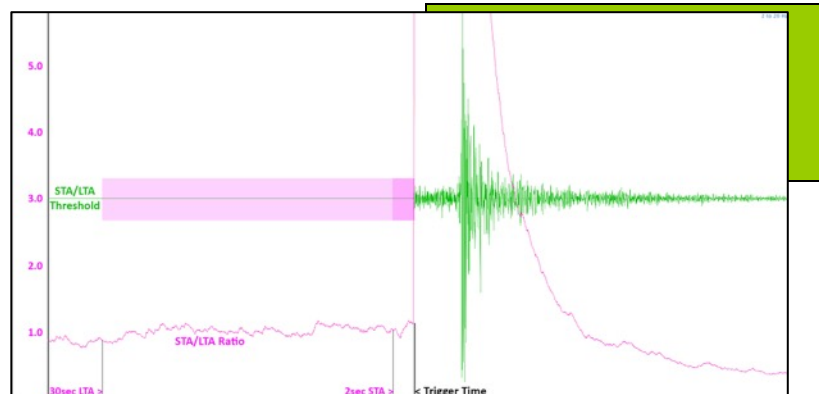
```
% of Full Scale
  5.00 %
  0.10316 g
MMI: VI    PEIS: 6
```

STA/LTA Triggering

By default the STA/LTA trigger process is OFF. Toggle this ON/OFF using the **Right** button.

```
STA/LTA Triggering
  Enable: Off
> Threshold
  STA window
  LTA window
  Filters: 2-20Hz
  Channel: 3D
```

The Short Term Average (**STA**) signal level divided by the



Long Term Average (**LTA**) signal level produces a ratio indicating how much above-average signal is occurring.

If you want to declare an event when the short term average signal level is three times higher than the long term average signal level, you set the **Threshold** to 3. The length of the short and long term time windows is also user selectable. The LTA value must be larger than the STA value.

Signal averages can be calculated using the raw data or filtered to suit to local earthquake detection. On the **Filters** line, use the **Right** button to toggle the 2-20Hz filter on or off.

The STA/LTA algorithm can run on one of the triaxial channels (Z, N or E), on the 1D channel, or on all of the 3D input channels. Toggle the **Channel** using the **Right** button.

A more detailed explanation of the STA/LTA trigger algorithm is provided in our **Waves** data analysis application's user manual. You can visualise the effect of changing the various STA/LTA settings using **Waves**.

Alarm Outputs

There are two alarm outputs available on the Gecko ERI. The relays are rated to 10A maximum at 250VAC resistive load or 10A maximum at 28VDC resistive load.

```
Alarm Outputs
#1: Level - High
> #2: Level - Low
Normally: Open
Alarm Duration
```

Each Alarm can be controlled by Level triggers, STA/LTA triggers, or System Alerts; or the alarm feature can be turned Off. To allocate a process to an alarm output, press the **Right** button to cycle through options for each alarm. For Gecko ERI, the output must be set to Normally Open.

This means that the input wire connected to pin 7 on the terminal connection is normally connected to output to pin 6 for Alarm #1, and input pin 4 is connected to output pin 3 for Alarm #2. When the Alarm #1 condition is met, the input on pin 7 switches to output to pin 8 for the duration of the alarm; and when the Alarm #2 condition is met, pin 4 outputs to pin 5 for the duration of the alarm.

The final menu determines how long the alarm stays active after being triggered. If this value is set to zero, the alarm will continue until it is manually reset from the home screen.

System Alerts

System Alerts enable an alarm to be raised when certain monitored parameters get to a particular level that may indicate an impending problem with the system. The values are user-editable, but by default the alert will be raised when the voltage drops below 11.9V, or the CPU temperature exceeds 55°C.

On-screen Alerts

When an enabled alarm is triggered, a message will appear on the home screen to indicate which of the two Alarm Outputs has activated, and which parameter triggered the alarm.

```
2023-03-01 11:52:16
Alarm1: Level - High
Alarm2: Low Voltage
Press > to dismiss
```

The on-screen alert will be cleared after the Alarm Duration time has elapsed if the alarm condition is no longer true (e.g. when the ground motion subsides after an earthquake).

If the alarm condition persists (e.g. low voltage) the alert will be displayed on the LCD until the user presses the **Right** button to dismiss the alert. The on-screen alert for this alarm will not be displayed again until the condition changes to false (e.g. voltage returns to normal) and then becomes true again.

The Gecko uses a data ring buffer, which means it will overwrite old data with new data when the memory card has only 1% storage remaining. A Low Memory alert will be raised when less than 4% of storage remains to indicate an issue with the memory card.

Telemetry

Communications

```
> Mode: Continuous  
Device: Ethernet
```

The Gecko ERI has an Ethernet port to allow streaming of continuous data to a remote computer that is running our Streams application, or to an eqServer/Seismosphere cloud service. The reception computer receives Gecko data and outputs the MiniSEED files to an archive and/or SeedLink ring buffer. The computer can then display the data on screen, and allows you to remotely change the Gecko settings or remotely upgrade Gecko firmware. The Gecko can stream data with or without an SD card present.

Mode

Use the **Right** button to toggle between three modes: Off, Continuous, and Triggered. When **Continuous** mode is selected, the enabled "Channels to Send" (see main menu) will be streamed continuously to the remote server. A good network connection should be able to support a sample rate of 500sps for continuous telemetry.

If **Triggered** mode is selected, a connection to the remote computer is maintained, and heartbeat signals are sent to the server every few seconds. If a Level or STA/LTA trigger process is enabled and detects an event, a trigger packet will be immediately sent to the remote server. The Gecko will immediately streaming all channel defined in "Channels to Store" and also dump data from these channels from its buffer. The amount of data in the pre-trigger buffer that is streamed immediately will depend on the sample rate, from around 80 seconds at 50sps to around 4 seconds at 1000sps. The length of time continuous streaming will continue after a trigger also varies by sample rate: 300 seconds at 50sps, 150 seconds at 100-250sps, and 30 seconds for 400-1000sps. When telemetry mode is set to **Off** the Gecko will not attempt to start a serial connection.

Device

The Gecko ERI $\pm 2g$ has an integrated Ethernet interface, so the selected device should be "Ethernet". This setting should not be changed. See Appendix B for information on Ethernet adaptor configuration.

SD Storage

You can save or load the configuration of your Gecko to a text file on the SD card, and now you can re-format the SD card, all from the "SD Storage" menu.

```
SD Storage
  Load Settings
> Save Settings
  Format Card
```

Use the **Right** button to select the action. When the Gecko settings are saved, a file called "user-settings.dat" is written to the top level folder of the SD card. Similarly, using the Load command will read in this file and apply the settings contained therein. If a user-settings.dat file does not exist, no settings will be changed.

If you use the **Right** button to select "Format Card", a confirmation screen will appear that allows you to cancel or proceed with the action. If you proceed, the formatting process can take a few minutes. Once completed, the Gecko will reboot and the home screen should show that there is 99.99% storage free.

Sensor Control

Start Calibration

The Gecko ERI $\pm 2g$ can send a step-pulse calibration signal to the sensor. Initiate a calibration sequence by pressing the **Right** button on the first menu item.

```
Sensor Control

> Start Calibration
  AUX#2 Pin P: Low
```

Once started, the raw ENZ channel values are shown in real time. The bottom line shows that you can press **Left** to abort the calibration process, and also shows a countdown timer describing the current stage of the process.

```
E:      696726
N:     -715236
Z:     -705975
<Abort ON DELAY  4
<Abort CALSIG ON  4
<Abort OFF DELAY  4
```

There are three stages to the process – the on-delay, the signal, and the off-delay.

The start delay gives you time to hold still before the calibration signal is applied to the sensor is switched on. The sensor should not be disturbed during the test process. View the files from the continuous data archive to see how the sensor responded compared to past tests.

Sensor Control Lines

The remaining items in the Sensor Control menu do not apply to the Gecko ERI $\pm 2g$ and can be ignored.

Data Storage and Formats

The Gecko stores continuous data to the SD card in a logical file hierarchy to make it easy to find the data you're looking for, but it also stores some additional files that you may find useful. The SD card is formatted in standard FAT32 file system and can be read by most computers with an SD card slot or using a USB SD card reader.

The sample rate affects the size of the data files stored, so we will briefly discuss how much data you can expect to record given a particular sample rate. The Gecko is recording data to the SD card continuously in MiniSEED format using Steim-1 compression. Data is stored on the SD card in one-minute long files in a Year > Month > Day > Hour folder hierarchy to make browsing data on your computer as easy as possible.

Your Gecko will probably be recording low levels of signal from your sensor most of the time, so the data files are usually quite small. The occasional earthquake or noise signal will increase the size of the data files in the short term, but for estimation purposes we will look at what volume of data is generated at typical background signal levels.

Recording 3-channels at 100sps in an urban environment generates about 2GB per month. Increasing the sample rate to 250sps generates about 5GB per month, and running at 4000sps creates about 70GB per month, so the sample-rate to data-volume relationship is reasonably linear. Low noise environments (such as underground vaults or remote stations) will generate smaller amounts of data due to the MiniSEED format data optimisation.



Recording at 250sps, the included 64GB SD card will typically store over 1 year of continuous 4-channel data.

We recommend replacing the SD card every year for archiving and reliability.

You can view your data by inserting your SD card into your computer and starting up **Waves**. Simply drag a single file, an hour folder, or a day folder (Waves can display up to 24 hours data in a single window) onto the empty Waves viewer window to view your data. Waves will read the ".ss" file from your data folder to auto-fill the station information. Keep your files in their respective folders or risk losing this meta-data link, or save the file in a meta-rich format like PC-SUDS, or as a MiniSEED zip file (where the waveform file and .ss files are zipped together into a folder that can be read directly by Waves without decompression).

Download **Waves** for free from <http://www.src.com.au/downloads/waves/>

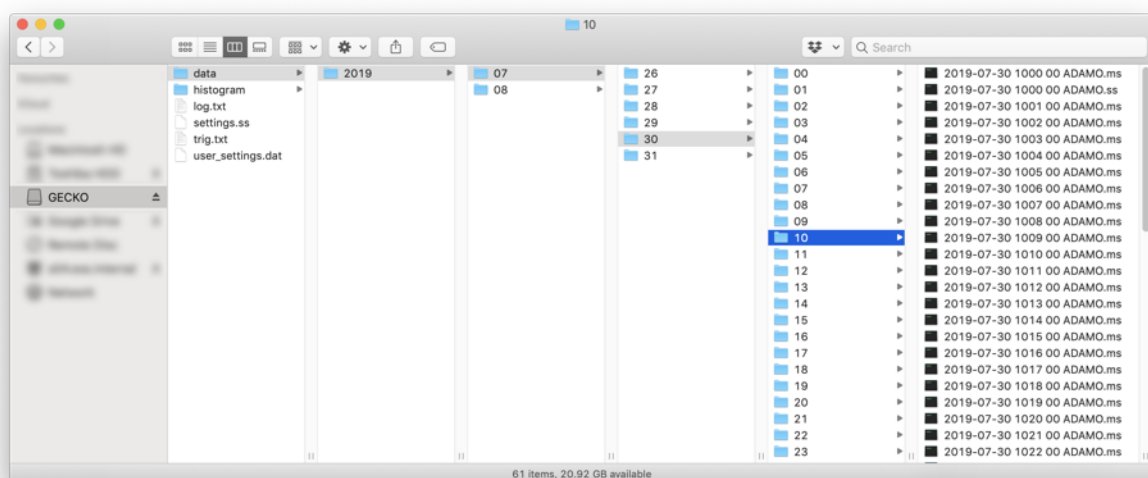
The Root Directory

The root directory contains a folder called “data” that contains all of the seismic waveform files, and a folder called “histogram” which contains daily files that record data values each minute. The top level folder also contains a number of other files:

- **log.txt** (and older log_0.txt ... log_9.txt): a simple text files that record several parameters for instrument performance analysis, such as history of restarts and any system exceptions. Up to 10 past text files are stored, with a new file started on power-up if the current log file is too big
- **settings.ss**: also a text file, containing all of the current configuration settings of the Gecko. It is updated each time the user changes a setting.
- **user-settings.dat**: the current configuration of the Gecko as written by the Load/Save Settings function described earlier
- **trig.txt**: a list of times and information when a trigger process was activated

The Data Folder

The top level folder named “data” contains subdirectories named by date to allow you to quickly find the files you’re looking for. The first level down is the Year folder, which contains Month folders, which in turn contain Day folders, and the Hour folders are the next and final folder level. Each hour folder will contain MiniSEED format data files, each file being one minute long. Each hour folder also contains one or more files ending in “.ss” which contains information about the recorder parameters which include the correction factors that are needed for analysis of the data.



The Histogram Folder

The top level folder named "histogram" contains daily CSV files where an entry is written to file every minute. You can optionally store data every 2 or 5 seconds. The files are named by date (e.g. 2022-10-03.csv) and can be opened using Excel or a text viewer. Opening the file using Waves will plot 3D peaks, voltage and temperature.

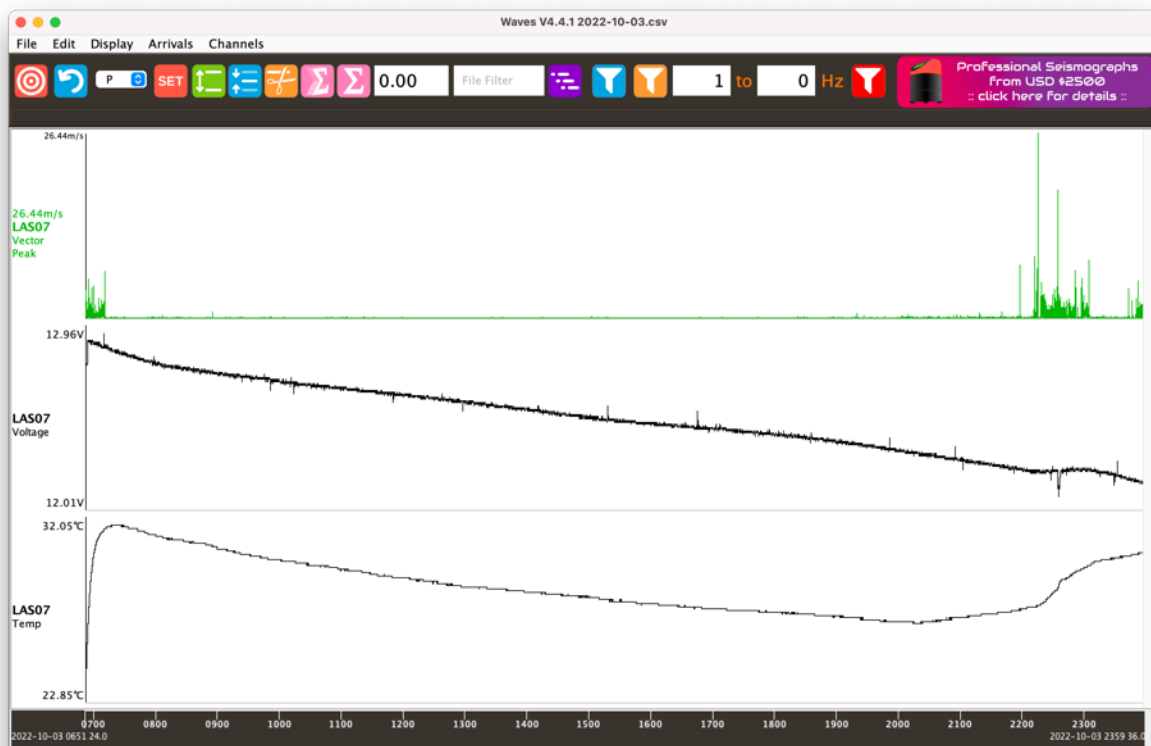
The file contains a header with some variables based on the Gecko and sensor settings:

- An estimate of the peak motion the 3D sensor in the last minute
- † The **raw ADC** value at the time of sampling for each channel: E N Z
- † The absolute peak unit values for each channel in the last minute
- Input Voltage and CPU Temperature at the time of the data entry
- Latitude, Longitude, Altitude, and number of visible GPS satellites
- The percentage of storage memory available

† These values are only stored in one-minute mode, not when logging at 2- and 5-second intervals

The file header contains information about the station, including parameters for converting raw values into sensor units. Divide the **raw ADC** value by the **sens_X** value to estimate the value in **units_XD** for this 1/12/30 samples per minute data,

e.g. $23009 \div 324303584 = 0.000071 \text{ m/s}$ (0.071 g).



Waves displaying the 3D vector peak, Voltage and Temperature as logged every 2 seconds.

Note that each "day" file can be several MB in size.

MiniSEED files

Continuous data files in the Gecko are in MiniSEED format, which is a widely adopted international standard format for seismic data. You can find out more about this data format at the IRIS website:

<http://ds.iris.edu/ds/nodes/dmc/data/formats/miniseed/>

Being a “data only” format, the lack of embedded station information makes it impossible to simply open a file and read a ground motion value (and therefore calculate magnitude). The way we have handled this is to embed a seismograph settings (.ss) file in every Hour folder. If you use our **Waves** application to open a data file, it will look for an .ss file in the file’s folder and automatically read and apply the appropriate corrections to the data so that ground motion units are displayed. Similarly if you drag an entire Hour or Day folder into Waves, it will read the first .ss file and apply these station settings to the merged data file displayed in the Waves window.

The problem then becomes needing to keep the .ss files and MiniSEED data files together to retain this association. The simplest solution is to use the “Save As...” function in **Waves** to save the file in “PC-SUDS” format (a less common international standard seismic data format) which embeds all of the relevant station data within the data file. Alternatively, select the option to save the file as a “MiniSEED zip” file which will bundle the .ms data with the .ss info file (and a station.xml file) into a zip file that can be read directly by Waves.

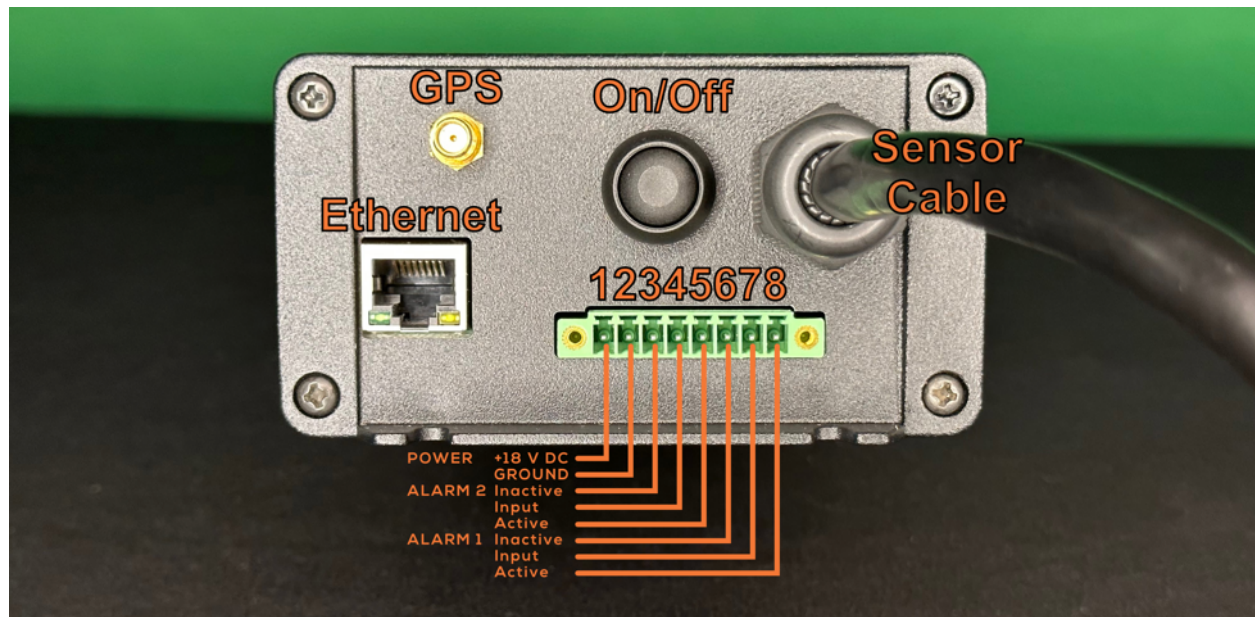
Upgrading the Gecko firmware

The process of upgrading the firmware in the Gecko is very simple. The firmware upgrade file is called **Rasbora.bin** and simply needs to be copied to the root level of your Gecko’s SD card. With the Gecko turned off, insert the SD card, then apply power. After a few seconds you will see a message indicating that it is “Upgrading Firmware”, which only takes a few seconds. The Gecko will then restart and the new firmware features will be available.

A Gecko will only upgrade its firmware if the Rasbora.bin file has a later firmware number, otherwise the file will be ignored. After the upgrade the Rasbora.bin file remains in the root folder of the SD card so that the card can be used to upgrade other Gecko recorders, but it can be deleted from the folder at any time with no adverse effect on the Gecko.

Always check your settings after an upgrade to be sure something has not unexpectedly changed, which can happen when upgrading from much older versions of firmware.

Connector Panel



Technical Specifications

Analogue to Digital Converter: 32-bit ADC on each channel

Input 40V peak to peak (at gain x1)

Pre-gain sensitivity (gain x1 to x4): 406,000* counts per volt

Pre-gain sensitivity (gain x8 to x512): 419,430* counts per volt (all serial numbers)

Data Format: MiniSEED with STEIM-1 compression

Stored as 24-bit number ($\pm 8,388,608$ counts)

Frequency Response: Flat from DC to ~40% of sampling frequency

**Nominal ‡See our website to download the Gecko Data Sheet for full technical specifications for each model*

Sampling and Linear Phase Filter Stages & Coefficients

32-bit ADC Rate FIR Filtered	Apply Gecko FIR filter	Decimation	24-bit Output Rate	Band Code
250	YES	/5	50	B
500	YES	/5	100	H
1000	YES	/5	200	H
250			250	C
2000	YES	/5	400	C
500			500	C
4000	YES	/5	800	C
1000			1000	F
2000			2000	F
4000			4000	F

	32-bit ADC Rate FIR Filter Coefficients			
	SESSION 1	SESSION 2	SESSION 3	SESSION 4
	1/512	1/8388608	134,217,728	134,217,728
1	3	-10,944	0	-132
2	0	0	0	-432
3	-25	103,807	-73	-75
4	0	0	-874	2,481
5	150	-507,903	-4,648	6,692
6	256	0	-16,147	7,419
7	150	2,512,192	-41,280	-266
8	0	4,194,304	-80,934	-10,663
9	-25	2,512,192	-120,064	-8,280
10	0	0	-118,690	10,620
11	3	-507,903	-18,203	22,008
12		0	224,751	348
13		103,807	580,196	-34,123
14		0	893,263	-25,549
15		-10,944	891,396	33,460
16			293,598	61,387
17			-987,253	-7,546
18			-2,635,779	-94,192
19			-3,860,322	-50,629
20			-3,572,512	101,135
21			-822,573	134,826
22			4,669,054	-56,626
23			12,153,698	-220,104
24			19,911,100	-56,082
25			25,779,390	263,758
26			27,966,862	231,231
27			25,779,390	-215,231
28			19,911,100	-430,178
29			12,153,698	34,715
30			4,669,054	580,424
31			-822,573	283,878
32			-3,572,512	-588,382
33			-3,860,322	-693,209
34			-2,635,779	366,118
35			-987,253	1,084,786
36			293,598	132,893
37			891,396	-1,300,087
38			893,263	-878,642
39			580,196	1,162,189
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Register for Updates

We highly recommend registering your Gecko with us so that we can add you to our product update notification list. Simply email sales@src.com.au with your Gecko serial number and we will notify you when Gecko firmware updates and Waves or Streams software updates are available – usually just a few times per year.

You can also register for email updates on the Waves, Streams or Gecko product pages at <http://src.com.au> or directly through the MailChimp service at <http://eepurl.com/hgD3HD>

You can opt out of emails at any time using the automated Unsubscribe link in the emails.

Warranty

Seismic equipment manufactured by ESS Earth Sciences 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 ESS Earth Sciences 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.

ESS Earth Sciences 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 ESS Earth Sciences; and to return the goods within the warranty period.

Extended warranty

Extensions to the standard 12-month warranty are available. These are available at the time of purchase, or at any time before the expiry of the original warranty. Extended warranties have the same conditions as the original warranty. Please contact ESS Earth Sciences for further information.

Products that are out of warranty can be returned to the factory for refurbishment and will then qualify for extended warranty. Contact ESS Earth Sciences for further information.

Seismology Research Centre - www.src.com.au

ESS Earth Sciences - www.essearch.com

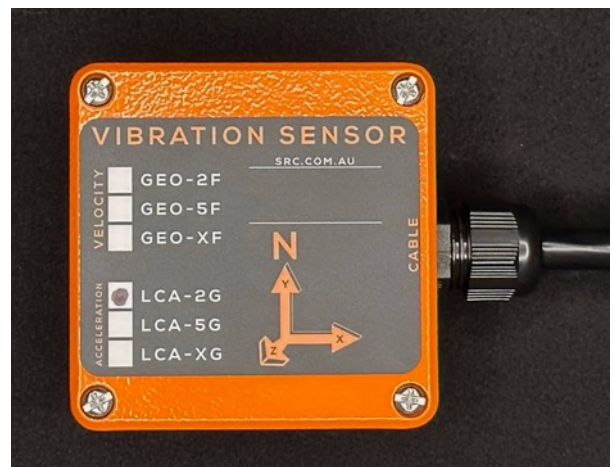
Appendix A

Mounting the Gecko ERI sensor

To install a Gecko ERI $\pm 2G$ sensor (also known as an LCA-2G), you'll need a hammer drill, a hammer, and the included installation kit that comprises a mounting plate, countersunk M8x12 screw, and an M8 drop-in anchor. **A reusable toolkit** comprising Phillips head screwdrivers (PH02 and PH03), a 10mm masonry drill bit, #3 metric Allen key, and anchor setting tool is also required and is **available for separate purchase**.

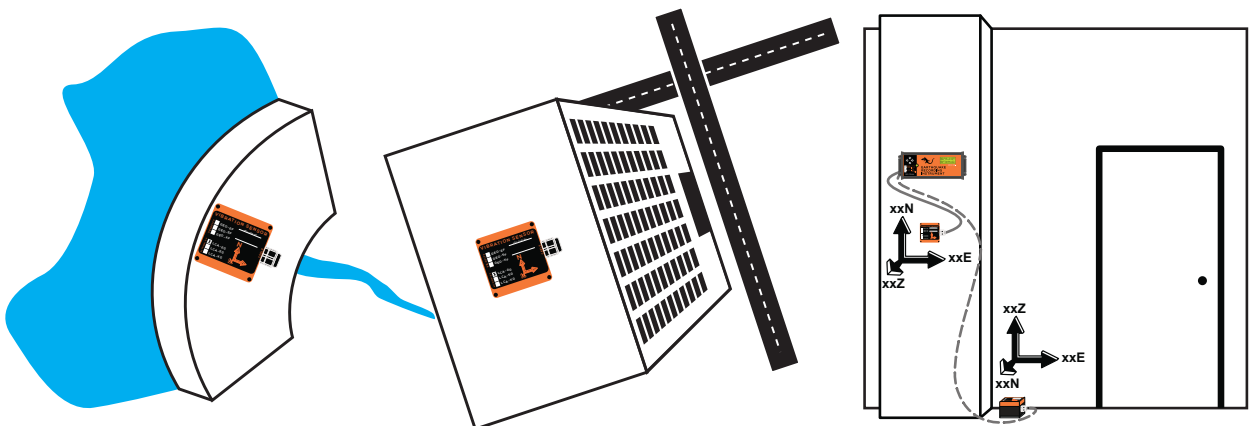


The LCA-2G label indicates the axes of the sensor when installed on the ground, but if the sensor is installed on a wall, the axes will no longer correspond to the East, North, and Up. When mounted on a wall with the "N" arrow pointing up, channel xxE (East) shows motion along the wall (i.e. left to right), channel xxN (North) shows vertical motion, and channel xxZ (Up) shows the back and forth motion of the wall (i.e. perpendicular to the wall).



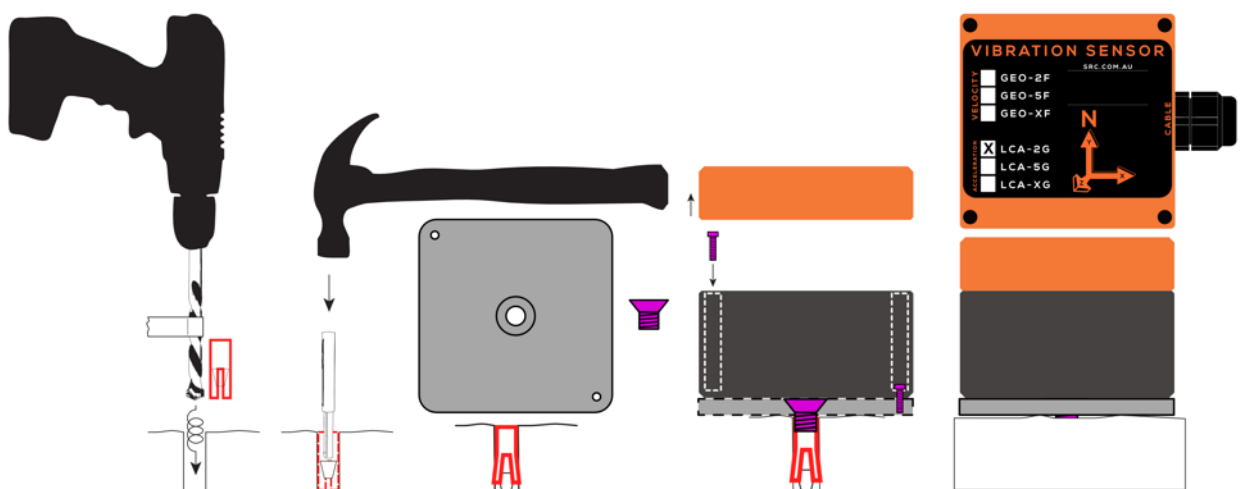
Orienting your recorder depends on your application. We recommend:

- For earthquake monitoring, rotate the sensor so that the arrow is pointing North
- For dam monitoring, point the North arrow along the dam wall with East direction pointing downstream
- For building monitoring, align the arrow of the Gecko to the axis of your building that is closest to North
- If mounting on a vertical column, align the sensor with the arrow pointing up.



Installing the mounting plate & sensor

1. Use a 10mm masonry bit and your hammer drill, make a hole in the floor or wall for the drop-in anchor. Measure the depth of the anchor and place a mark or some tape on the drill bit so you know how deep to drill the hole.
2. Drop the anchor thread-side up into the hole. Gently tap it down with a hammer until the top of the anchor is flush with the surface.
3. Insert the tapered end of the anchor setting tool into the anchor.
4. By tapping down the embedded spreader, the anchor will bite into the hole. A few firm taps of your hammer will be enough to punch the spreader to the bottom of the anchor.
5. Place the mounting plate over the anchor and insert the countersunk screw through the plate's central hole, then screw it into the anchor using a PH03 screwdriver. After tightening, ensure the plate is flush with the surface and does not rotate.
6. Before proceeding any further, ensure the Gecko ERI is switched off so that no power is being delivered to the LCA-2G sensor.
7. Remove the 4 screws from the lid of the LCA-2G sensor using a PH02 screwdriver. You will notice two M4 socket head screws in two of the mounting holes. Move them to the holes that align with the tapped holes in the mounting plate, then screw the sensor down to the mounting plate using an M3 Allen key.
8. Replace the lid of the sensor, using the "CABLE" marking on the label to check the lid's orientation, then screw the lid back on to the sensor case.



Appendix B

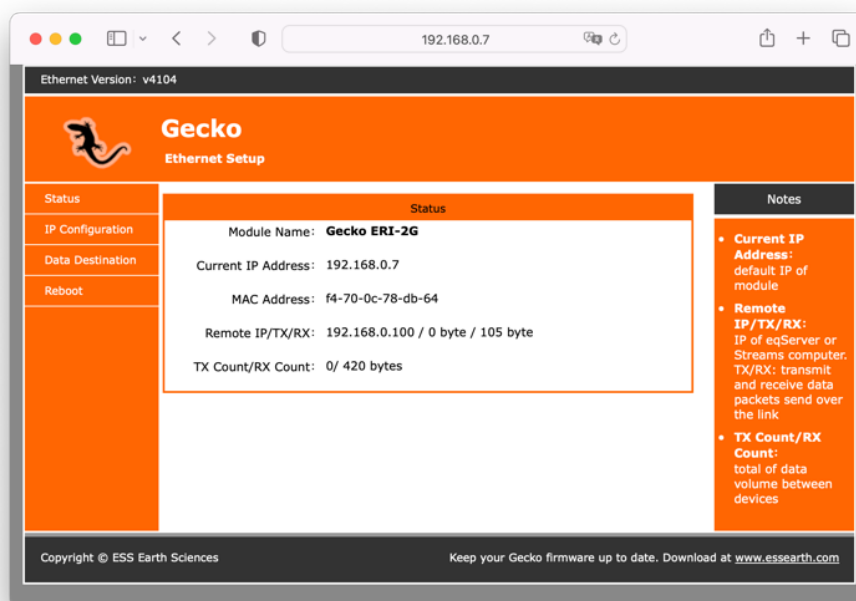
Gecko ERI Ethernet Interface

You can stream seismic data over a Local Area Network (LAN) or over the Internet in real time to our Streams application or to our cloud-based eqServer data management system via the Ethernet port.

To configure the Ethernet port, use an Ethernet cable to connect the Gecko ERI's Ethernet port to your computer's Ethernet port. You will need to configure the IP address of your computer to be 192.168.0.100 with a subnet mask address of 255.255.255.0.

Once your computer's IP address is saved, open a web browser and type **http://192.168.0.7/** into your web browser. When prompted, log in with username and password **admin** and **admin**.

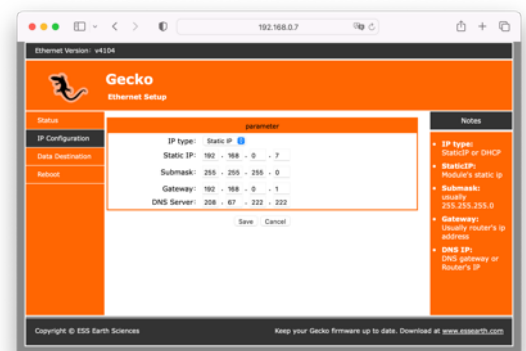
You will be presented with the web page below after logging in.



If you need to change the IP address of the device to use it on your network, click on the the IP Configuration menu on the left.

IP Configuration

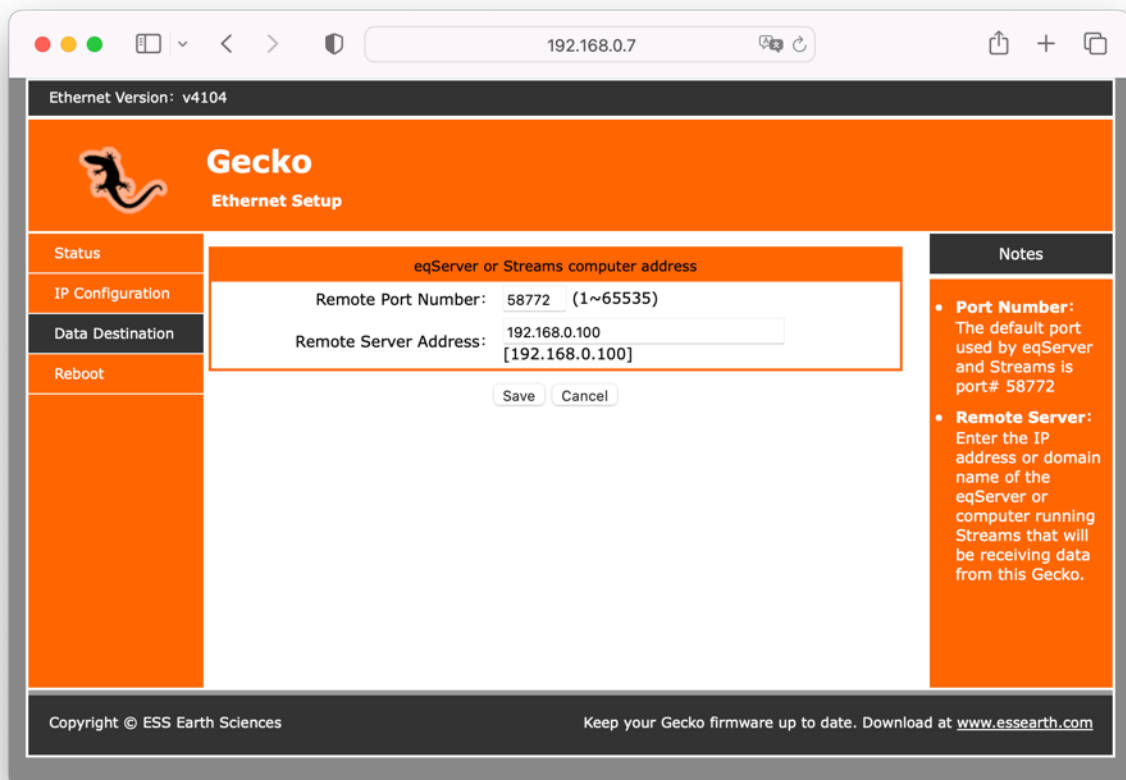
If you change the IP configuration of your device, be sure to note down these changes so that whoever connects to the device knows what IP address to use on the device. Consult your IT administrator for assistance with setting up the device on your network.



Data Destination

The main setting that you will need to change in the Ethernet adaptor's web page configurator is the destination of the data – i.e. the address of the remote computer where you want the data to appear. This be a Windows/macOS/Ubuntu computer that is running Streams, or to a Ubuntu server that is hosting instance of eqServer or Seismosphere.

If you are running Streams on your computer that is connected to the Gecko ERI, set the "Remote Server Address" to your computer's IP address, which should be 192.168.0.100. Data should start to appear in Streams almost instantaneously.



If you wish to stream data to another computer on your network, enter that computer's IP address in that field. If you wish to stream data to a remote computer on the internet, you can enter the IP address or domain name of that computer in the address field. If you are using a domain name, ensure that the Gateway and DNS Server addresses are valid in the IP Configuration page.

The default communication port for a Gecko is 58772, which is also the port expected by Streams/eqServer/Seismosphere. You can change this port number if it conflicts with another service on your network, but it will also need to be changed on the reception computer. See the Streams user manual for more information.

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