# Güralp Artius

## *Technical Manual*

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*Designed and manufactured by*
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# 1. Preliminary Notes

## 1.1. Proprietary Notice

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## 1.2. Notes Cautions and Warnings

Note Cautions and Warnings are displayed and defined as follows:

**Note:** Indicates a procedural or advisory information

**Caution:** Highlights a condition or action that, if not followed, may result in equipment damage, reduced performance, or loss of data.

**Warning:** Alerts to a hazard that could result in personal injury or serious damage to the equipment if ignored.

## 1.3. Manuals and Software

All manuals and software referenced in this document are, unless stated otherwise, available from the Güralp Systems Ltd website: www.guralp.com.

## 1.4. Conventions

Throughout this manual, examples of command-line interactions are shown in a fixed-width typeface:

```
fixed-width example
```

Commands you must type appear in **bold**:

```
bold fixed-width example
```

Variable elements you must replace with values specific to your configuration are blue and shown in bold:

```
Bold blue fixed-width example
```

Putting these together into a single example:

```
System prompt: User input variable parameter
```

On-screen buttons referenced in procedures are shown using the following style:

Example Button

# 2. Overview

Thank-you for purchasing the Güralp Artius broadband node.

The Güralp Artius is an advanced, ultra-compact 3-component digital broadband seismic node designed for rapid, high-density seismic deployments. It features internal 24-bit digitiser, GNSS, Bluetooth and miniSEED output.


## 2.1. Key Features

- Digital, three-axis, broadband, force-feedback seismometer.
- Flat response to ground acceleration from 30 s to 200 Hz.
- Standard gain equivalent to 500 V/ms$^{-1}$.
- Selectable sample rates from 1 to 1000 samples per second.
- Compact form, measuring just 80 × 80 × 105 mm$^3$ and 1.4 kg weight.
- Single port for connection to power supply and docking station.
- Internal ±2 g MEMS accelerometer for orientation.
- Identification of IP address via Güralp Discovery software and docking station.
- Optional docking station (fits up to 8 Artius) for configuration and data handling operations.
- Android app for installation integrity checking via Bluetooth.
- Data storage with 64 GB microSD card (option of 128 GB).
- In-built GNSS receiver, compatible with GPS, GLONASS and Galileo constellations (BeiDou optional).
- Optional Power Pack Module (PPM) with rechargeable lithium batteries and integrated charge controller.

## 2.2. Typical Applications Examples

- Network densification
- Temporary seismic investigations
- Rapid response
- High resolution imaging
- Microseismic monitoring
- Aftershock studies
- Environmental and induced seismicity monitoring

## 2.3. System Description

### 2.3.1. Digital Broadband Node

The Güralp Artius is a broadband triaxial seismometer integrated with a Minimus Lite digitiser front end. The Minimus Lite acquires data from the instrument and provides direct control of its operation.

### 2.3.2. Internal GNSS

The in-built GNSS receiver supports the GPS, GLONASS and Galileo satellite constellations, with BeiDou as an option. The top panel of the Artius is made of tempered glass to provide the GNSS receiver with an unobstructed view of the sky for signal acquisition.

### 2.3.3. Single Connector

The Artius is equipped with a single connector on the rear panel, which supplies power and supports communication via an M12 Automation Connector (Decoding M12).

### 2.3.4. LED indicator

Artius units have an LED indicator on the top, which provides status and configuration information.

When powered-up, the Artius' LED will indicate its status. After the startup - during which the LED is white ⚪ - the LED repeats a sequence of three flashes, followed by a pause:

- Flash 1: SD card status
- Flash 2: Centring sensor status
- Flash 3: GPS time lock

Each flash is either:

- Green 🟢: Status OK / good GPS lock
- Red 🔴: Status error / no GPS lock

The LED flashing blue 🔵 indicates active data offload.

Example:

🟢🟢🔴 🟢🟢🔴 🟢🟢🔴

SD card is recording, sensors are centred, but lock to GNSS has not been achieved.

### 2.3.5. Bluetooth Connectivity

The Artius features Bluetooth connectivity, allowing sensor and state-of-health data to be monitored using the Güralp GüVü app running on an Android mobile phone or tablet.

Bluetooth can be disabled via software to save processing power, but the hardware module cannot be switched off. BLE (Bluetooth Low Energy) technology is used to minimise the power requirement. The Bluetooth transmitter/receiver is in permanent standby mode and always ready to receive a connection from a phone or tablet.

### 2.3.6. MEMS Accelerometer

The Artius is equipped with a triaxial Micro Electro-Mechanical System (MEMS) accelerometer with a measurement range of ±2 g. The three axes of sensitivity, Z, N and E, align with those of the main seismometer outputs.

### 2.3.7. Data Storage

The Artius uses a microSD card to store seismic data within the instrument. The microSD card is internal and cannot be removed by the user. The standard storage capacity is 64 GB, but it can be increase to 128 GB upon request when placing the order. Data is recorded in miniSEED format, while metadata is stored in dataless SEED, Station XML and RESP files.

## 2.4. Package Content

The Artius package includes:

- Artius seismic node
- Artius power-data cable
- Docking Station with power cable (optional)
- Accessories, such as Power Pack Module, deployment feet or spikes (optional)

### 2.4.1. Artius Seismic Node

Description in Section 2.3.

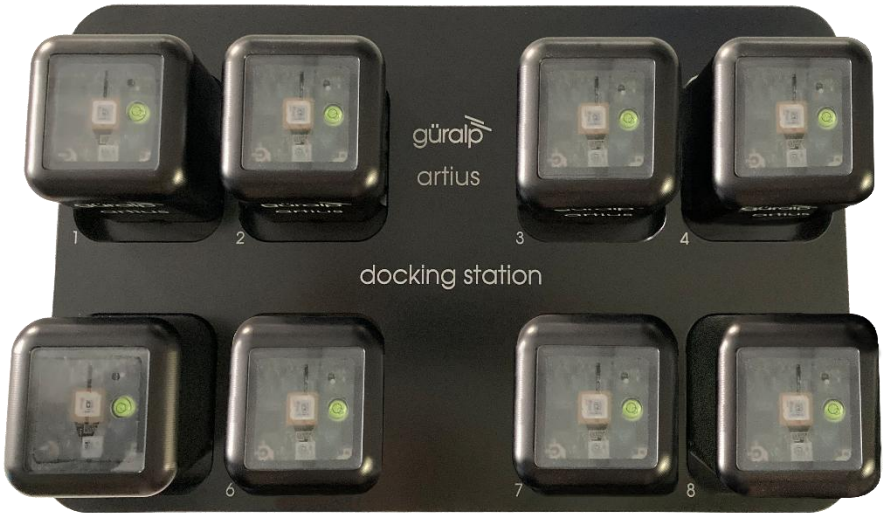
### 2.4.2. Power-Data Cable

The Artius comes with a dedicated power-data cable with a M12-D-Coded automation connector on one end and bare ends at the other. The power-data cable connects to the single connector on the Artius' rear panel (see Section 2.3.3)

Pin-out details are provided in Section 8.1.

### 2.4.3. Docking Station (Optional)

The Docking Station supports up to 8 Artius nodes, optimising both pre-deployment configuration and post-deployment data transfer. The Artius nodes are inserted vertically and slide into place.




The docking station provides power to each Artius units, so no external power supply is required. The docking station is connected to power through a single connector.

Two separate Ethernet ports on the rear of the Docking Station provide access to slots 1-4 and 5-8. When used in conjunction with our Discovery application a dedicated interface streamlines configuration and data download. An Ethernet switch, or similar equipment, is required to connect both rows of the Docking Station simultaneously.

### 2.4.4. Power Pack Module (Optional)


The Güralp Power Pack Module (PPM) is a smart charge-controller and battery system that can provide continuous power to an Artius unit. It can be used either as a stand-alone battery for short-term, off-grid deployments or as power source in a solar-powered installation. When used with solar panels, the integrated charge controller operates on the MPPT (Maximum Power Point Tracking) principle to continuously adjust its input impedance to draw the maxim power from the connected solar panel, under varying light conditions.

**Note:** Please refer to the Power Pack Module manual for more details and user instructions.

A version of the PPM with modem incorporated is available for online deployments. Contact sales@guralp.com for more details.

## 2.4.5. Deployment Feet or Spikes (Optional)

The Artius can be supplied with deployment feet, one spike or three smaller spike to suit various styles of deployment and types of terrain. The recommended setup of the Artius is described in Section 7.1 and involves burying the instrument along with the connected cable and power supply. This helps to mitigate noise generated by the local environment and provide better coupling.

Should the ground be too hard or hazardous to dig into, the 250mm or 162mm spike(s) can be attached to the Artius to secure it firmly while leaving the instrument at the surface.

Artius may be deployed on its standard feet in environments which have already been shielded from local noise and coupled to the ground, such as on top of a concrete base of a seismic station. In this setting, the instrument may also be placed in a box and surrounded by sand for additional coupling and thermal insulation.


## 2.5. Companion Software

This section introduces the Güralp software available for interacting with Minimus.

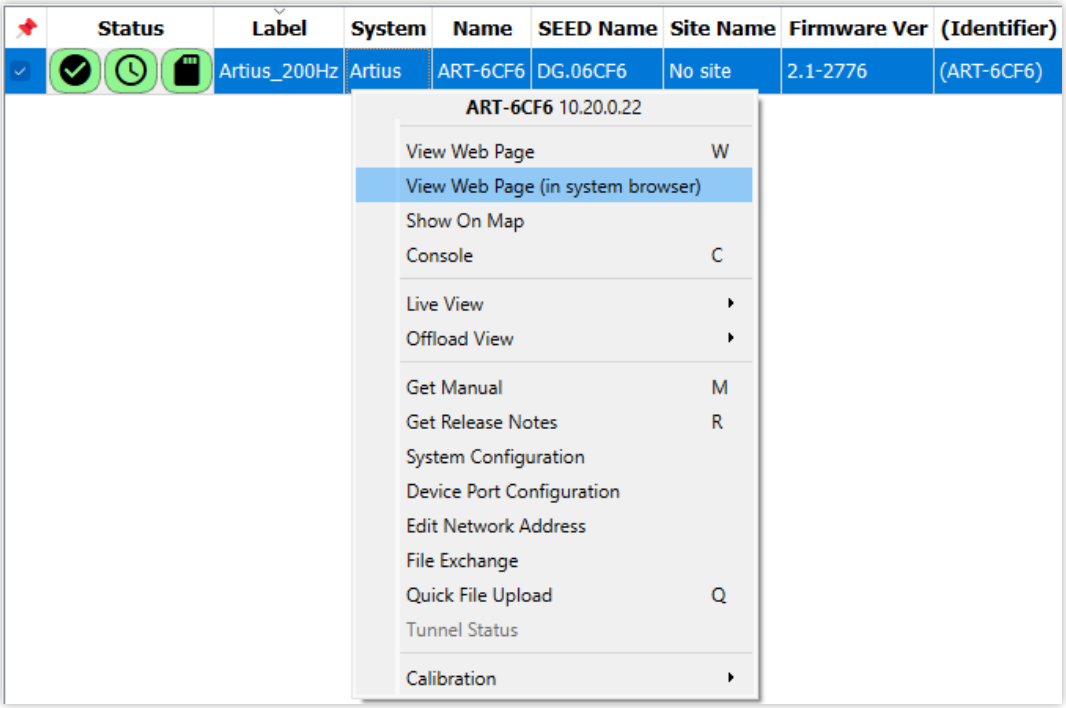
### 2.5.1. Discovery

Güralp's Discovery software for Windows and Linux allows users to configure instruments, monitor state-of-health, view waveforms, acquire data and perform analysis on live or recorded data via filtering or creating plots - such as a PSD or Spectrogram. It can locate instruments on a local network and, when configured, enable remote access to networked instruments in the field.

**Note:** Comprehensive guidance for Discovery is beyond the scope of this document, see the full Discovery manual: MAN-DIS-0001.

### 2.5.2. Web Interface

The Artius hosts a web server accessible via any browser, providing a user-friendly interface for monitoring and configuration. Users can view sensor readings, adjust parameters, manage data streaming, and access data retrieval tools. This webpage is accessible by right-clicking the Artius entry in Discovery. Selecting the (in system browser) will open the webpage in the user's default browser and is recommended for ease of downloading data.




### 2.5.3. GüVü

The GüVü Android app enables monitoring and control of nearby instruments via Bluetooth, particularly useful for verifying post-deployment configurations in the field. Instructions for using GüVü are provided in Section 5 of this manual.

# 3. Configuration

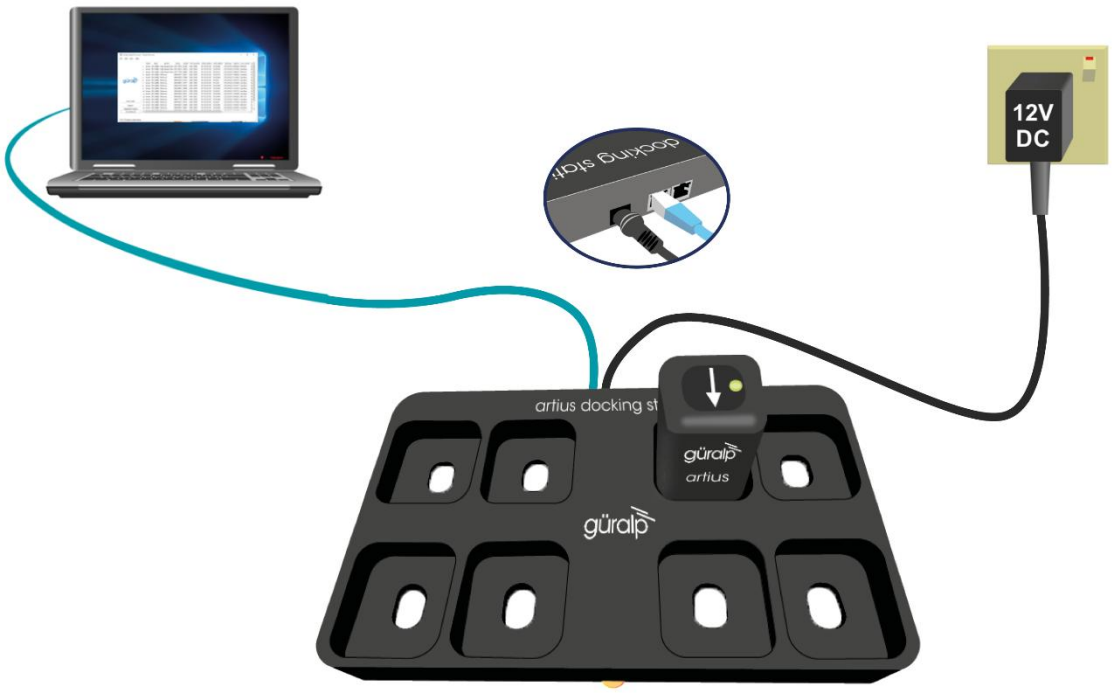
> **Note:** Güralp strongly recommends exploring and familiarising yourself with the Artius in a controlled environment, such as your lab or office, before deploying it in the field.

## 3.1. Physical Setup

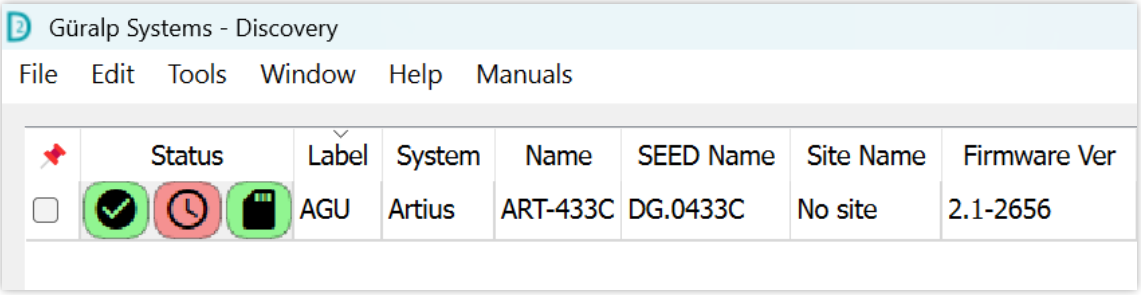
First connect the Docking Station, described in Section 2.4.3, to power using the mains-12VDC cable provided. The Artius slots into one of the 8 provided slots along the white rails and into the power and data port. The Artius should sit firmly in the Docking Station. Once connected, the Artius' LED will start flashing with the sequence described in Section 2.3.4.

> **Note:** A full 3D GPS lock requires a clear view of the sky and may not be achievable when the device is operated indoors or in areas with significant obstructions. Even with an unobstructed view of the sky, the GPS receiver may require up to 15 minutes after initial power-up to acquire a stable 3D satellite lock on the Artius.

Connect to correct ethernet port of the Docking Station to an ethernet switch configured to your local network or directly to your laptop/PC.




The Artius will appear as an entry in Discovery.




**Note:** If the Artius does not appear in Discovery, try connecting the Ethernet cable to the other Ethernet port on the rear of the Docking Station, as each port services a different instrument row.

## 3.2. Access the Web Interface

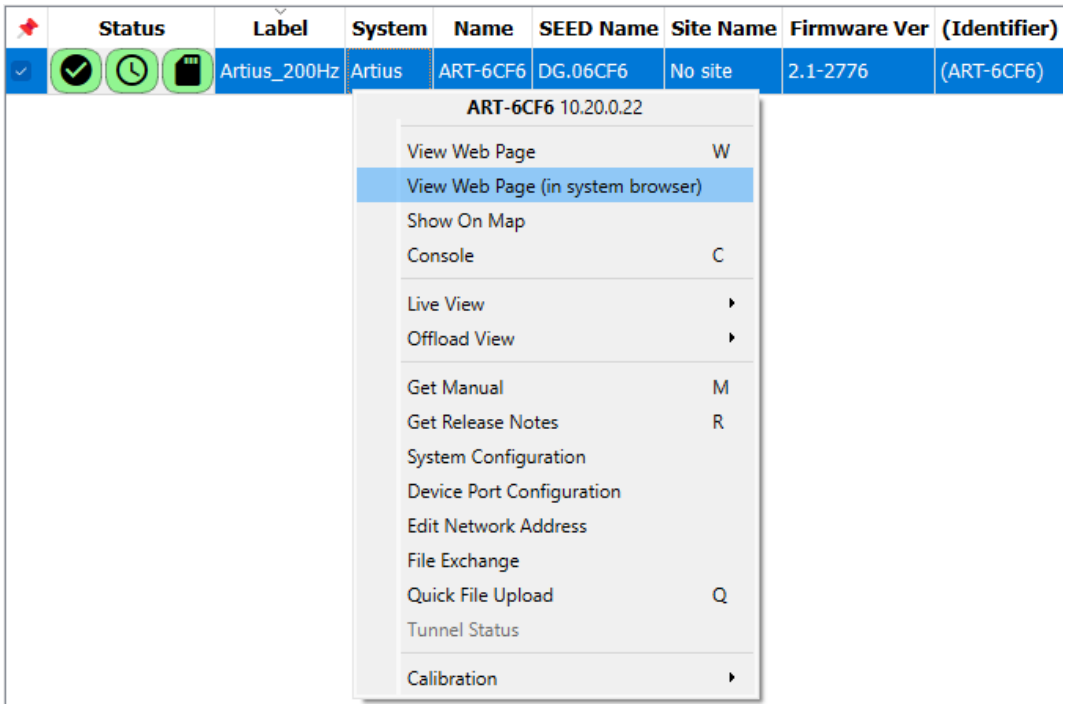
By default, the Artius uses DHCP (Dynamic Host Configuration Protocol) to obtain an IP address. If no DHCP server is available, the Artius will fall back to a link-local (APIPA) address in the range 169.254.0.1 to 169.254.255.254 with a subnet mask of 255.255.0.0. In this case, a directly connected laptop configured for DHCP will also assign itself an APIPA address, allowing direct communication without additional network configuration.

### 3.2.1. Finding the Artius with Discovery

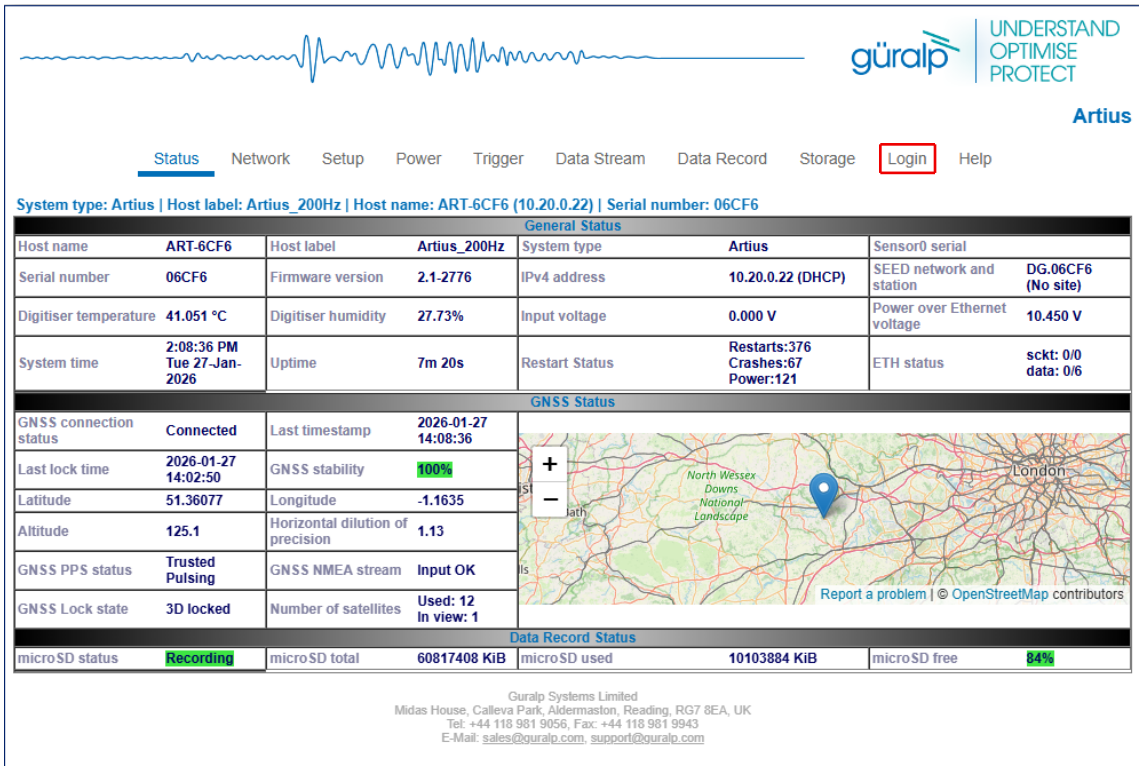
Once the Artius and your laptop are on the same subnet, opening Discovery will list all Güralp devices on the local network. To refresh the list, click the Scan locally button in the bottom left corner.

### 3.2.2. Logging In

To access the Artius web interface, right click its entry in Discovery and select 'View Web Page', the (in system browser) option is recommend for ease of downloading data.



This will open the webpage on the Status tab. Use the Login option to access further information and functionalities.




This will open the login page.

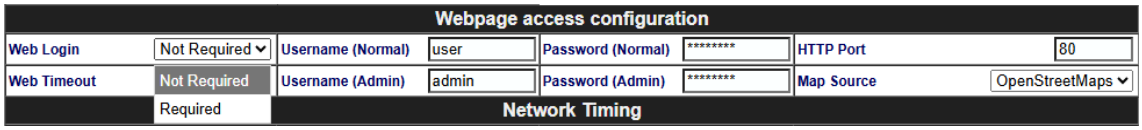

The Minimus web interface provides two levels of access: **administrator** and **user**. Each level has default credentials as follows:

| Access Level | Username | Password | Description |
|---|---|---|---|
| User | user | user | Limited access to core settings. Configuration controls are restricted. |
| Admin | admin | admin | Full access to all configuration settings, including network, setup, and sensor parameters. |

**Note:** For regular use and basic configuration changes, Güralp suggests logging in as `user`. Log in as `admin` only if necessary to unlock features only available in the administrator account.

### 3.2.2.1. Changing Default Credentials

After logging in as an administrator, you can manage web access options from the Network page. Here, you can select whether the web interface should always prompt for login or allow automatic access as the user account with the Web Login drop down.




The same menu also provides controls for changing the username and password of both the user and administrator accounts. Updating these credentials is strongly recommended to improve security.

## 3.3. Web Interface Overview

The Minimus web interface is organised into several main pages, each providing access to settings and functions. The list below gives a brief overview of the purpose of each page:

1. **Status:** Displays the current operational state of the device, including sensor firmware version, humidity and temperature, GNSS status, SD card state, etc. Use this page to monitor the overall health of your Artius station.
2. **Network:** Provides configuration options for basic and advanced networking features, as well as control over security settings and timing sources.
3. **Setup:** Allows configuration of the station's SEED codes, Bluetooth PIN and calibration signals.
4. **Power:** Available when used with the Power Pack Module described in section 2.4.4
5. **Trigger:** Enables setup of triggers to generate events when predefined thresholds are breached.
6. **Data Stream:** Provides options to configure channels to stream.
7. **Data Record:** Provides options to configure channels that will be recorded to the onboard SD card.
8. **Storage:** Provides access to recorded miniSEED data, as well as metadata and logs.

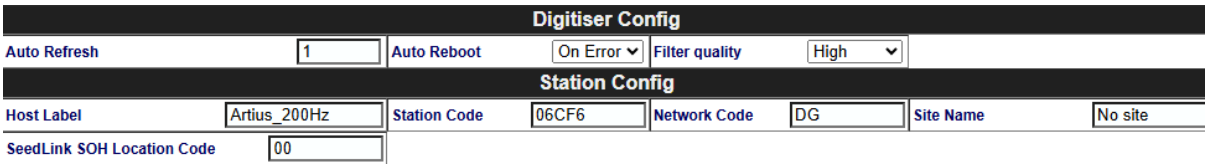
## 3.4. Station Metadata

In this section we discuss naming conventions, focusing on SEED (Standard for the Exchange of Earthquake Data) names and how to configure them for your station. While the guidance provided here is advisory, it is recommended to establish a consistent naming scheme for your network to support future expansion.

SEED names are standardized identifiers used in seismology to uniquely label stations, networks, and channels. They consist of a network code, station code, location code, and channel code, allowing instruments and data streams to be easily recognised and analysed. You can read more about SEED names on Earthscope website: SEED Channel Names

To configure your station names, login as either user or administrator and navigate to the Setup tab. Under the heading "Station Config" you will find several fields that define your

station's identity and how it is represented both in the interface and in SEED-formatted data. Some fields are used for SEED naming, while others are for display purposes in Discovery and the web interface:




| Field | Description | SEED-related |
|---|---|---|
| Host Label | A user-friendly name for the instrument in the web interface and Discovery. | No |
| Station Code | The station code used to identify this station, forming the second part of a SEED name. | Yes |
| Network Code | A two-character identifier for the network this station belongs to, forming the first part of a SEED name. | Yes |
| Site Name | A descriptive name for the station location in Discovery. | No |
| SeedLink SOH Location Code | The SEED location code used for text-based status messages in SeedLink. | Yes |

# 3.5. Timing Options

The Artius system synchronises its sample clock using an integrated GNSS receiver.

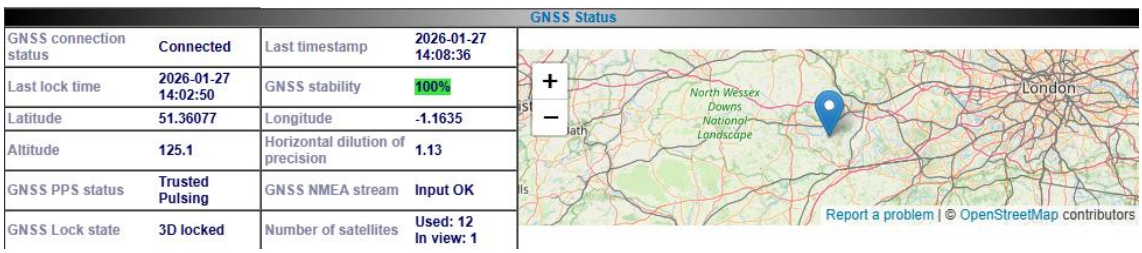
The currently supported GNSS systems are Navstar (GPS), GLONASS, BeiDou and Galileo.

**Note:** The GNSS can use only three different types of satellites simultaneously and GPS is always used, if available. The other two spots available can be either GLONASS, BeiDou or Galileo.

If visibility of the satellite constellation is available, this is the most accurate way to synchronise your Artius.

## 3.5.1. GNSS lock status

This is available in the Status tab of the instrument's web page.




A number of GNSS reporting parameters are given, including:

- Connection status

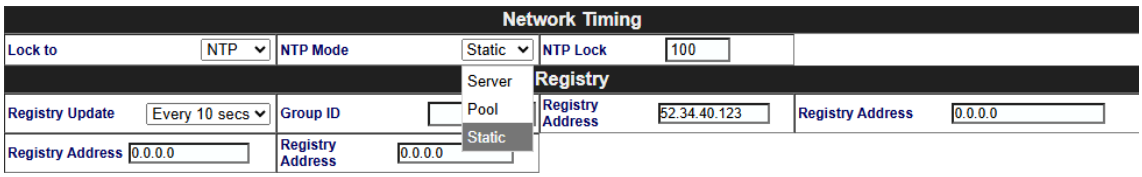
- Last GNSS update (sync) & last GNSS lock date/time
- GNSS Stability:
- 0% = no receiver connected.
- 1% = receiver connected, but waking up (this can occur if the GNSS receiver has been moved a long distance since last power-up).
- 2-99% = view of sky obstructed.
- 100% = normal operation with clear view of sky
- Latitude, longitude, altitude
- Horizontal dilution of precision (quality of satellite fix due to position of satellites relative to receiver)
- GNSS PPS status
- GNSS NMEA streaming
- GNSS lock state (No lock/2D/3D)
- Number of available satellites (in use / in view)

### 3.5.2. NTP (Network Timing Protocol) configuration

This gives the system time to within 1 second. It is not generally recommended that this is used as the main time source for deployments. GNSS offers accurate time for this purpose.

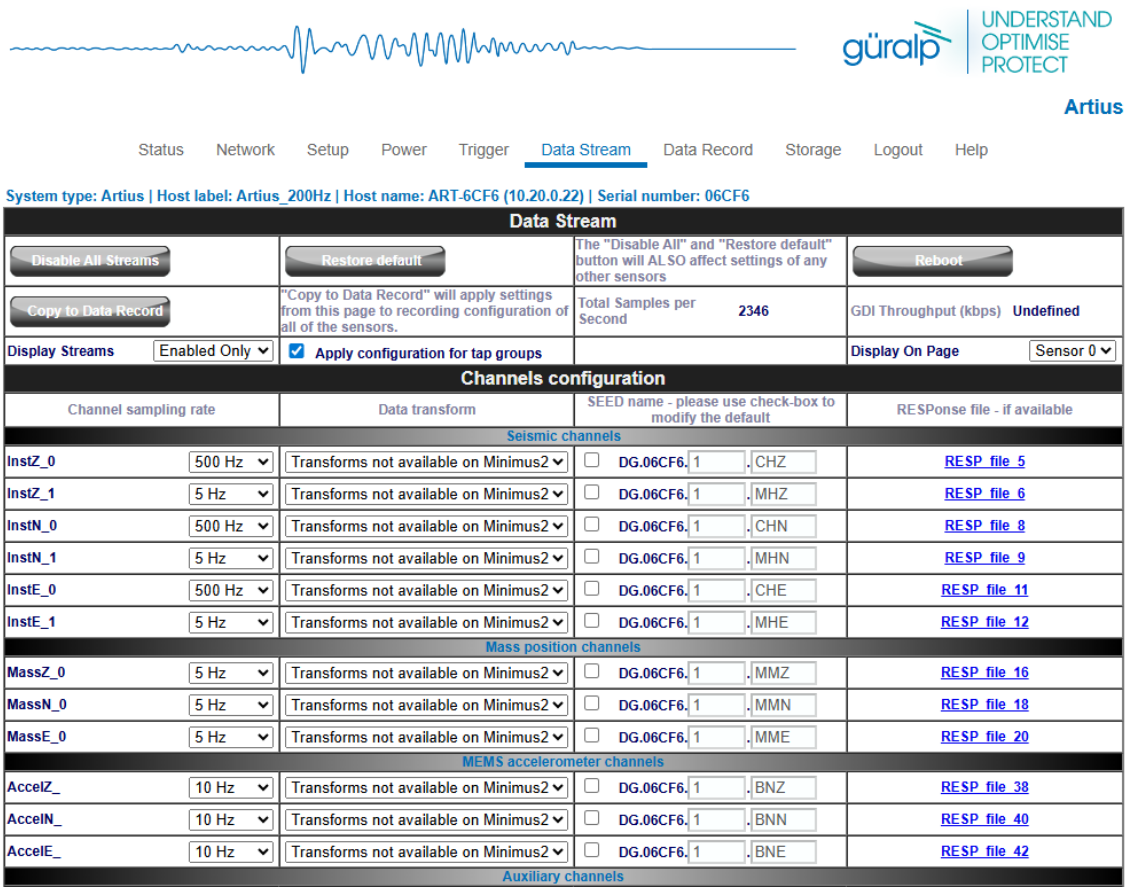
By default, the NTP server option (located under the Network tab of the instrument's web page) is set to "Pool" which uses the virtual server pool `pool.ntp.org`. This accesses a dynamic collection of networked computers that voluntarily provide moderately accurate time via the NTP to clients worldwide.

Alternatively, it is possible to specify the IP address of your preferred NTP server. To do this, select the "Static" option from the "NTP server" drop-down menu, which activates the "NTP IP Addr" setting, and enter the IP address of your NTP server here.




## 3.6. Data Transmission

The monitoring and configuration of transmitted data is handled using the **Data Stream** tab of the instrument's webpage.




A brief description of each channel is available by hovering the mouse cursor on the channel name.

> **Note:** When changing a setting in the Artius webpage, ensure that you wait until the page refreshes before changing another setting. This allows time for the previous change to take effect.

The drop-down box named Display Streams found within the Data Stream section of the page filters out visible channels with options for All, Enabled Only and Disabled Only.

The option Apply configuration for tap groups automatically applies the same configuration to the three streams that belong to the same tap (*e.g.* InstZ_0, InstN_0, InstE_0).

The Channel configuration section is divided into four columns:

- In the first column “Channel sampling rate”, drop-down boxes are available for each channel to either select a sample rate or to exclude the channel from streaming by selecting the Disabled option (under the lowest sample rate available). All channels can be stopped from being streamed by clicking the Disable All button. The same configuration can be applied to recorded channels by clicking the Copy to Data Record button. The default channel configuration can be applied by clicking the Restore default button.
- Contrary to the Minimus digitiser, transforms are not supported by Minimus Lite and therefore Artius, and this is reflected in the second column “Data transform”.

- In third column “SEED name”, Location and Channel SEED codes can be configured. Options are greyed out with default values applied; they can be edited by clicking on the checkbox at the start of the cell.
- In fourth column “RESPonse file” there are links to the RESP files associated to each of the seismic channels (see Section 4.2.1 more details).

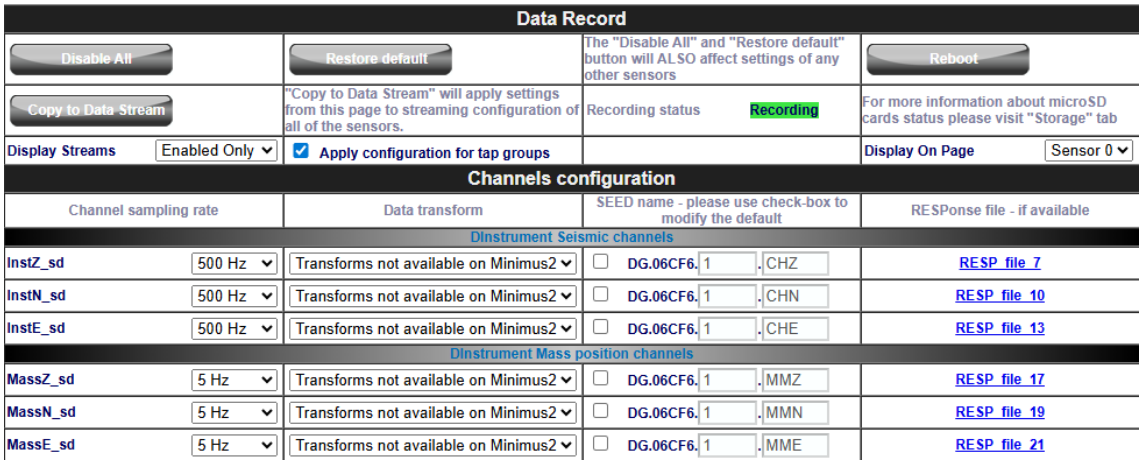
All streaming can be stopped by clicking the Disable All Streams button. The same configuration can be applied to recorded channels by clicking the Copy to Data Record button. Default channel configuration can be applied by clicking the Restore Default button.

Upon changing the sample rate, enabling a transform, or changing Location and Channel codes, the Minimus will need to be restarted for the changes to come into effect; this can be done by pressing the Reboot button. During the reboot, the LEDs will flash, displaying the starting-up sequence (see Section 2.3.4) and you will momentarily lose connection to the webpage.

Once the Artius has successfully rebooted, the full web browser display and controls will be available for use.

## 3.7. Data Recording

The main panel of the Data Record tab in the web interface is shown here:




A brief description of each channel is available by hovering the mouse cursor on the channel name.

**Note:** When changing a setting in the Artius webpage, ensure that you wait until the page refreshes before changing another setting. This allows time for the previous change to take effect.

The drop-down box named Display Streams found within the Data Stream section of the page filters out visible channels with options for All, Enabled Only and Disabled Only.

The option Apply configuration for tap groups automatically applies the same configuration to the three streams that belong to the same tap (*e.g.* InstZ_sd, InstN_sd, InstE_sd).

The page is divided in four columns:

- In the left-most column, drop-down boxes are available for each channel to either select a sample rate or to exclude the channel from streaming (by selecting the “Disabled” option). All streaming can be stopped by clicking the

Disable All button. The same configuration can be applied to real-time transmission channels by clicking the Copy to Data Stream button. The default channel configuration can be applied by clicking the Restore default button.

- Contrary to the Minimus digitiser, transforms are not supported by Minimus Lite and therefore Artius, and this is reflected in the second column "Data transform".
- In third column from left, Location and Channel SEED codes can be configured. Cells are greyed out by default (default values applied) and they can be edited by clicking on the check-box.
- In most-right column contains links to the RESP files associated to each of the seismic channels (see Section 4.2.1).

Upon changing the sample rate, or changing Location and Channels codes, the Artius needs to be restarted for the changes to come into effect; this can be done by pressing the Reboot button. During the reboot, the LEDs will flash, displaying the starting-up sequence (see Section 2.3.4) and you will momentarily lose connection to the webpage.

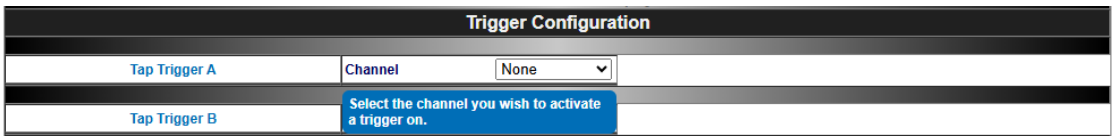
Once the Artius has successfully restarted, the full web browser display and controls will be available for use again.

# 3.8. Earthquake Early Warning

The Trigger tab is dedicated to Earthquake Early Warning settings. These are disabled by default because of the amount of processing resource – and hence, power – consumed by triggering calculations.

## 3.8.1. Trigger Configuration

The Trigger Configuration section of the web page under the Triggers tab enables the user to configure the triggering system. The trigger taps should first be selected from the drop-down list of all possible channels.




The heart of the Earthquake Early Warning subsystem are the triggering algorithms: an STA/LTA (Short-Time-Average divided by Long-Time-Average) and Threshold (level) algorithms.

### 3.8.1.1. Common options

**Channel -** Once this is selected, options will appear to enable the sending of a CAP message, configure the sample rate the trigger will use, select the trigger type, and all the necessary triggering options required.

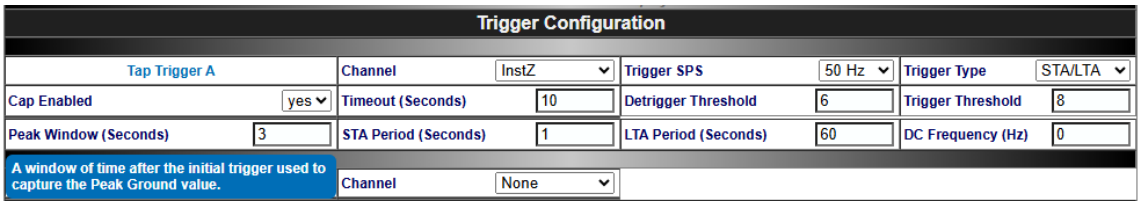
**Trigger SPS -** It is recommended that Trigger SPS is kept the same as the channel it is on. I.e., if InstZ is streaming at 250 sps, then Trigger SPS should be set to 250 sps to perform the best STA/LTA calculations.

**Trigger Type –** STA/LTA or Threshold

**CAP Enabled** – This option will allow the sending of a CAP message on the initial trigger, when enabled it will also show the option for Peak Window which is a time after the initial trigger in which Peak Ground data will be measured. If the Peak Window is set to a number other than 0, a second CAP message will be sent after the window expires containing the peak value measured.

**Timeout** – After an event has occurred, subsequent triggers within this window will be treated as part of the same event (while also restarting the timeout period).

### 3.8.1.2. STA/LTA




The STA/LTA algorithm continuously calculates the average values of the absolute amplitude of a seismic signal in two simultaneous moving-time windows. The short-time-average (STA) is sensitive to seismic events while the long-time-average (LTA) provides information about the current amplitude of seismic background noise at the site.

**Trigger Threshold –** When the ratio of STA to LTA exceeds the set threshold value an event is “declared”. To trigger below a ratio value instead of above, simply set the detrigger threshold to be higher than the trigger threshold.

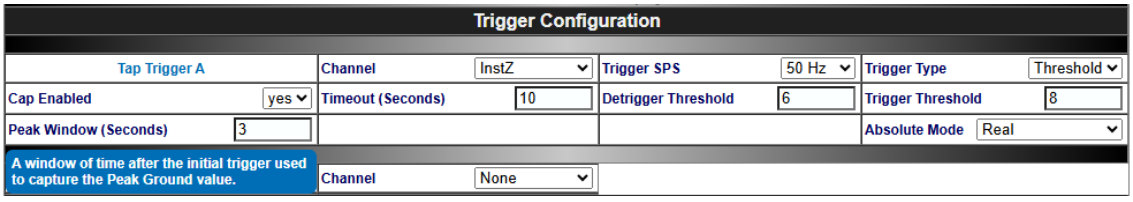
**Detrigger Threshold –** This is the ratio value to stop triggering. This will likely happen within the Timeout. The trigger event itself will only end when the Timeout and Detrigger conditions have been met.

**STA Period –** Number of seconds to measure the short period

**LTA Period –** Number of seconds to measure the long period

**DC Frequency –** The cut-off frequency of the high pass filter in Hz

### 3.8.1.3. Threshold




**Trigger Threshold** - The threshold algorithm, instead, declares the presence of an event when the signal exceeds a particular value. To trigger below a value instead of above, simply set the detrigger threshold to be higher than the trigger threshold.

**Detrigger Threshold** - This is the signal value to stop triggering. This will likely happen within the Timeout. The trigger event itself will only end when the Timeout and Detrigger conditions have been met.

**Absolute Mode –** The signal value used to trigger can be Real, Absolute, or Absolute (No DC). The latter is an option for seismic channels to remove the DC offset.

Although the above is available, it is recommended to use STA/LTA for seismic triggers as it was developed specifically to address the pitfalls of threshold triggering.

## 3.8.2. CAP receiver

The EEW Configuration section of the web page under the Triggers tab controls the CAP message configuration parameters, which include the IP address and Port No. of the CAP message receiver as well as other configuration parameters for the contents of the CAP message.

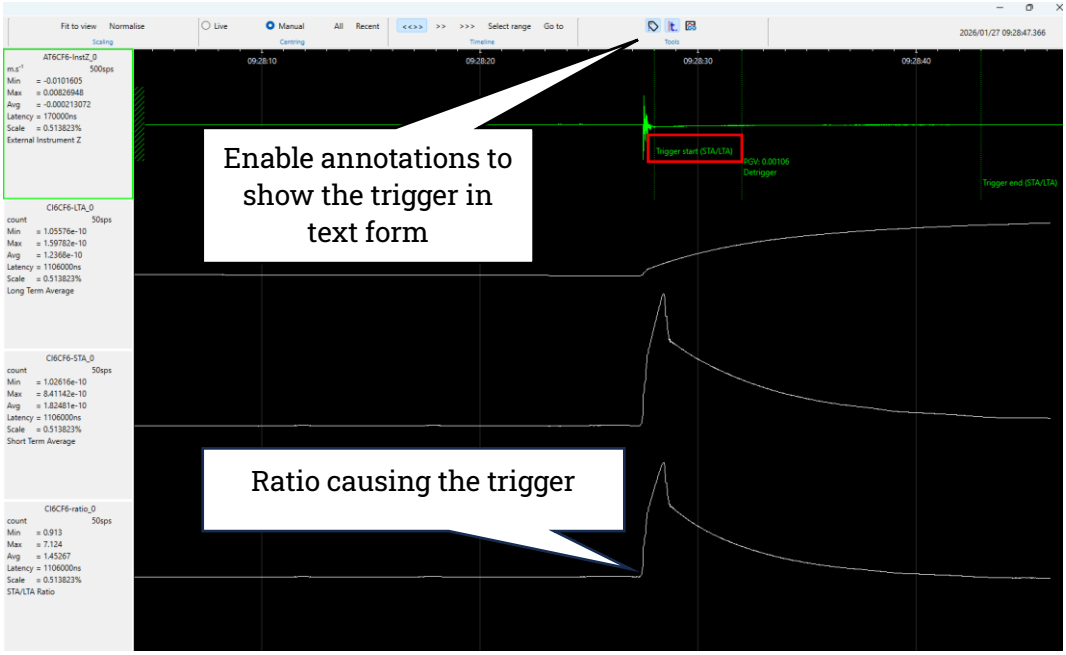
Güralp Discovery includes a CAP (Common Alerting Protocol) receiver. It listens on a specified UDP port for incoming CAP messages. When one arrives, it is displayed and plotted on a map. In addition, the receiver can open a TCP connection to the cloud-based registry server and display CAP messages that have been sent to the registry server.

**Note:** For more details about the Discovery's built-in receiver and configuration of the registry server, please see Discovery manual.

## 3.8.3. STA/LTA Streams

After enabling a trigger, a system reboot is required for the changes to take effect. Once the device restarts, additional data streams become available, displaying the calculated STA, LTA and their ratio (STA/LTA)

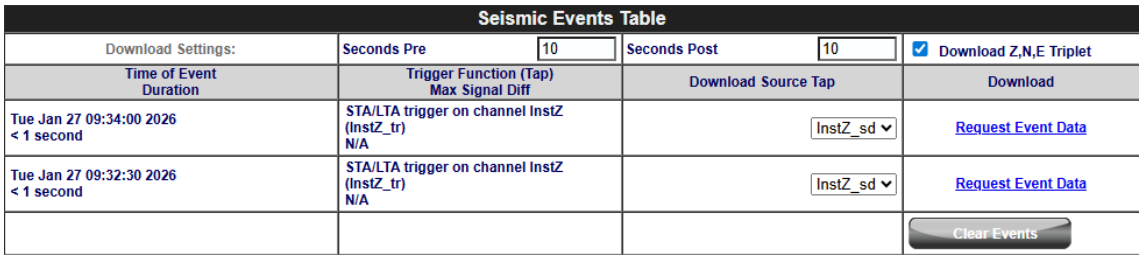
The STA/LTA ratio is evaluated against a threshold configured as described above. Viewing these streams is recommended to better understand the behaviour of the ratio values and to assess the impact of the selected time windows.




## 3.8.4. Seismic Event Table

The Artius can generate a "Seismic Event Table". This is list of events detected by the STA/LTA or threshold trigger enabled on taps. It contains information about the time when the event occurred, its duration, the channel that generated the trigger and the peak magnitude of the event. The seismic data before, during and after the event are saved in miniSEED format and can be downloaded using links in the table.

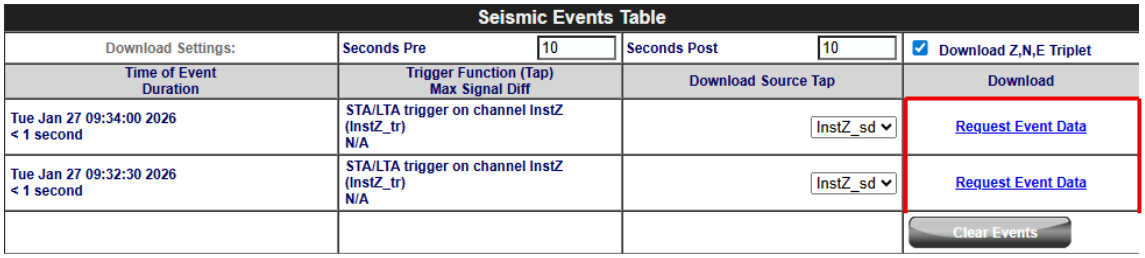
The table is located at the top of the Trigger tab in the web page. It might be necessary to refresh the webpage after a trigger is detected to see the even in the Seismic Event Table.




The Artius allows the download of event data in miniSEED format in a time range that is user selectable. The user can select how many seconds before and after the event detection to include in the miniSEED file.


The event table shows which of the components has caused the trigger and the user can choose to either download data related to that single component by deselecting the option “Download Z,N,E Triplet” or download data for all three components by leaving the option enabled.


The last column of the table contains links to downloaded and saved miniSEED files related to each event.



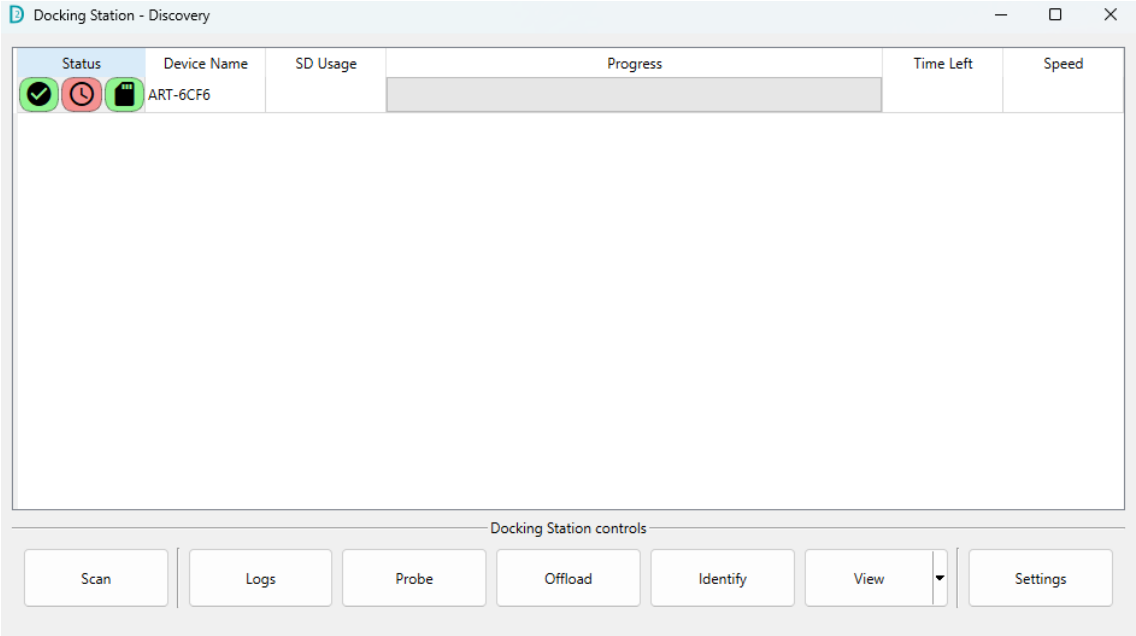

**Note:** The links produce downloadable miniSEED files if and only if the requested data is available in the microSD card. This depends on last flushing time and selected post event time. Use the flush data button in the Storage tab to copy most recent data into the microSD cards (see Section 4.1.2).

# 4. Data Access

## 4.1. Seismic and SOH miniSEED files

### 4.1.1. Data download: Discovery's Docking Station Tool

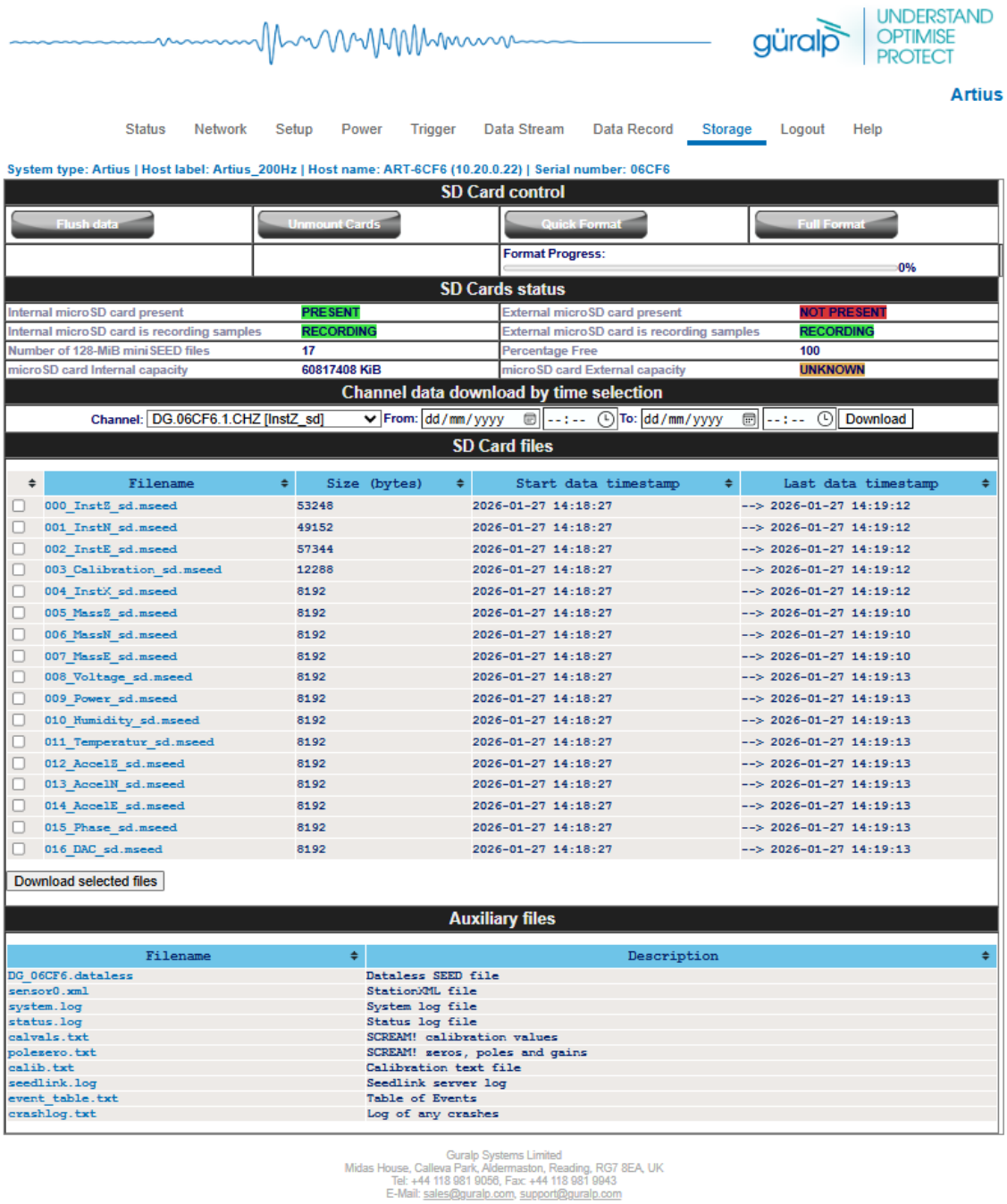
For data handling, including data download, Güralp recommends using the dedicated **Docking Station** tool available in Discovery 2 (version 2.1.3559 onwards): this tool offers a fast and streamlined data download process. The applet is available from the Tools menu of Discovery's main window and looks like in the figure below.




**Note** Please refer to the Discovery manual (under the "Tools Menu" section) for more details and user instructions.

### 4.1.2. Bulk Data Download via Webpage

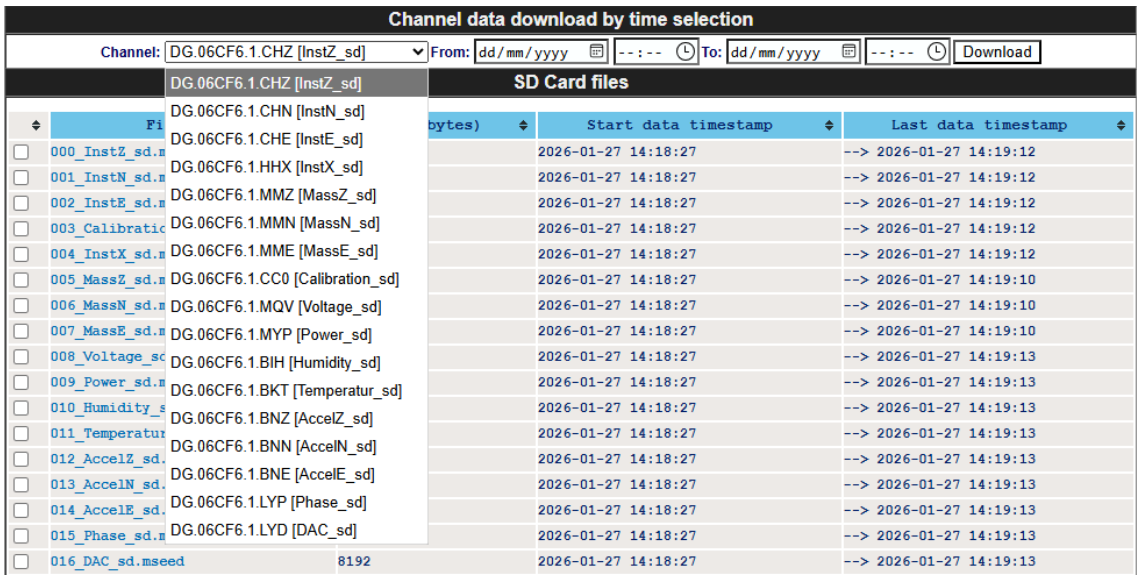
An alternative way to download data from the Artius is through the **Storage** tab of the web interface. This tab displays the miniSEED files stored on the microSD card:



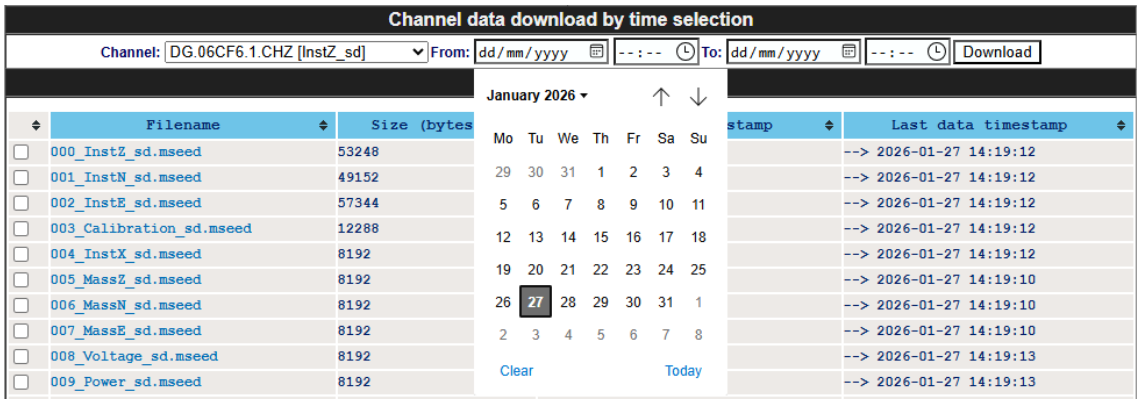

Single or multiple files can be downloaded simultaneously by ticking the check-boxes on the left of each link and clicking on Download Selected Files button. Pressing Flush data is recommended first to force-write the most recent data from the internal buffer to the SD cards.

### 4.1.3. Time-Based Data Download via Webpage

From the Storage tab of the web interface, data for a single stream spanning a specific time-interval can be downloaded. To do this, start by selecting the desired stream from the drop-down menu:




Next select the start and end dates using the pop-up calendar, then the desired time range in 24-hour format :




Lastly, click the Download button to initiate a file transfer to your local device.

### 4.1.4. Bulk Data Extraction via Network

Files stored on the SD card can be downloaded using HTTP. The example bash script below can be used from a Linux PC or from the WSL shell on a Windows PC. The script extracts all files from the SD Card into a directory named after the date and the network address of the Artius.

```
#!/bin/bash
# Invoke with one argument: the network
# address of the Artius

set -x

if [ "$#" -ne 1 ] ; then
  echo "Usage: $(basename $0) network_address"
  exit 1
fi

NET_ADDRESS=$1
DATE=$(date --iso-8601)
SAVEDIR = ${DATE}_${NET_ADDRESS}
echo Saving to $SAVEDIR

mkdir $SAVEDIR
```

```
cd $SAVEDIR
wget -rnp http://$NET_ADDRESS/tab9.html
cd ..

echo Done
```

### 4.1.5. Time Based-Data Extraction via Network

The example Python script below will extract seismic data from the SD card based on a specified time interval. This is similar to the FDSN (International Federation of Digital Seismograph Networks) data archive retrieval service: https://www.fdsn.org/webservices/fdsnws-dataselect-1.1.pdf.

Channel names are as given on the **Data Record** tab of the web interface, and the times are specified in UTC time format. The resulting file will be in miniSEED format.

**Note** The script forms an http request to the instrument in the form of:

http://<<IP Address>>/data?channel=<<Channel>>&from=<<Unix Epoch Seconds>>&to=<<Unix Epoch Seconds>>

which for the example below, would appear as:

http://192.168.254.101/data?channel=DG.TEST.01.CHZ&from=1740114000.0&to=1740117600.0

```
import os
import wget
from obspy import read, read_inventory, UTCDateTime
from obspy.signal import PPSD

######### Start of variable to set #############
sensor = "192.168.254.101"
channel = "DG.TEST.01.CNZ"
start = UTCDateTime("2025-02-21T05:00:00.0")
end = UTCDateTime("2025-02-21T06:00:00.0")
############ End of variables to set ############

startUNIX = UTCDateTime(start).timestamp
#We use the 'start'&'end' to cut the data using Obspy
endUNIX = UTCDateTime(end).timestamp
# We use the 'startUNIX'&'endUNIX' to pull the
# data from the Minimus

#if os.path.exists(r"{0}\tt.mseed".format(temp)):
# See if temp file exists, if so delete.
#os.remove(r"{0}\tt.mseed".format(temp))

if os.path.exists(r"{0}_{1}_{2}.mseed".format(sensor, channel,
start)):
    os.remove(r"{0}_{1}_{2}.mseed".format(sensor, channel,
start))

print(start)

print(r"http://{0}/data?channel={1}&from={2}&to={3}".format(senso
r, channel, startUNIX, endUNIX))
```

```
wget.download(r"http://{0}/data?channel={1}&from={2}&to={3}".form
at(sensor, channel, startUNIX, endUNIX),
r"{0}_{1}.mseed".format(channel,startUNIX))
```

The following example in Bash allows you to extract from the SD card the three seismic components of a sensor for a given date over a specified time frame. It then combines the three components into an individual miniSEED file, whose name will include the network code, station code, start date and start time:

```
#! /bin/bash
# Invoke with one argument: the IP address. For example
./script_name 192.168.254.101

set -x

# enter your network details
net_code=DG
station_code=04D67
location_code=0L

#enter the sensor codes for the location targeted, found on the
Data Stream tab of discovery, the last 3 characters/values of the
SEED name (HNZ)
sensor_code1=HNZ
sensor_code2=HNN
sensor_code3=HNE

# choose the day
day=2024-04-28

# choose the start time in 24-hour format (e.g. 16 = 4pm)
start_hour=16

# choose the number of hours to include in the miniSEED file(e.g.
1 = 1-hour-long miniSEED)
step=1

utc=$(date --date ${day} +%s)
start_utc=$(expr $utc + 3600 \* ${start_hour})
end_utc=$(expr ${start_utc} + 3600 \* ${step})

echo $utc
echo $start_utc
echo $end_utc

wget -v -Oz_component.mseed
http://$1/data?channel=${net_code}.${station_code}.${location_cod
e}.${sensor_code1}\&from=${start_utc}\&to=${end_utc}
wget -v -On_component.mseed
http://$1/data?channel=${net_code}.${station_code}.${location_cod
e}.${sensor_code2}\&from=${start_utc}\&to=${end_utc}
wget -v -Oe_component.mseed
http://$1/data?channel=${net_code}.${station_code}.${location_cod
e}.${sensor_code3}\&from=${start_utc}\&to=${end_utc}

# Convert from Unix timestamp to date and time
date_string=`date -d @${start_utc} +'%Y.%m.%d-%H.%M.%S'`


# In this example, the 3-components miniSEED file will be named
"DG.04D67-2024.04.28-16.00.00.mseed"
```

```
cat z_component.mseed n_component.mseed e_component.mseed >
${net_code}.${station_code}-${date_string}.mseed
```

# 4.2. Metadata

The Artius provides several forms of metadata describing the configuration, sensitivity, and response of all connected sensors and digitiser channels. Metadata is essential for understanding and correctly interpreting recorded data. It defines how the digitiser converts analogue motion into digital counts, and how each sensor channel responds across frequency.

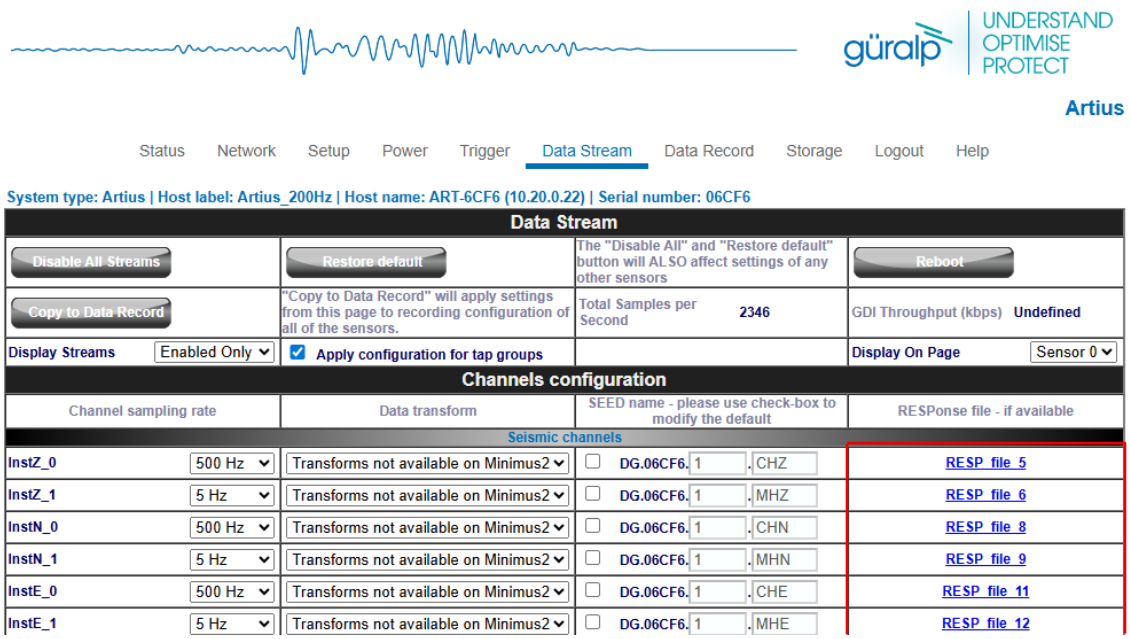
The device automatically generates three metadata formats: RESP files, Station XML files, and a Dataless SEED volume. Each format serves a different purpose, ranging from per-channel response information to complete system-wide metadata. The following sections describe each type and explain how to download them.

## 4.2.1. RESPonse Files

RESP files contain channel-specific response information. Each RESP file describes a single sensor channel. This includes the overall sensitivity, gain and filter stages, poles and zeros, and instrument identifiers. They are human-readable text files commonly used by analysis tools such as ObsPy, SAC, and PDCC.

**Accessing RESP files**:

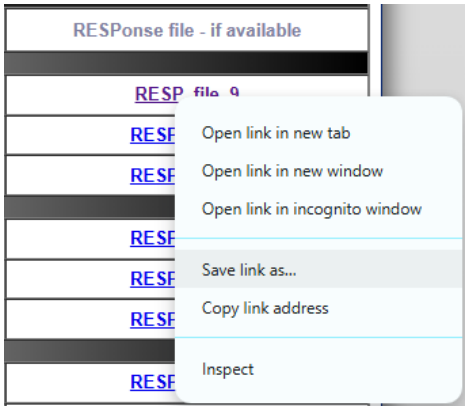
Each channel's RESP file is available from the Data Stream and Data Record pages via the RESP file link:




Clicking the link opens the RESP information in your browser:

```
#              << Guralp SEED response file builder v2.1-2776 >>
#
#              ======== CHANNEL RESPONSE DATA ========
B050F03     Station:     06CF6
B050F16     Network:     DG
B052F03     Location:    1
B052F04     Channel:     CHZ
B052F22     Start date:  2025,268,15:58:35
B052F23     End date:    No Ending Time
#              ======================================
#              +                 +--------------------------------------+                 +
#              +                 |   Channel Sensitivity, 06CF6 ch CHZ  |                 +
#              +                 +--------------------------------------+                 +
#
B058F03     Stage sequence number:                0
B058F04     Sensitivity:                          8.196721E+08
B058F05     Frequency of sensitivity:             1.000000E+00 HZ
B058F06     Number of calibrations:               0
#
#              +              +-------------------------------------------+               +
#              +              |   Response (Poles & Zeros), 06CF6 ch CHZ  |               +
#              +              +-------------------------------------------+               +
#
B053F03     Transfer function type:               A [Laplace Transform (Rad/sec)]
B053F04     Stage sequence number:                1
B053F05     Response in units lookup:             M/S - Velocity in Metres Per Second
B053F06     Response out units lookup:            V - Volts
B053F07     A0 normalization factor:              1.547554E+06
B053F08     Normalization frequency:              1.000000E+00
```

To download the file, right-click the link and select Save Link As:




RESP files can also be accessed by URL, for example:

`http://<device-ip>/RESP_file_<n>.txt`

Example using wget from a command line:

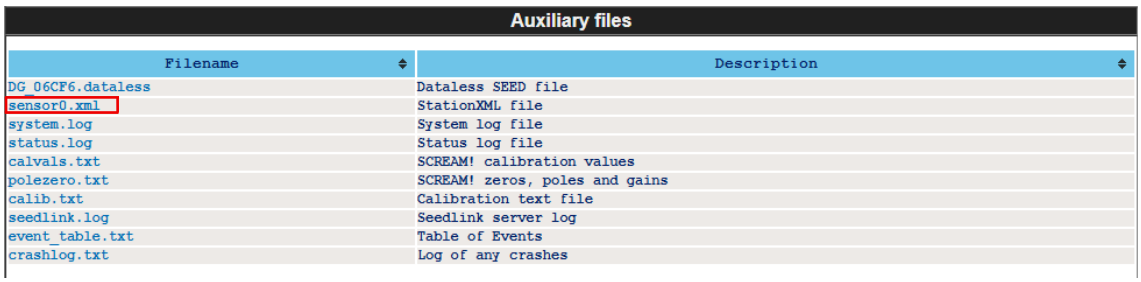
```
wget http://10.20.1.82/RESP_file_7.txt
```

## 4.2.2. Station XML Files

Station XML is a modern format widely used for exchanging seismic metadata. It contains structured metadata for an entire sensor, including all channel responses, sensor orientation and location, calibration constants, digitiser sensitivity, and station identifiers.

**Accessing Station XML files**:

The Station XML file is available from the Storage page as Sensor0.xml under the Auxiliary Files.



Auxiliary files

| Filename | Description |
|---|---|
| DG_06CF6.dataless | Dataless SEED file |
| sensor0.xml | StationXML file |
| system.log | System log file |
| status.log | Status log file |
| calvals.txt | SCREAM! calibration values |
| polezero.txt | SCREAM! zeros, poles and gains |
| calib.txt | Calibration text file |
| seedlink.log | Seedlink server log |
| event_table.txt | Table of Events |
| crashlog.txt | Log of any crashes |

They can also be accessed via direct URL, for example:

`http://<device-ip>/sd/Sensor0.xml`

Example using wget from the command line:

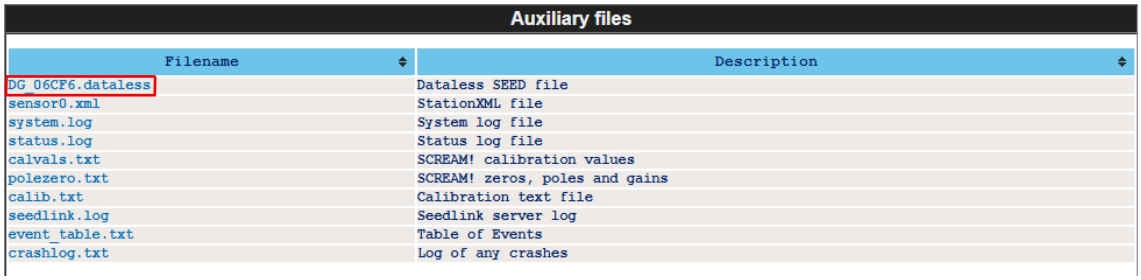
```
wget http://10.20.1.82/sd/Sensor0.xml
```

### 4.2.3. Dataless SEED Volume

A Dataless SEED Volume contains all metadata for the digitiser and every connected sensor, including response stages, sensitivities, channel naming, and network/station codes. It does not contain waveform data; instead, it complements miniSEED files by providing the metadata needed to interpret them.

**Accessing dataless SEED Volume:**

The dataless volume is available from the Storage page under Auxiliary Files. Clicking the filename will download it directly to your computer:



Auxiliary files

| Filename | Description |
|---|---|
| DG_06CF6.dataless | Dataless SEED file |
| sensor0.xml | StationXML file |
| system.log | System log file |
| status.log | Status log file |
| calvals.txt | SCREAM! calibration values |
| polezero.txt | SCREAM! zeros, poles and gains |
| calib.txt | Calibration text file |
| seedlink.log | Seedlink server log |
| event_table.txt | Table of Events |
| crashlog.txt | Log of any crashes |

It can also be retrieved by URL. The filename is formed from the two-character network code and the station code. For example, if the network code is DG and the station code is TADL, the dataless filename is:

`DG_TADL.dataless`

The direct URL would be:

`http://<device-ip>/<net_code>_<stat_code>.dataless`

Example using wget from the command line:

```
wget http://10.20.1.82/DG_TADL.dataless
```

# 5. Bluetooth Connectivity: the GüVü App

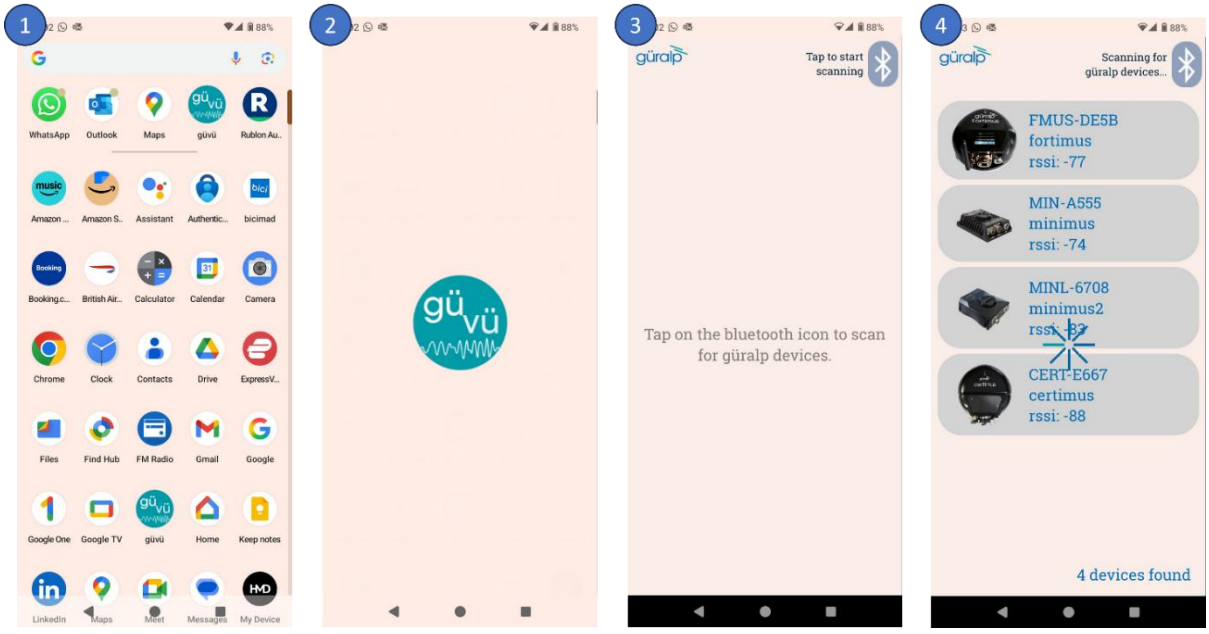
The GüVü app provides monitoring and control of nearby Artius units using the Bluetooth protocol. It is available for Android devices.

GüVü can be downloaded from the Google Play store at:

https://play.google.com/store/apps/details?id=com.guralp.whisper

## 5.1. Getting Stated

To launch GüVü, follow the steps shown in the figure below:

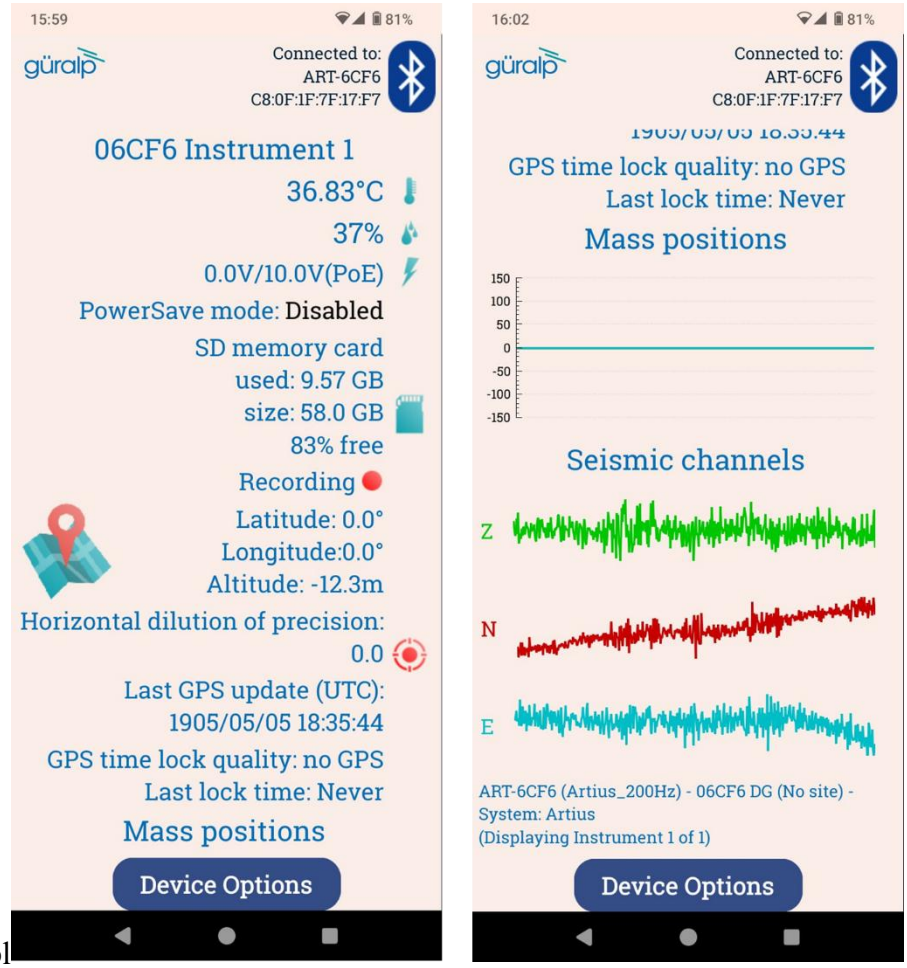



Steps for launching the GüVü App:

1. Launch by clicking on the GüVü icon from either the Apps Menu or from the Home Screen.
2. Wait a few seconds for the app splash screen.
3. Press the Bluetooth icon to enable Bluetooth connectivity (if not already enabled) and to search for available devices to with which to pair.
4. Select the appropriate device from the list to pair. Wait a few seconds for the main viewer screen to show.

If you experience problems connecting, try going closer to your instrument, or forcing GüVü to quit and then re-launching the app.

Once the device is connected, the main view of the app will be displayed. This screen displays a number of status indicators associated with the Artius.




appl

## 5.2. View Settings

The user can customise the view of the main instrument status window. Four different view options can be cycled through by tapping Device Options menu on the main instrument status window:

- **Show overview** – the default view setting; show state-of-health status, mass positions, and sensor traces on a single screen.
- **Show status view** – show state-of-health on the main screen only.
- **Show mass graph view** – show mass position traces on the main screen only; and
- **Show velocity graph view** - show sensor traces on the main screen only.

## 5.3. Instrument Control

Several features of the Artius can be controlled and configured remotely over Bluetooth using GüVü:

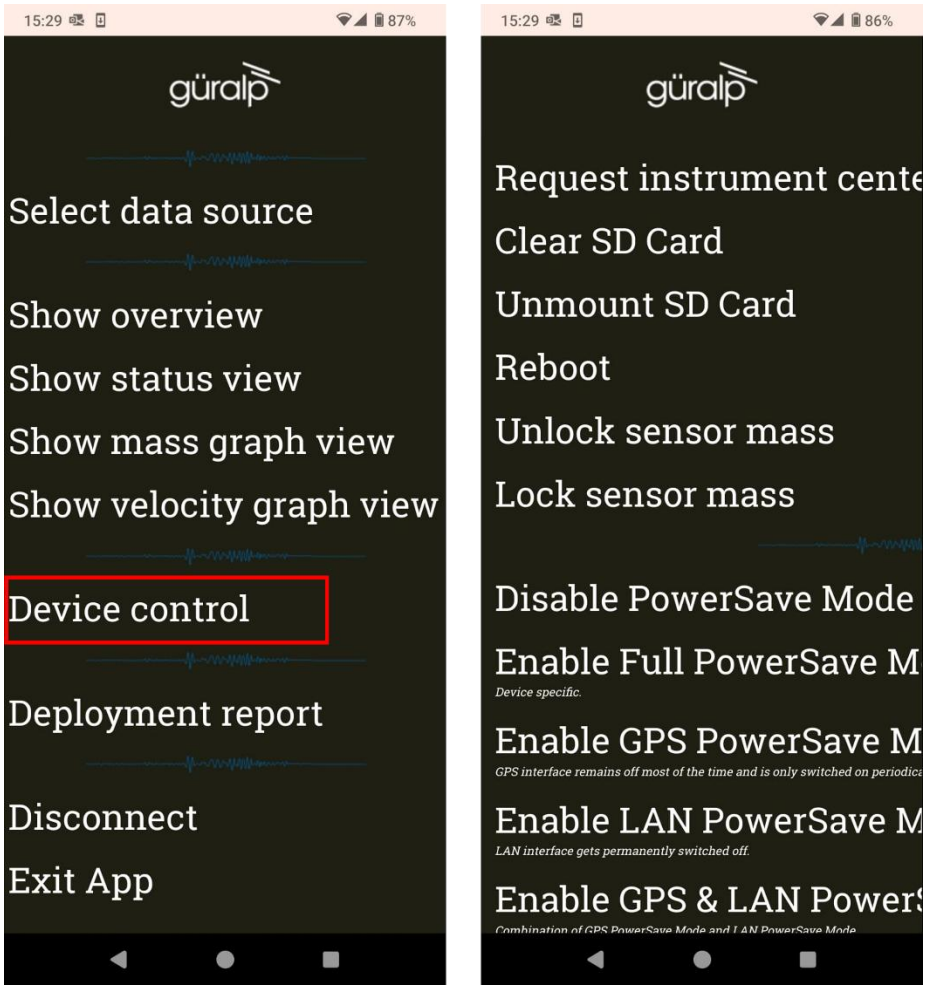
- Rebooting the Artius
- Station metadata (User Label, Station Name, Network Code, Site Name)
- Network setting (IP, Netmask, Gateway)

- Changing channels' sampling rates

In each case, GüVü will report whether the selected command has been successfully sent to the device.

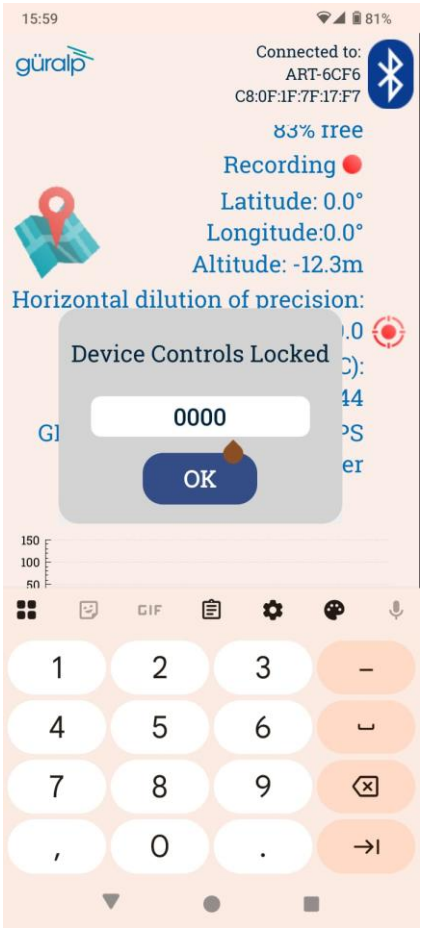
**Note:** The GüVü App contains functions for all Güralp instruments, some of which are **not** applicable to the Artius. These include:

- Select data source
- Unlock/Lock sensor mass
- PowerSave modes
- Unmount SD Card




**Note:** After any modification to channels' sampling rates or network settings (available through "Change station settings") the Artius must be rebooted before the changes will take effect.

These options can be accessed by tapping the **Device Options** menu and choosing the Device control option. To access the instrument control and configuration sub-menu, a PIN code has to be entered by selecting the text entry box and tapping OK.

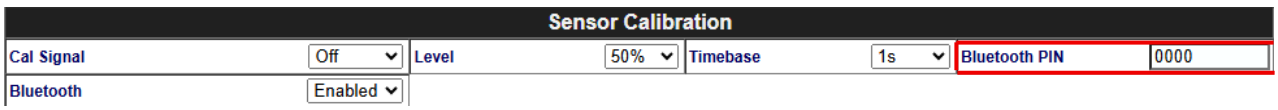



The default PIN code used to access the Instrument Control menu is "0000".

**Caution:** Güralp recommends changing the PIN code from the default, as described in the following section, in order to maintain station security.

### 5.3.1. Setting the PIN Code

The PIN code for accessing the instrument control menu of GüVü can be changed from the Setup tab of the web page. The new four-digit PIN code should be entered into the "Bluetooth PIN" field. The new value is applied by keying Enter; or clicking the left mouse button in any other setting box.




## 5.4. Emailing a Deployment Report

The GüVü app has a feature that allows the user to generate an automatic deployment report that can then be filed via email.

The deployment report includes the following details:

- System name.

- Station name.
- Network code.
- Instrument user label.
- Memory card storage size and recording status.
- Location of site (GNSS latitude, longitude, elevation).
- Time of deployment.
- GNSS lock quality.
- Power supply status.
- Instrument temperature and humidity recordings.

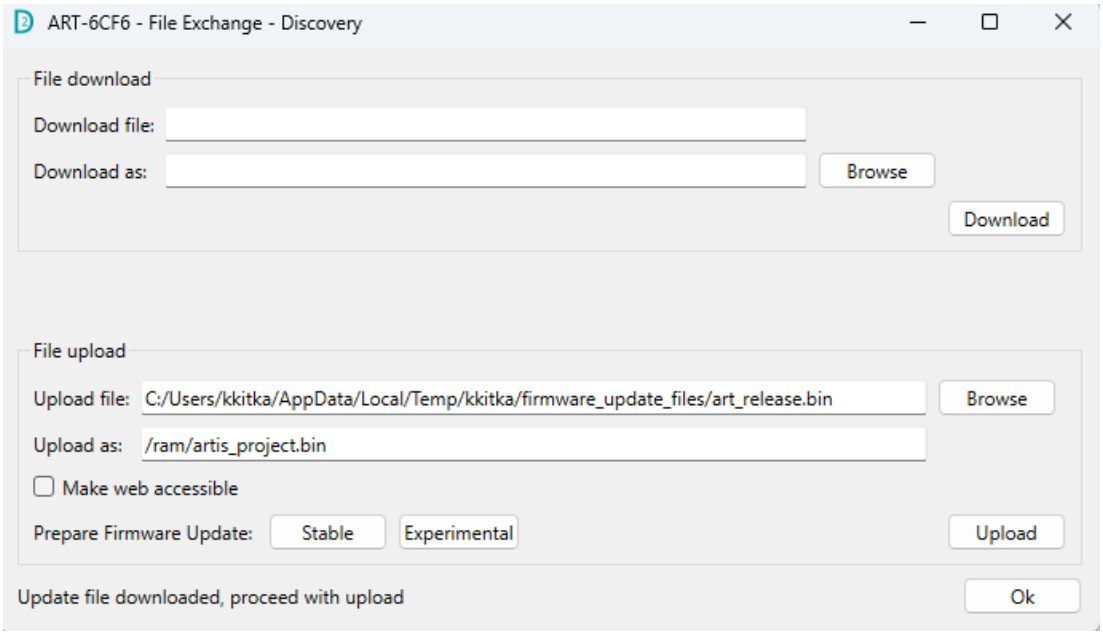
To send a deployment report, tap the Device Options menu and choose the "Deployment report" option. GüVü will then open the default email application on the device, showing a draft email which will include the parameters described above.

# 6. Firmware Update

The firmware of the Artius is upgradeable. New releases appear regularly – mostly to add new features but, occasionally, to fix problems. Güralp recommends that the Artius is regularly checked for availability of firmware updates and, when convenient, these updates should be installed. If in doubt whether to upgrade the firmware or not, please check the release notes (london.guralp.com/download/sw/release_ART.shtml) or contact support@guralp.com.

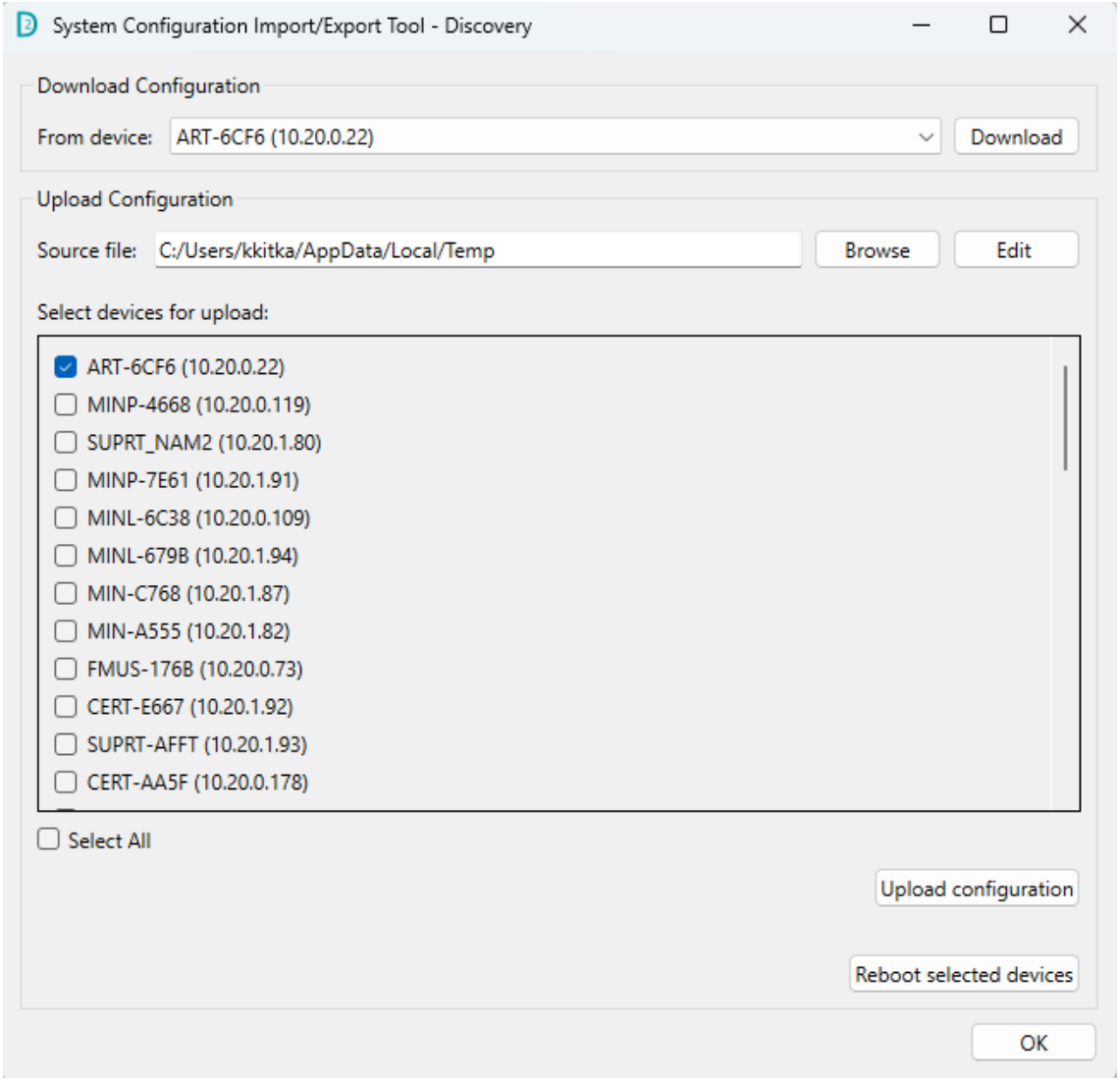
To upgrade :

1. Run Discovery.
2. Right-click on the Artius in Discovery main window and select “File Exchange”.
3. In the “File Exchange” tab, click on the Stable or Experimental button depending on which firmware you want to install




4. Do not change the upload file name but leave it exactly as it automatically appears.
5. Press upload.
6. The upload takes approx. 40 seconds. The LED on the Artius should change colour after the upload completes: persistent red erasing internal FLASH memory, then persistent blue during programming, then finally persistent white when complete.
7. DO NOT remove power for the whole duration of the firmware update

**Note:** IP address, system name, netmask are all preserved. To preserve general settings, offload the config first. Use Discovery, right click and select “System Configuration”. Download first and upload after the update. Uploading will prompt the Artius to reboot automatically.




**Caution:** Minimus$_2$/Minimus Lite firmware differs from and is incompatible with Artius. Thus, previously saved firmware files for these digitisers should not be uploaded through the File Exchange to the Artius node. The Stable and Experimental options will automatically pull correct Artius files from the Guralp server. A stable internet connection is advised.

# 7. Installation

**Note:** For further recommendations regarding Artius installation, or if your intended deployment is not covered in this guide, please contact support@guralp.com.

## 7.1. Direct Burial with PPM

For the best results, Güralp recommends following the installation procedure below.


- **Dig the main hole**
  Dig a hole deep enough to reach compact earth. If compacted soil is not accessible, manually compact the base of the hole.

- **Shape the hole**
  The hole must have extra space extending southward to accommodate the Artius body and its connector. This orientation ensures that once deployed the Artius points North, with the connector exiting to the South.

- **Set the depth**
  The hole should be deep enough so that the top of the Artius sits 1-2 cm above ground level after placement.

- **Prepare the power supply**
  Dig a separate hole for the Artius Power Pack Module (PPM) or any compatible 7-16 V DC power source. Dig a connecting trench between the two holes to bury the power cable.

- **Connect the hardware**
  Connect the cable to the Artius and attach the spike, if purchased.

- **Place the Artius**
  Align the Artius so the North arrow on the device points North. Gently press the spike into the base of the hole, using your foot if necessary.

- **Level the device**
  Use the built-in bubble level to check horizontal alignment. If needed, remove and adjust the base of the pit or reposition the Artius using the spike.

- **Lay the cable**
  Ensure the cable is not coiled around the Artius and does not apply any pressure on the connector port. If the cable is too long, coil any excess around the power supply, not the Artius.

- **Connect solar panel (if applicable)**
  Connect solar panels to the Charge Input connector of the PPM before backfilling.

- **Check device status**
  Before the next step, ensure that the Artius LED is flashing three green lights.

- **Backfill and compact**
  Fill both holes and trench with the removed soil or substrate. Compact the surface to minimize future settling.

- **Provide thermal insulation**
  If you expect large thermal variations, insulate the Artius. This can be done by putting some wool sheets or bubble wrap on top of the Artius and covering it with a box.

- **Post-deployment cleanup**
  After retrieving the Artius from the field, remove dirt from the bottom grooves using a stiff nylon brush or similar tool to ensure no mud or dirt is left. Inserting the device into the docking station with dirt might cause damage.

## 7.2. Surface Deployment with Spike

- **Connect the hardware**
  Connect the spike to the Artius and find a suitable area with firm soil to place.

- **Place the Artius**
  Align the Artius so the North arrow on the device points North. Gently press the spike into the base of the hole, using your foot if necessary.

- **Prepare the power supply**
  Place the Artius Power Pack Module (PPM) or any compatible 7-16 V DC power source securely to the ground nearby and connect to the Artius.

- **Lay the cable**
  Ensure the cable is not coiled around the Artius and does not apply any pressure on the connector port. If the cable is too long, coil any excess around the power supply, not the Artius. Bury the cable between the power supply and Artius to avoid damage from the environment.

- **Level the device**
  Use the built-in bubble level to check horizontal alignment. If needed, remove and adjust the base of the pit or reposition the Artius using the spike.

- **Connect solar panel (if applicable)**
  Connect solar panels to the Charge Input connector of the PPM.

- **Check device status**
  Before the next step, ensure that the Artius LED is flashing three green lights.

- **Provide thermal insulation**
  If you expect large thermal variations, insulate the Artius. This can be done by putting some wool sheets or bubble wrap on top of the Artius and covering it with a box.

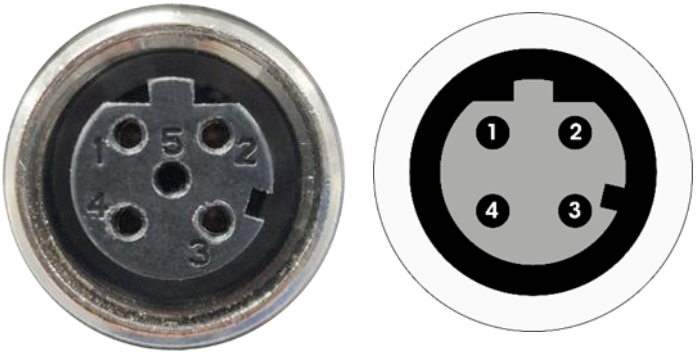
- **Post-deployment cleanup**
  After retrieving the Artius from the field, remove dirt from the bottom grooves using a stiff nylon brush or similar tool to ensure no mud or dirt is left. Inserting the device into the docking station with dirt might cause damage.

# 8. Appendices

## 8.1. Connector Pin-Outs

This is a 4-pin M12 D-code Automation connector.

| Pin | Function |
|---|---|
| **1** | Power + |
| **2** | RS232 transmit |
| **3** | Power - |
| **4** | RS232 receive |
| **Shielding** | Ground |
| **5** | Unconnected |




## 8.2. Network Ports

The following network ports are used by Artius:

| Port | Layer 4 Protocol | Description |
|---|---|---|
| 80 | TCP | HTTP server |
| 1565 | TCP | GDI transmission protocol |
| 1567 | TCP/UDP | GCF transmission protocol |
| 4242 | TCP | File exchange protocol |
| 4244 | TCP | Remote console |
| 11788 | UDP | Remote procedure calls |
| 18000 | TCP | SEED-link transmission protocol |
| 8190 | TCP | Tunnel connection to server |
| 7190 | TCP | Tunnel Discovery to server |

## 8.3. Channel Names

The tables in this section are designed to inform users of the names and codes of the streamed and recorded channels present in the Artius. The first character of a miniSEED channel code represents the sample rate. The possible values are shown in the table below:

| Code | Sample Rate |
|---|---|
| **F** | ≥ 1000 Hz to < 5000 Hz |
| **C** | ≥ 250 Hz to < 1000 Hz |

| | |
|---|---|
| **H** | ≥ 80 Hz to < 250 Hz |
| **B** | ≥ 10 Hz to < 80 Hz |
| **M** | > 1 to < 10 |
| **L** | ≈ 1 |

The “Live Stream Codes” of the seismic channels are postfixed with “0” or “1”. This notation distinguishes between the two different sample rates that is possible to select for each streamed channel. For example, the streams `InstZ_0` and `InstZ_1` carry digitisations of the same signal, differing only in the sample rate.

Only one sample rate is available for the recorded seismic channels.

| Sensor | Comp. | Data streaming | | | Data recording | |
|---|---|---|---|---|---|---|
| | | Digital filter mode | Live stream name | Live stream code | Data record name | Mini SEED channel code |
| Seismic channels | Vertical | Acausal | InstZ | InstZ_0 | InstZ_sd | xHZ |
| | | | InstZ | InstZ_1 | | |
| | | Causal | InstZ_eew | InstZ_eew_0 | InstZ_eew_sd | xHZ |
| | North | Acausal | InstN | InstN_0 | InstN_sd | xHN |
| | | | InstN | InstN_1 | | |
| | | Causal | InstN_eww | InstN_eew_0 | InstN_eww_sd | xHN |
| | East | Acausal | InstE | InstE_0 | InstE_sd | xHE |
| | | | InstE | InstE_1 | | |
| | | Causal | InstE_eew | InstE_eew_0 | InstE_eew_sd | xHE |
| Mass position channels | Vertical | Acausal | MassZ | MassZ_0 | MassZ_sd | xMZ |
| | North | Acausal | MassN | MassN_0 | MassN_sd | xMN |
| | East | Acausal | MassE | MassE_0 | MassE_sd | xME |
| MEMS accelerometer | Vertical | Acausal | AccelZ | AccelZ_ | AccelZ_sd | xNZ |
| | North | Acausal | AccelN | AccelN_ | AccelN_sd | xNN |
| | East | Acausal | AccelE | AccelE_ | AccelE_sd | xNE |
| Calibration channel | | Acausal | Calibration | Calibration_0 | Calibration_sd | xC0 |
| Temperature | | Acausal | Temperatur | Temperatur_0 | Temperatur_sd | xKT |
| Input voltage | | Acausal | S0Voltage | 0VINP0 | Voltage_sd | xQV |
| Power usage | | Acausal | S0Power | 0PINP0 | Power_sd | xYP |
| Relative humidity | | Acausal | Humidity | Humidity_0 | Humidity_sd | xIH |
| NTP channels | Phase | Acausal | NTP_DAC_ | NTP_DAC_ | NTP_DAC_sd | LYT |
| | DAC | Acausal | NTP_Phase_ | NTP_Phase_ | NTP_Phase_sd | LYD |
| | Lpf | Acausal | NTP_lpf_ | NTP_lpf_ | NTP_lpf_sd | LYU |
| | Hpf | Acausal | NTP_hpf_ | NTP_hpf_ | NTP_hpf_sd | LYV |
| Internal Clock | PLL lock phase | Acausal | Phase_ | Phase_ | Phase_sd | LYP |
| | DAC | Acausal | DAC_ | DAC_ | DAC_sd | LQD |
| Battery pack | Voltage | Acausal | BattVoltage_ | BattVoltage_ | BattVoltage_sd | LQV |
| | Current | Acausal | BattCurrent_ | BattCurrent_ | BattCurrent_sd | LYI |
| | Charge Volts | Acausal | BattChargeV_ | BattChargeV_ | BattChargeV_sd | LQQ |
| | Charge current | Acausal | BattChargeI_ | BattChargeI_ | BattChargeI_sd | LYQ |
| | Temperature | Acausal | BattTemp_ | BattTemp_ | BattTemp_sd | LYT |
| | Charge | Acausal | BattCharge_ | BattCharge_ | BattCharge_sd | LYC |
| | Power | Acausal | BatteryPower_ | BatteryPower | BatteryPower_sd | LYW |

# 9. Revision History

| Revision | Summary | Date |
|---|---|---|
| A | Initial document release | 05/11/2025 |