güralp

Güralp Minimus$_2$ and Minimus Lite

Technical Manual

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Table of Contents

1   Preliminary Notes

1.1   Proprietary Notice

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1.2   Cautions and Notes

Cautions and notes are displayed and defined as follows:

Caution: A yellow triangle indicates a chance of damage to or failure of the equipment if the caution is not heeded.

Note: A blue circle indicates a procedural or advisory note.

1.3   Manuals and Software

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

1.4   Conventions

Throughout this manual, examples are given of command-line interactions. In these examples, a fixed-width typeface will be used:

```
Example of the fixed-width typeface used.
```

Commands that you are required to type will be shown in bold:

```
Example of the fixed-width, bold typeface.
```

Where data that you type may vary depending on your individual configuration, such as parameters to commands, these data are additionally shown in italics:

```
Example of the fixed-width, bold, italic typeface.
```

Putting these together into a single example:

```
System prompt: user input with variable parameters
```

1.5   System Overview

Thank-you for purchasing a Güralp Minimus$_2$ or Minimus Lite digitiser.

This section describes the key components of a Minimus$_2$ system. The Minimus$_2$ unit is the main, standard product in the system; other components and accessories are optional and can be purchased separately. Please check your order confirmation to see which components were purchased with your system.

The Minimus$_2$ has four fully-featured analogue input channels.

1.6   Key features

- 24-bit, four-channel digitiser with nominal 2.44 µV/count sensitivity.

- Compact form, measuring just 134 × 99 × 45 mm and weighing just 0.6 kg.

- Compatible with all analogue seismic sensors with a voltage output.

- Simultaneously accommodates one triaxial sensor(s), one infra-sound sensor(s).

- Supports automatic Identification of IP addresses via Güralp Discovery software and a cloud-based or organisational registry server.

- Remote instrument and data management via Discovery.

- Bluetooth Android app for installation integrity checking.

- Low-latency mode for Earthquake Early Warning (< 40 ms).

- Hot-swappable data storage with dual redundant microSD cards.

- GNSS time-synchronisation, compatible with Navstar (GPS), GLONASS, Galileo and BeiDou constellations.

1.7   Typical applications

- Earthquake Early Warning systems.

- Volcanology.

- Multi-scale seismic networks.

- Structural health monitoring.

- Hydrocarbon exploration.

- Permanent reservoir monitoring.

- Induced seismicity detection.

- Explosion monitoring.

2 System description
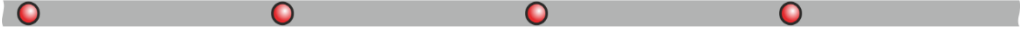
2.1 Güralp Minimus₂ digitiser

The Güralp Minimus₂ is a combined digitiser and advanced communications unit. The Minimus₂ acquires data from – and allows direct control (where appropriate) of – connected analogue instruments (*e.g.* Güralp Fortis, 3-series, 5-series, 40T and 6T sensors) and digital instruments (*e.g.* the Güralp Certis).

When used with newer version of Güralp 3T instruments and the Certis Instrument, the digital serial connection available on the 26-way instrument connector is used to convey additional state of health information as well as calibration and response information.

2.1.1 LED indicator

The Minimus₂ has an LED indicator on the upper surface, which provides status and configuration information.

- **White**: This occurs from power-up until software starts

-

- Three flashes followed by a pause, then repeat.

- Each flash is either Red or Green

- First Flash – Internal SD card good and recordings (Green)

- Second Flash – External Removable SD card is good and recording (Green)

- Third Flash - GPS Time lock is good (Green)

- **1 blue flash**: a trigger event has been detected.

2.1.2 Bluetooth connectivity

The Minimus₂ features Bluetooth connectivity, allowing sensor and state-of-health data to be monitored using the Güralp GüVü app (see section 2.23) on an Android mobile phone or tablet.

The Bluetooth can be disabled via software to save processor usage 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.

See Chapter 2.23.4 for further details on connecting to the Minimus$_2$ and its attached sensors using a phone or tablet.

2.1.3 Data storage

The Minimus$_2$ uses microSD (non-volatile) memory technology to store seismic data locally. The Minimus$_2$ features two such microSD cards in order to provide redundancy; this helps to protect the recorded data in the unlikely event of any corruption or problem with the memory cards. One card is internal and cannot be removed by the customer; the other is hot-swappable and easily accessible without any technical knowledge.

The Minimus$_2$ is supplied with two microSD cards that are of equal storage capacity (*e.g.* two 64 GB cards).

Güralp recommends the use of industrial-grade SD cards.

2.1.3.1   External microSD card – new style

The upper surface of the Minimus$_2$ has a waterproof screw-in card-holder that is sealed by an O-ring.

To insert or replace a microSD card, proceed as follows:

1. Rotate the card-holder in an anti-clockwise direction, unscrewing it from the body of the digitiser.

Caution: The card holder connects electrically to the Minimus2 via a series of slip-rings which ride on metal fingers in the main body of the digitiser:

It is very important that the slip-rings and the metal finger-contacts do not become damaged or tarnished. Take care not to touch either part. If a Minimus2 has had its card-holder removed, do not leave it exposed to the elements. If a card-holder is to be transported when it is not installed in a Minimus2, enclose it in a protective bag or covering so that it cannot be scratched or contaminated.

2. The microSD card is accessible via the slot in the side of the card-holder. Push the card in gently and then release the pressure: the card will spring outwards a little. It can now be grasped and withdrawn.

3. To insert a new card, line it up with the slot as shown and push it gently into place. Once you feel the spring pressure, continue pushing until more resistance is felt and then release the pressure: the card will lock into place.

4. Finally, replace the cap and rotate clockwise until hand-tight. Do not over-tighten and do not use tools.

Note: In order to ensure data integrity and security, Güralp only recommends the use of the supplied industrial-grade microSD cards.

2.1.3.2   Internal microSD card

The second microSD card is factory-installed in a slot inside the unit.

Caution: The internal microSD card is not accessible by the user. Attempts to remove or replace it will void the warranty.

2.1.4 Web interface

The Minimus$_2$ contains on-board firmware that presents monitoring and configuration interfaces. These are accessible through Güralp's Discovery software or, with the built-in web server, via Discovery's browser interface or any standards-conformant web browser.

The Discovery interface allows a number of instrument monitoring, control and configuration options:

- Sensor readings and instrument State-of-Health

- Network configuration and authentication

- Sensor, timing, and station configuration/information

- Remote data-streaming configuration

- Local data-storage configuration

2.2   Accessory package

2.2.1 Ethernet cable

The Ethernet connector allows use of 10BASE-T, 100BASE-T networks. The cable that connects to the Minimus$_2$ has a metal cover which is IP68-rated and ensures consistent connections in harsh installation environments. At the other end of the blue Ethernet cable, there is a standard 8P8C modular jack (often incorrectly called an RJ45) for attachment to all common networking devices (*e.g.* PC, laptop, router, switch, modem etc.).

Please see section 7.1 for the pin-out and further details.

2.2.2 Compact GNSS receiver and cable

The Minimus$_2$ is supplied with a new-generation compact GNSS receiver with an in-built antenna that supports the GPS (Navstar), GLONASS, BeiDou and Galileo satellite constellations.

The receiver comes with a black RS-422 cable that has an over-moulded 14-way LEMO connector. LEMO connectors use an innovative latching mechanism which is different to the bayonet connectors used elsewhere. To mate, simply line up the red marks – one on the chassis and one on the free connector – and gently push the connector into place until they latch together with a click. To disconnect (un-mate), grasp the outer sleeve of the connector and pull gently.

> ⚠️ **Caution:** Do not twist the connector or use any tools.
>
> 🚫 🚫 🚫 🚫

Please see section 7.3 for pin-out details.

2.2.3 Power cable

The Minimus$_2$ comes with a dedicated power cable with a standard military-specification bayonet connector on one end and bare ends at the other. Two pins are employed to carry power. The second pair of pins carry a serial port. When used in conjunction with a Güralp Power Pack Module, these carry information about charge status, solar panel operation, battery capacity etc.

> 🛈 **Note:** The does not use a grey/blue combined power/data cable, as used with many other Güralp products.

Please see section 7.2 for the pin-out details.

2.2.4 Diagnostic GNSS to Serial cable adapter

The Minimus$_2$ comes with an adapter to connect the GNSS LEMO connector to a female nine-pin D-subminiature connector (DE9f), which can be used with a standard serial port to allow diagnosis and debugging of the using a serial terminal emulator (see section 3).

A serial-to-USB converter (not supplied) may need to be used to connect to PCs or laptops that don't have a nine-pin serial connector. Please see section 7.3 for full pin-out details.

2.3   Güralp Discovery software

Güralp Discovery is a software application for seismometer configuration and control, state-of-health monitoring, and waveform viewing and acquisition.

Discovery can be downloaded from the following link:

https://www.guralp.com/sw/download-discovery.shtml.

An important benefit of Discovery is that it allows the user to identify the instruments' IP addresses on a LAN or via a cloud-based or organisational registry server without the need for static IP addresses at the stations.

Discovery also provides simple, convenient instrument and data management with access to hardware State-of-Health (SoH), data streaming; GNSS location; response and calibration data.

Discovery can download Minimus2 firmware from the Internet and remotely install it onto any connected digitisers.

Running Discovery on a network connected PC will show any connected Güralp products as below:
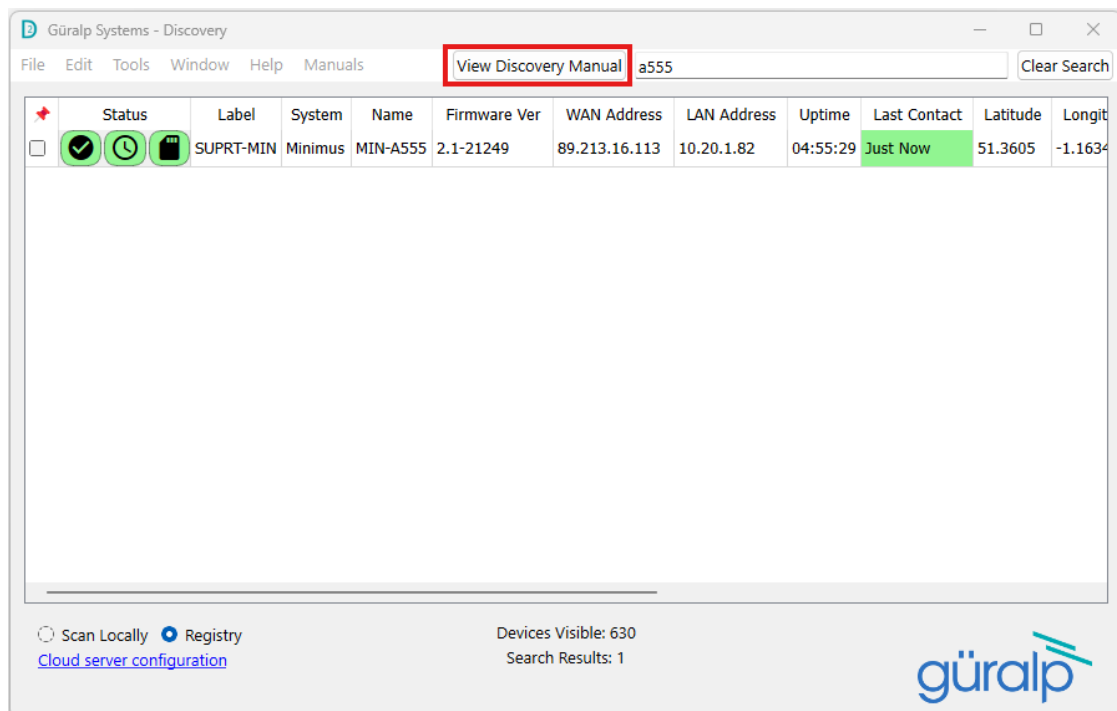
> **Note:** This document provides some information about Discovery, especially when related to the use of Minimus$_2$ and Minimus Lite units, including firmware upgrades and configuration instructions.
>
> However, full user instructions for Discovery are beyond the scope of this document. For full user information, please refer to Discovery's manual MAN-DIS-0001 (also accessible from Discovery's dashboard as in figure above).

2.4   Güralp GüVü Android app

For added confidence during deployments in the field, Güralp GüVü, a Bluetooth App, displays waveforms, orientation, temperature and humidity data for instant checking of installation integrity.

Please refer to Chapter 2.23 for installation and usage instructions. Its available on PlayStore.
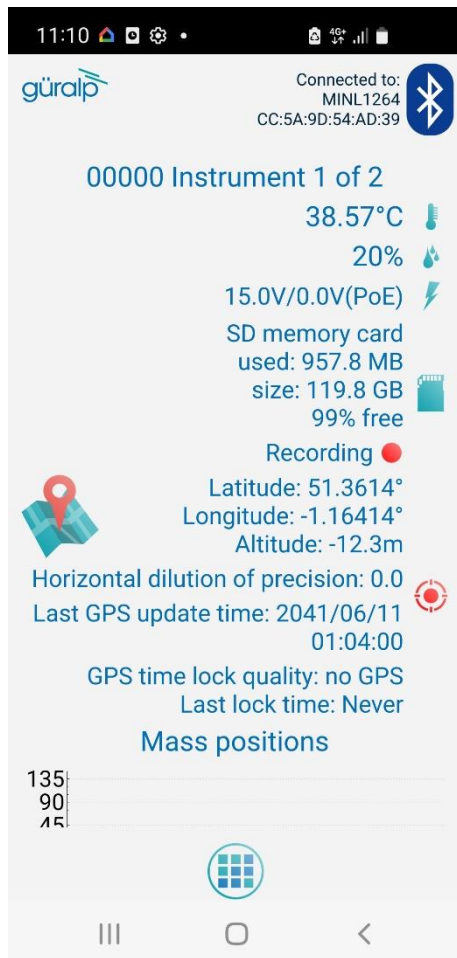
2.5   Getting started

2.5.1 System set-up

Güralp highly recommends exploring and gaining familiarity with the inside your lab before installation in an outdoors environment.

Power up the using a power supply with a DC output of between 10 and 36 Volts. We recommend fitting an in-line 3.5 A anti-surge fuse in the positive power lead to protect the external wiring of the installation. The will, in turn, provide power to all connected instruments. Alternatively, the system can be powered by POE (Power over ethernet).

If the Minimus$_2$ is directly connected to a laptop or PC using the blue Ethernet cable, make sure that the laptop or PC is configured to obtain an IP address automatically. More details on how to correctly configure the connection using APIPA (Automatic Private IP Addressing) are in section **Error! Reference source not found.**.
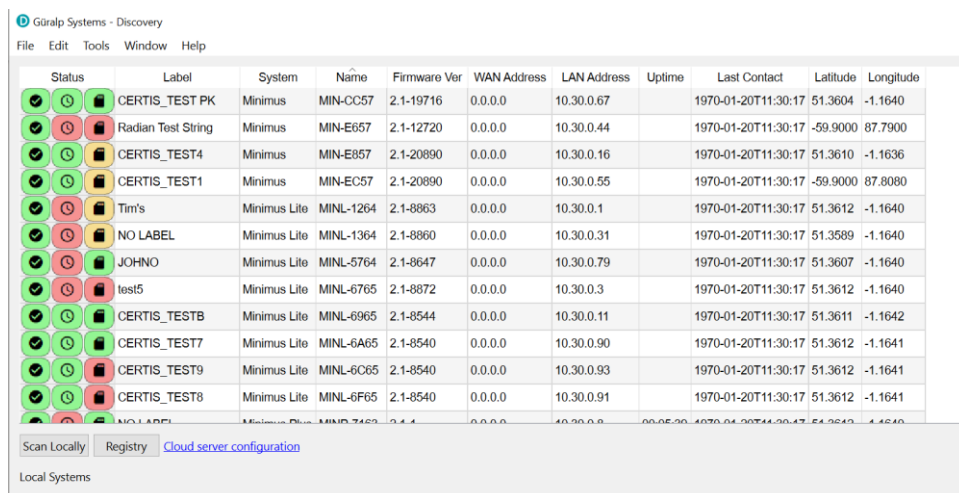
2.5.2 Güralp Discovery software installation

Discovery is a convenient way to identify a device without having to know its IP address. It allows easy access to the WEB configuration page as well as live waveforms, and to control and configure the Minimus$_2$ and connected sensors.

Visit www.guralp.com/sw/download-discovery.shtml for links for all available platforms (currently Windows 32-bit and 64-bit and Linux 64-bit).

Download the installer appropriate for your architecture and operating system, run the installer and follow the instructions on screen.

Under Windows, the first time that you start Discovery, Windows may ask you to specify how you wish Discovery to interact with the Windows Firewall. Because Discovery requires network communication in order to function, it is important that allow access.

The Discovery software 'looks' on the local network for any connected Güralp devices. These are displayed as shown below:

Any device on the same subnet will be displayed. The protocol uses a 'broadcast' UDP packet to request a response from connected systems. This will likely not penetrate routers, firewalls etc unless expressly permitted.

However, any device on a local ethernet hub or switch should respond. This allows connection without using or typing specific IP addresses.

In an office environment, a local DHCP server will likely offer an address to any connected device. Güralp digitisers have DHCP enabled by default so making connection to the network trivial. Discovery will display the device as above without any worry about addresses.

You can choose which information is shown for each device in the main window. You can select which columns to display – and hide unwanted ones – by clicking on "Show" from the "View" menu.

The "Status" column is composed of three icons that represent the Minimus$_2$ connectivity status (whether device is reachable/active or not), timing status (GNSS or PTP) and storage status (primary/secondary) respectively.

Hovering the mouse over any of these three icons will display tool-tips giving a brief description of the status including, for the timing indicator, details of which timing subsystems are operating:
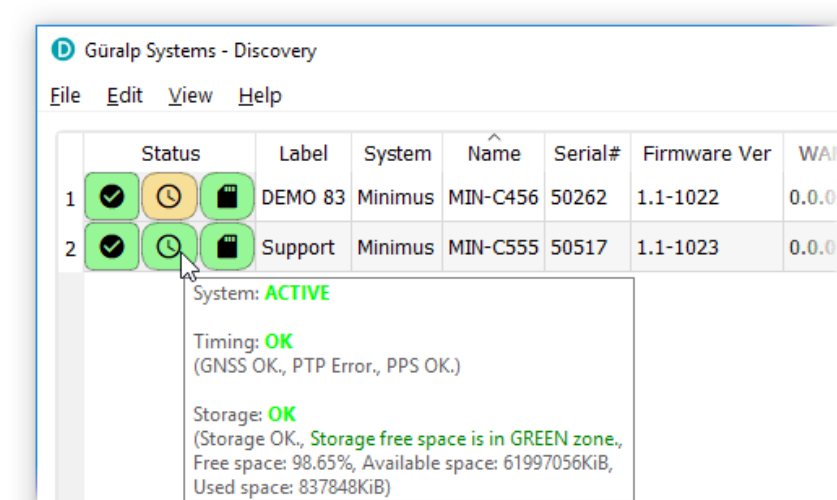
Within Discovery, internal and connected sensors are referred to as follows:

2.5.3 Viewing waveforms and system state-of-health

Waveform data recorded by the ' internal sensors and other connected sensors can be viewed using several methods, which are described in the following sections.

2.5.4 Using Discovery's "Live View" window

Discovery offers a versatile live waveform/data viewer. To open the Viewer, in Discovery's main window, select an instrument and, from the View tab in the toolbar, select "Live View".

The menu will then present three options for data streaming:

- GDI and GCF channels

- GDI only

- GCF only

The GCF option uses the Scream! Protocol to stream data in GCF packets of, typically, 250, 500 or 1,000 samples. The GDI protocol streams data sample-by-sample and also allows the sending of each instrument's calibration parameters so that data can be expressed in terms of physical units rather than digitiser counts.

Güralp recommends using the "GDI only" option for waveform viewing. Metadata (including Calibration) is automatically sent with a stream. The display is thus shown in real units – not just counts.

The main features of – and the key buttons within – the Live View window are shown in the following screen-shot. Basic amplitude and time zoom functions are given in the Window zoom controls panel and streams can be easily added to or removed from the window by using the check-boxes in the left panel.

The channels are divided in groups with different hierarchical importance. The most important are the velocity/acceleration channels with higher sample rates: these belong to group 1. The least important belong to group 6, which includes humidity, temperature, clock diagnostics *etc*. When the live view is launched, only the channels in group 1 are selected. It is possible to change this setting by selecting a different group number from the "Select group up to" box at the bottom of the channel list.
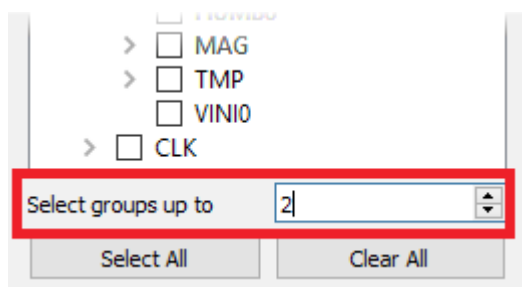
When only few channels are selected for viewing, the channel name labels also show data statistics, including the maximum, minimum and average amplitudes in physical units.

If too many channels are in view for this information to be visible, you can left-click on a label and the label and trace will then expand to half the height of the screen, revealing these statistics. The other channels will be compressed into the remaining space. Another left-click on the same channel will return the window to normal. Alternatively, a left-click on a different channel will shrink the original one and expand the newly-selected one.

By selecting and dragging the mouse over a window of waveform data, the viewer will display similar statistics for the data within the selected window. When a window of data is selected, use the ⬆ key to subtract the ADC offset from the maximum, minimum and average values. Use the Alt key to calculate the integral of the selected data. By right-clicking on the window, you can perform advanced

analysis on the data, including plotting power spectral density graphs (PSDs), spectrograms and discrete Fourier transforms (DFTs), as shown below:

You can change the display of the waveforms with based on a combination of keystrokes and mouse-wheel scrolling (or track- / touch-pad scrolling on a laptop).

These commands are shown in the table below:

Command	Window control
Amplitude control	
	Increase/decrease amplitude of all traces
+ hover cursor over channel label	Increase/decrease amplitude of individual trace
+ hover cursor over channel label	Shift individual trace offset up/down
Time control	
+	Pan time-scale right/left
+	Zoom time-scale in/out
Trace focus	
on trace label	Focus on individual trace
Trace selection	
+ hover cursor over on individual trace / trace label	Remove / de-select trace from Viewer window
Details control	
+ hover cursor over on individual trace / trace label	Reset the maximum and minimum values to the average value of the selected data

2.5.4.1   GDI connection settings

The GDI protocol allows a receiver, such as Discovery, to select which channels to receive by use of a "channel subscription list". This feature can be useful in cases where the connection between Minimus$_2$ and Discovery has limited bandwidth. To subscribe to specific channels, right-click on a digitiser in Discovery's main window and select "GDI Configuration" from the context menu.
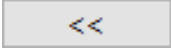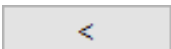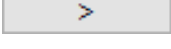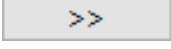
The resulting window has two very similar tabs. The "Subscription configuration" tab refers to channels selected for transmission and the "Storage configuration" tab affects which channels are selected for recording.

Click on the button to connect to the GDI server.

By default, Discovery subscribes to all channels. To alter this behaviour, change the radio-button from "Automatically subscribe to all available channels" to "Use

subscription list". In subscription list mode, the channels in the list on the left-hand side are those to which Discovery subscribes. All available channels are listed on the right-hand side.

Channels can be moved between lists – *i.e.* switched between being subscribed and being unsubscribed – by using the arrow buttons on the middle:

<<	Subscribe to all channels shown in the **Available channels** list
<	Subscribe to all selected channels in the **Available channels** list
>	Unsubscribe from all selected channels in the **Subscribed channels** list
>>	Unsubscribe from all channels in the **Subscribed channels** list

2.5.4.2   Backfill from microSD card

Gaps in the waveforms due to network disconnections can be backfilled by requesting missing data to the local storage.

In the Discovery GDI "Live View", highlight the portion of data including the gap, right-click and select "Request backfill".

The gaps are backfilled automatically for all the streams selected, if the requested data is available in the microSD card.

2.5.5 Using Scream!

Data from the Minimus$_2$ and attached sensors can also be viewed and analysed using Güralp's Scream! Software.

> **Note:** Full user instructions for Scream! are beyond the scope of this document. Please refer to the Güralp manual: MAN-SWA-0001 for full Scream user instructions.

In Scream!'s Network Control window, add a UDP or TCP Server using the address reported under "LAN Address" in Discovery's main window (as described in section 0).

	Status	Label	System	Name	Serial#	Firmware Ver	WAN Address	LAN Address	Uptime	Latitude	Longitude
1	✓ 🕐 🔒	Support	Minimus	MIN-C555	50517	1.1-1022	0.0.0.0	10.10.0.13	00:15:10	51.3607	-1.1630

Right-click on the newly-added server and select `GCFSEND:B` (or `Connect`) from the context menu. This sends a command to the Minimus$_2$ to start data transmission. Once the `GCFSEND:B` (or `Connect`) command has been issued, the instruments and their associated streams should begin to appear in Scream!'s main window.

To configure the Minimus$_2$, double-click on its entry to open its web page.

System configuration, control and configuration tools are available by selecting an instrument in Discovery, right-clicking its entry and selecting "View Web Page". Alternatively, the web interface can be viewed by navigating to the LAN or WAN address of the instrument from any common web browser.

Some changes in config. Require a reboot to take effect. The banner at the top of the WEB page reflects this if required.

2.6 Web Page login

The web interface can be protected by username and password. There are two levels of access to the web page: normal user and administrator.

If the login is required, the web interface will initially show a status display only.

Clicking on "Login" opens allows to type in the user-name and password to access the content of the web page.

Logging in with normal user account unlocks only basics configuration and control features in order to prevent any advanced settings to be modified. The default user-name for normal user login is user and password of user.

Logging in with the administrator account unlocks all the configuration and control features available in the web page. The default user-name for administrator user login is admin and password of admin.

Once logged in, the "Web Login" drop-down menu in the Network tab allows to disable the request of login every time the web page is accessed. The user-name and password for both normal user and administrator login are configurable in the "Network" tab.

2.7 System status

The "Status" tab of the web browser interface provides state-of-health information about the Minimus$_2$ and connected instruments.

Host Label can be set in the Setup page. This is also visible on the Discovery front page.

The map requires access to the internet to display correctly. The computer used to view the Minimus$_2$ must therefore be internet connected.

The MicroSD Used item acts as a verification that the system is truly recording data. If this item shows periodic changes, the data is being written to the card.
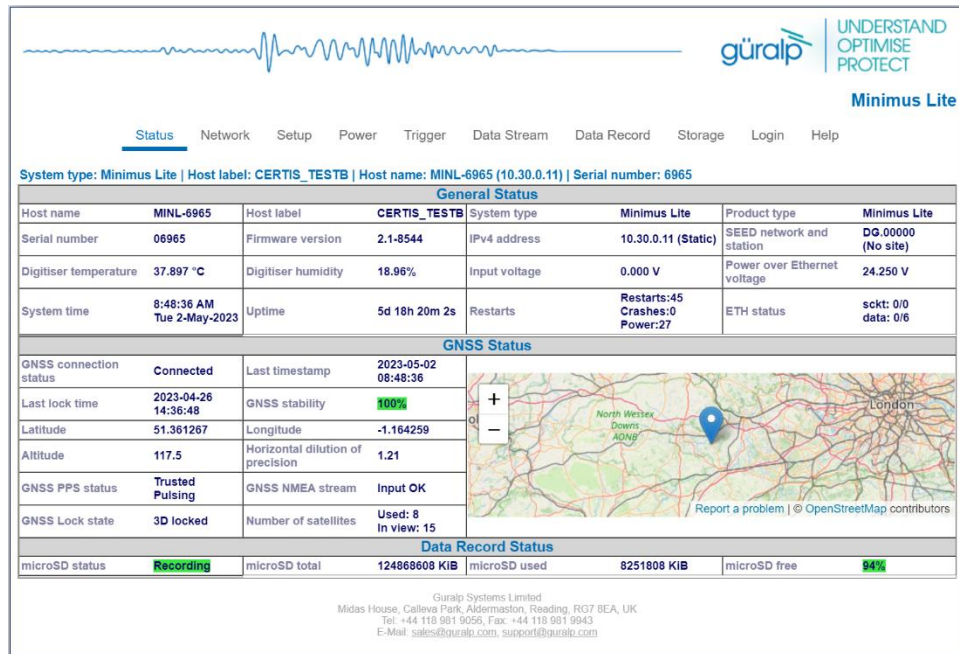
2.8   Data streams

In addition to the main seismic streams, there are a number of other data streams. These can be seen from the Data Stream or Records tabs. Use hover help on the stream name to gain more insight as to what the stream represents.

Many of the additional streams should be recorded at low sample rates during deployment. They are a vital tool to understanding the deployment and environment.

E.g.: The temperature and GPS time phase measurement (PLL) together can be used to diagnose possible reasons for time lock degrading in a deployment. In the event of snow covering the GPS antenna, the temperature and Phase measurements will show significant changes. A stable phase of a few counts from zero is expected as the GPS time is compared to internal time. Flatlining of the phase implies a loss of GPS time signal. When signal is regained, the phase will start with a larger value and gradually reduce as timelock ensues.

2.8.1 Low Bandwidth Considerations

If streaming data with a low bandwidth connection, it is advised to minimise channel sampling rates where possible to prevent issues with data streaming. The default

calibration sampling rate is 4000 Hz, it would be recommended to reduce this in the case of a low bandwidth connection. This channel is not always enabled so if it doesn't appear within the 'Data Stream' tab, select 'All' under 'Display Streams' and it will appear.

If connecting to the Minimus$_2$ via a modem, such as in our Rapid Deployment Kit, a low bandwidth would be expected and the above should apply.

2.9   Station meta-data

Discovery provides a number of flexible station meta-data inputs. These are accessible from the "Setup" tab of the instrument's web page.

"**Label**" and "**Site Name**" are used in Discovery only and appears in the list of instruments in the main window.

"**Station Name**", "**Network Code**" are all standard meta-data header values used by the miniSEED file format, which will be included in locally-stored miniSEED files (see section 2.13.6).

2.10   Network configuration

2.10.1   IP address and gateway

By default, the Minimus$_2$ uses DHCP (Dynamic Host Configuration Protocol) to acquire its network configuration but static addressing can be used if required.

To configure static addressing, visit the "Network" tab of the instrument's web page and, under "DHCP", change the mode from "Enabled" to "Disabled" in the drop-down menu. In this mode, it is possible to specify the IP address, the Netmask and the address of the Gateway (default router), as shown:

Before any changes made here will take effect, the Minimus$_2$ must be re-booted. To do this, click the [Reboot] button.

Network settings are also available in Discovery by right-clicking on the entry in Discovery's main window and selecting "Edit Network Address".

2.10.2   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 "Setup" 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.

2.11   GDI push (auto-connection)

A Minimus$_2$ normally acts as a GDI server, where a client initiates a connection in order to pull data from it. This is the mechanism used when the GDI viewer in Discovery is launched.

The "GDI auto-connection" feature enables the Minimus$_2$ to establish *outgoing* network connections in order to *push* data to one or more remote clients, such as Platinum systems or an Earthworm system running the `gdi2ew` plug-in.

To configure an auto-connection, type either the IP address or the host-name of the target client, a colon (':') and the port number (*e.g. 192.0.2.91:1566* or *affinity10.example.com:1566*), into any of the connection fields in the "Network" tab of the web page.

When auto-connection from a Minimus$_2$ to a host is configured, the Minimus$_2$ will attempt to open a connection to the host. If it fails, it will re-try every 60 seconds. A suitably configured host will accept the connection and the Minimus$_2$ will then negotiate a link and start streaming data.

If the connection drops, the Minimus$_2$ will attempt every 60 seconds to reconnect.

> **Note:** The default port number for a GDI-link receiver is 1566. Push servers will normally connect to this port. The default port number for a GDI-link transmitter is 1565. Receivers wishing to pull data will normally connect to this port. See Chapter 6 for a list of the network ports used by the Minimus$_2$.

2.12 Data storage

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

Data Record				
Disable All	Restore default	The "Disable All" and "Restore default" button will ALSO affect settings of any other sensors		Reboot
Copy to Data Stream	"Copy to Data Stream" will apply settings from this page to streaming configuration of all of the sensors.	Recording status **Recording**	For more information about microSD cards status please visit "Storage" tab	
Display Streams [Enabled Only ∨]	☑ Apply configuration for tap groups		Display On Page [Sensor 0 ∨]	

Channels configuration				
Channel sampling rate	Data transform	SEED name - please use check-box to modify the default	RESPonse file - if available	
Seismic channels				
InstZ_sd	[250 Hz ∨]	[Transforms not available on Minimus2 ∨]	☐ DG.00000.[1].[CHZ]	RESP_file_7
InstN_sd	[250 Hz ∨]	[Transforms not available on Minimus2 ∨]	☐ DG.00000.[1].[CHN]	RESP_file_10
InstE_sd	[250 Hz ∨]	[Transforms not available on Minimus2 ∨]	☐ DG.00000.[1].[CHE]	RESP_file_13
Mass position channels				
MassZ_sd	[1 Hz ∨]	[Transforms not available on Minimus2 ∨]	☐ DG.00000.[1].[LMZ]	RESP_file_17
MassN_sd	[1 Hz ∨]	[Transforms not available on Minimus2 ∨]	☐ DG.00000.[1].[LMN]	RESP_file_19
MassE_sd	[1 Hz ∨]	[Transforms not available on Minimus2 ∨]	☐ DG.00000.[1].[LME]	RESP_file_21

This page allows to configure the recording channels for each of the connected instruments and sensors internal to the Minimus$_2$.

The names and contents of each channel are described in Section 4 .

> **Note:** When changing a setting in the Minimus$_2$ web page, 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 at the top-left of the page named "Display Streams" filters out visible channels among All, Enabled and Disabled. The option "Apply configuration for tap groups" automatically apply the same configuration to three streams that belong to the same tap, *e.g.* InstZ, InstN, InstE. The drop-down box at the top-right of the page named "Display On Page" is used to select the Sensor configuration to display on the page.

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

 button. The same configuration can be applied to real-time transmission channels by clicking the button. The default channel configuration can be applied by clicking the button.

- 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 2.16.5).

Upon changing the sample rate, or changing Location and Channels codes, the Minimus$_2$ needs to be restarted for the changes to come into effect; this can be done by pressing the button.

During the reboot, the LEDs will flash, displaying the starting-up sequence (see Section 2.1.1) and the instrument web page will display the following screen.
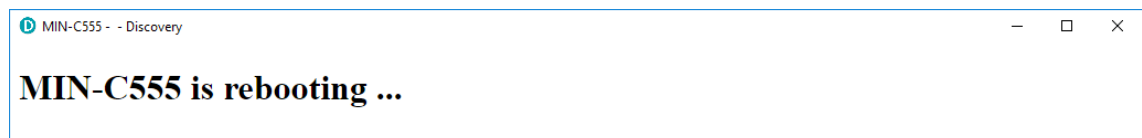
Once the Minimus$_2$ has successfully restarted, the full web browser display and controls will be available for use again.

2.13 Storage

2.13.1 Recording status

MicroSD cards need to be specifically formatted to operate with the Minimus$_2$. The cards shipped with the Minimus$_2$ are supplied pre-formatted.

Data are stored on the microSD cards in miniSEED format. Each channel is saved as a series of 128 MiB files. Instrument and station meta-data (*e.g.* instrument response, coordinates, compression type etc.) are stored in "Dataless SEED" format.

The MicroSD card and data recording status can be monitored in the upper panel of the "Storage" tab.

The left-hand column provides details of the external (primary, removable) microSD card and the right-hand column shows the status of the internal (backup, fixed) card.
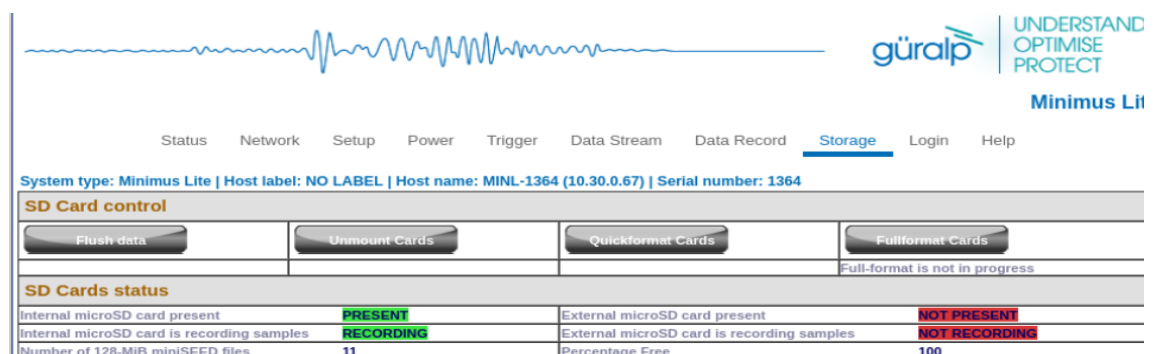
Sections of this panel indicate the status of the following:

- Whether a card is inserted;

- Whether an inserted card is usable (*i.e.* correctly formatted); and

- Whether the card is recording data.
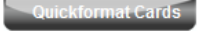
> **Note:** If the recording status of the cards is marked NOT RECORDING, clicking on the Quick Format button may solve the issue. Note that the quick format simply moves the write-pointer to the beginning of the recording space, hence overwriting any existing data.

The card re-formatting process fills the card with 128 MiB files. Each file is given a temporary, place-holder name. When data are written, these files are renamed and then over-written with data.

The quick format mode should be used for pre-deployment tests (*e.g.* stomp/huddle tests) to ensure that the instruments are operating properly. This mode simply marks the existing files as empty without deleting their contents. The formatting process formats both fixed and removable cards, simultaneously.

2.13.1.1   *Quick format*

Ensure that the external microSD card is correctly inserted. Click the **Quickformat Cards** button in the "Storage" tab: The button legend will change to ask for confirmation. Press a second time to start the format: The progress bar should immediately start at 1% and take about 5 minutes to complete.
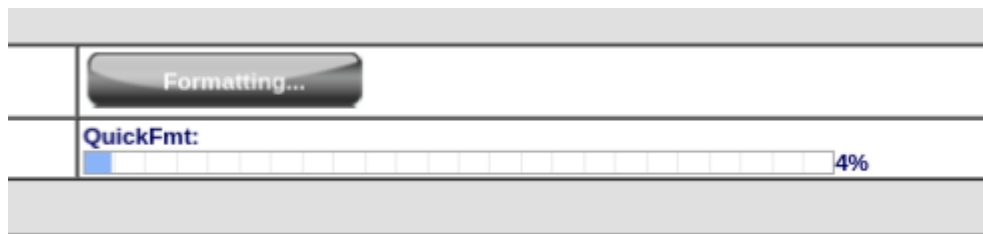
The instrument web page will refresh and return to the "Status" tab. The reformatting operation is now complete.

2.13.2   MicroSD card data flushing and unmounting

The **Flush data** button flushes data still in the buffer into the microSD card storage. Perform a flushing before downloading data from the Storage tab if the very latest data is required. Data is written roughly every 2 minutes.

The **Unmount Cards** button flushes the data from the buffers into the microSD cards and interrupts the recording. The recording restarts if a new card is inserted in the slot or if a quick-format (or full-format) is performed.

2.13.3 Downloading recorded data

The "Storage" tab of the web browser interface displays the miniSEED files stored on the microSD card:

	Filename	Size (bytes)	Start data timestamp	Last data timestamp
☐	000_InstZ_sd.mseed	134217728	2023-06-22 16:20:39	--> 2023-06-30 12:43:08
☐	001_InstN_sd.mseed	134217728	2023-06-22 16:20:39	--> 2023-06-30 12:47:02
☐	002_InstE_sd.mseed	134217728	2023-06-22 16:20:39	--> 2023-06-30 12:40:07
☐	003_InstX_sd.mseed	54644736	2023-06-22 16:20:39	--> 2023-07-03 12:40:09
☐	004_Temperatur_sd.mseed	7405568	2023-06-22 16:26:48	--> 2023-07-03 12:30:05
☐	005_Humidity_sd.mseed	8916992	2023-06-22 16:26:48	--> 2023-07-03 12:26:37
☐	006_Voltage_sd.mseed	5984256	2023-06-22 16:26:48	--> 2023-07-03 12:35:44
☐	007_Power_sd.mseed	14512128	2023-06-22 16:26:48	--> 2023-07-03 12:30:16
☐	008_Phase_sd.mseed	466944	2023-06-22 16:26:48	--> 2023-07-03 08:59:50
☐	009_DAC_sd.mseed	471040	2023-06-22 16:26:48	--> 2023-07-03 08:59:50
☐	010_MassZ_sd.mseed	471040	2023-06-22 16:26:48	--> 2023-07-03 08:59:50
☐	011_MassN_sd.mseed	471040	2023-06-22 16:26:48	--> 2023-07-03 08:59:50
☐	012_MassE_sd.mseed	471040	2023-06-22 16:26:48	--> 2023-07-03 08:59:50
☐	013_InstE_sd.mseed	93237248	2023-06-30 12:40:18	--> 2023-07-03 12:41:25
☐	014_InstZ_sd.mseed	93171712	2023-06-30 12:43:19	--> 2023-07-03 12:41:24
☐	015_InstN_sd.mseed	93085696	2023-06-30 12:47:14	--> 2023-07-03 12:41:25

Download selected files

Clicking on the file from the list automatically starts a download using your browser's standard mechanism:
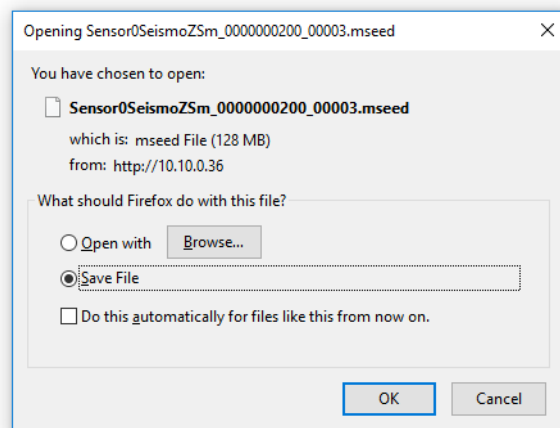
Multiple files can be downloaded simultaneously by ticking the boxes on the left of each link and clicking on Download selected files button.

The microSD cards are formatted with empty files which are filled with data as they become available. The file-names are also changed when the files are written to. Until they are written to, they are marked as "hidden" files, so that it is easier to see how many files contain data when looking at the contents of the card.

2.13.4 Downloading data for specific time-intervals

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

… then select the start and end dates and times using the pop-up calendars:

Lastly, click the ⬚Download⬚ download button to initiate a file transfer using your browser's standard mechanism.

2.13.5 Bulk data extraction

To view files saved on the external microSD card, remove the card, as described in Section 2.1.3.1. Insert the card into a microSD card reader (external or in-built) on your PC/laptop. Within a few seconds, the card should appear as a removable disk/drive.

A microSD card formatted for the Minimus$_2$ contains many "hidden" files. They are created at format time with no contents and then renamed, unhidden and filled with data as required.

When viewing files in Windows Explorer, it may be helpful to configure your system so that "hidden" files are not shown. In Windows 10, this can be done by clearing the "Hidden items" check-box within the ribbon of Windows Explorer.

2.13.6 The contents of the microSD card

The Storage tab on the web interface shows a list of files present on the SD card:

The root directory of the disk contains seven items:

- a file named `init.log`. This "write-once" file contains the first 32 MiB of system log information since the card was last formatted.

- a file named `system.log`. This "re-use" file contains the last 64 MiB of the system log;

- a file named `status.log`. This "re-use" file contains the last 32 MiB of damps of system state of health information. A new dump is generated every 20 minutes.

- a disk image file which Güralp technical support may ask you to use if you have problems with the card;

- a file named `table_of_events.bin`. This is not human readable: it is used by the Seismic Events Table in the "Trigger" tab

- a directory named `all_miniSEED_files_are_in_here`. Within this directory, there will be a miniSEED file for each recording channel. The file-name prefix is the same as the channel name description given in the "Data Record" tab. Each file is 128 MiB in size.

The typical contents of the `all_miniSEED_files_are_in_here` directory looks like this:
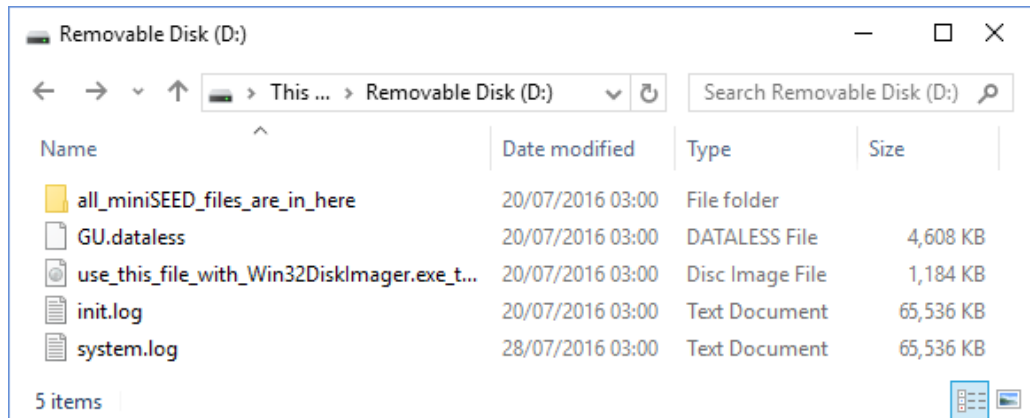
The file-name consists of four components:

- The stream name, truncated to 16 characters - see Section 4 for a full list of these;

- The sample rate (in samples per second) as a ten-digit decimal number, left-padded with zeros;

- A number which functions as a counter to ensure unique file-names for all files. Each time a file is created, this number is incremented so that the next file to be created will use the next value; and

- The `.mseed` extension which identifies this as a miniSEED file.

The "Storage" tab also shows links to five auxiliary files, which are either saved in the flash RAM or are dynamically generated:

- *network*`.DATALESS` : This is a Dataless SEED volume that contains meta-data including instrument responses, coordinates, compression type and more. It is generated from the RESP files for each channel. The first component of the file name depends on the two-character Network code defined in the "Setup" tab. If, for example, this is `GU`, the file is called `GU.DATALESS`.

- `fram.log` : this is the FRAM log file. It is stored in FRAM.

- `calvals.txt` : this file contains calibration information in a format compatible with the Scream software package. It is dynamically generated.

- `calib.txt` - this file contains calibration information with poles, zeros etc expressed in hexadecimal notation. It is stored in FRAM.

- `polezero.txt` : this file contains definitions of frequency responses in a format compatible with the Scream software application. It is dynamically generated.

2.13.7   Time based download 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(sensor,
channel, startUNIX, endUNIX))
wget.download(r"http://{0}/data?channel={1}&from={2}&to={3}".format
(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_code}
.${sensor_code1}\&from=${start_utc}\&to=${end_utc}
wget -v -On_component.mseed
http://$1/data?channel=${net_code}.${station_code}.${location_code}
.${sensor_code2}\&from=${start_utc}\&to=${end_utc}
wget -v -Oe_component.mseed
http://$1/data?channel=${net_code}.${station_code}.${location_code}
.${sensor_code3}\&from=${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
```

2.13.8   Request data from microSD card 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: It

extracts all files from the SD Card into a directory named after the date and the network address of the Minimus$_2$.

#!/bin/bash # Invoke with one argument: the network # address of the Minimus$_2$

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

2.14   Data transmission

The monitoring and configuration of transmitted data is handled using the "Data Stream" tab of the instrument's web page.

Three streaming protocols are supported:

GDI – Güralp data interchange. This is used with Discovery and offers live, low latency data combined with channel metadata. All calibration and response information is contained within the stream

GCF – A legacy protocol for use with Güralp Scream.

SeedLink – An industry standard, packet-based protocol. The packetising causes potentially significant delays. Güralp has implemented various extensions to the protocol to reduce packet size and payload to speed up for early warning applications. The meta data is not conveyed within the stream. The dataless file is required to be transferred separately to give calibration and response information. This can be error prone!

All 3 servers are active. Making the connection starts the stream.

This page allows to configure the transmitted channels for each of the connected instruments and sensors internal to the Minimus$_2$.

The drop-down box at the top-left of the page named "Display Streams" filters out visible channels among Enabled and Disabled. The option "Apply configuration for tap groups" automatically apply the same configuration to three streams that belong to the same tap, *e.g.* 0VELZ0, 0VELN0, 0VELE0. The drop-down box at the top-right of the page named "Display On Page" allows to move from different instruments, *e.g.* Sensor 1.

The page is divided in four columns:

- In most-left 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. 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.

- 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 2.16.5).

Upon changing the sample rate, or changing Location and Channels codes, the Minimus$_2$ 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 2.1.1) and the instrument web page will display the following screen.

Once the Minimus$_2$ has successfully restarted, the full web browser display and controls will be available for use again.

2.14.1 Scream! (GCF format + Scream protocol)

The Minimus$_2$ can act as a Scream! Server and stream data by sending GCF (Güralp Compressed Format) packets over a network connection using the scream data-transmission protocol.

This is primarily intended to support Güralp's Scream! Software (see Section 2.5.5) or any software that can communicate using the Scream! Protocol, including Earthworm.

These include:

- Güralp instruments with embedded acquisition modules (*e.g.* 40TDE)

- Güralp DM24 and CD24 digitisers with embedded acquisition modules (*e.g.* Güralp DM24S*x*EAM[U])

- Güralp Affinity digitiser

- Network Acquisition Module (Güralp NAM)

2.14.2 GDI-link protocol

The Minimus$_2$ can transmit data using the GDI-link protocol. GDI-link can currently be used with:

- Güralp instruments with embedded acquisition modules (*e.g.* 40TDE)

- Güralp DM24 and CD24 digitisers with embedded acquisition modules (e.g. Güralp DM24S*x*EAM[U])

- Güralp Affinity digitisers

- Güralp NAM (Network Acquisition Module)

- Earthworm software (www.isti.com/products/earthworm/)

GDI-link supports both data push and pull from/to the Minimus$_2$. See Section 2.11 to configure data push to one or more remote clients, *e.g.* NAM.

GDI-link provides a highly efficient, low latency method of exchanging data via TCP between seismic stations and data centres. The protocol allows state-of-health information to be attached to samples during transmission. The topology can be many-to-one or one-to many. This means that a receiver can accept data from multiple transmitters and a single transmitter can send data to multiple receivers, allowing maximum flexibility for configuring seismic networks. GDI-link streams data sample-by-sample (instead of assembling them into packets) to minimise transmission latency.

A significant advantage of GDI-link is that it has the ability to stream data pre-converted into real physical units instead of just as raw digitiser counts, obviating a requirement for receivers to be aware of calibration values.

For more information on GDI-link, please refer to Güralp manual **SWA-RFC-GDIL**.

2.14.3   SeedLink Protocol

The Minimus$_2$ can act as a SeedLink server to send SeedLink data packets over a network connection. The SeedLink server is enabled by default but it can be disabled and re-enabled if desired. The server has a configurable back-fill buffer.

In the "Network" tab of the ' web page, select the desired SeedLink mode:

SeedLink settings					
SeedLink Enabled, 65536 records	Send status.txt Every 300 seconds	SeedLink Data Packet Format Optimal	Send SeedLink EEW Packet Every 0 deciseconds		

The choices are:

- "Enabled" - This is the normal operating mode. Choose between backfill buffer sizes of 2,048 records, 65,536 records or 139,264 records.

- "Disabled" - turns off the SeedLink server.

- "Debug" - this mode produces additional messages in the file `seedlink.log` which may be helpful if trying to diagnose a problem. It is available with backfill buffer sizes as before and, additionally, a 512-record buffer. (622,592 is listed but not implemented).

Standard SeedLink has a fixed packet size of 512 Bytes and each miniSEED packet is completely populated with data before it is transmitted. The Minimus$_2$ supports a modified version of SeedLink that allows the transmission of incomplete packets. This improves latency.

The user can specify the rate at which miniSEED packets must be transmitted. If populating complete packets would result in this rate not being achieved, incomplete packets are transmitted instead. The number of samples in each packet, therefore, depends both upon this setting and on the sample rate.

In the "Network" tab of the web page, select the interval in deciseconds (1 decisecond = 100 ms or 0.1 seconds) between miniSEED packets ("Send SeedLink EEW Packets Every").

The modified SeedLink protocol also allows the use of 256-byte records as an alternative to the standard 512-byte format. The "Data Record Size" drop-down menu on the "Network" tab of the web page controls this behaviour.

Note: Not all SeedLink clients can accept 256-byte records. Consult your client's documentation if in doubt.

To test the SeedLink server, Güralp recommends using the *slinktool* software for Linux, which is distributed by IRIS. For more information and to download a copy, see http://ds.iris.edu/ds/nodes/dmc/software/downloads/slinktool/.

To show a list of available miniSEED streams, issue the command:

```
slinktool -Q IP-Address
```

Which produces output like the following:

```
DG TEST  00 CHZ D 2016-09-13 10:42:18  -  2016-09-13 10:46:56

DG TEST  01 HHZ D 2016-09-13 10:42:18  -  2016-09-13 10:46:56

DG TEST  00 CHN D 2016-09-13 10:42:18  -  2016-09-13 10:46:56

DG TEST  01 HHN D 2016-09-13 10:42:18  -  2016-09-13 10:46:56

DG TEST  00 CHE D 2016-09-13 10:42:18  -  2016-09-13 10:46:56

DG TEST  01 HHE D 2016-09-13 10:42:18  -  2016-09-13 10:46:56

DG TEST  00 MHZ D 2016-09-13 10:42:18  -  2016-09-13 10:46:56

DG TEST  00 MHN D 2016-09-13 10:42:18  -  2016-09-13 10:46:56

DG TEST  00 MHE D 2016-09-13 10:42:18  -  2016-09-13 10:46:56
```
⋮

To print miniSEED data records of a single channel, you will need the following command:

```
slinktool -p -S DG_TEST:00HNZ.D IP-Address
```

Which produces the following output:

```
DG_TEST_00_HNZ, 412 samples, 100 Hz, 2016,257,10:43:42.000000
(latency ~2.9 sec)

DG_TEST_00_HNZ, 415 samples, 100 Hz, 2016,257,10:43:46.120000
(latency ~2.6 sec)

DG_TEST_00_HNZ, 416 samples, 100 Hz, 2016,257,10:43:50.270000
(latency ~3.0 sec)

DG_TEST_00_HNZ, 413 samples, 100 Hz, 2016,257,10:43:54.430000
(latency ~2.6 sec)

DG_TEST_00_HNZ, 419 samples, 100 Hz, 2016,257,10:43:58.560000
(latency ~3.0 sec)

DG_TEST_00_HNZ, 418 samples, 100 Hz, 2016,257,10:44:02.750000
(latency ~2.6 sec)

DG_TEST_00_HNZ, 415 samples, 100 Hz, 2016,257,10:44:06.930000
(latency ~3.0 sec)
```

The SEEDlink server on the Minimus$_2$ also supports the use of the "**?**" character as a wild-card within network, station and channel codes. This allows you to request multiple streams using a single command.

> **Note:** Because the **?** character has special meaning to the shell, it is safest to quote this character with a preceding backslash ('\') when used in command arguments.
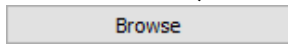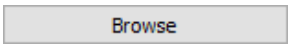
2.14.3.1   MiniSEED extractor
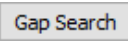
The miniSEED extractor serves two purposes:

- When an SD card is quick-formatted, each file is marked as unused but previously recorded data can still remain in them. Subsequent recordings overwrite these files from the beginning but, if the previous recording had a longer duration, old data will remain in the files. When the files are copied from the SD card to a PC, these older data can cause problems.

- The format used on the SD cards consists of fixed-length, 128 MiB files. Some recordings might not use all of this space. When the files are copied from the SD card to a PC, this can cause wasted disk space.

The miniSEED extractor reads miniSEED files on the PC and copies them to a selected Destination folder, keeping track of the latest block time-stamp as it goes. If it encounters either an unused block or a time-stamp which is earlier than the previous one, it stops copying, truncating the output file at that point. This guarantees that each output file contains only blocks in time order and contains no wasted space.
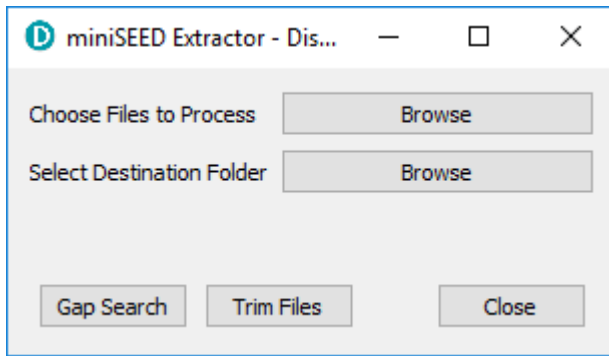
To use the tool, select "miniSEED Extractor" from the Edit menu. Click the first [Browse] button to select which files you wish to process and then the second [Browse] button to select the folder into which you wish the output files to be written. Finally, click the [Trim Files] button to extract the valid data from the selected files into new files in the selected destination folder.

The same tool can also generate a report of any gaps in the data from the input files. To use, select the input files as before and then click [Gap Search] to view the report.

2.15 Synchronisation of the sample-clock

The Minimus$_2$ system synchronises its sample clock using an attached GNSS receiver or, if that is not available, Precision Time Protocol (PTP).

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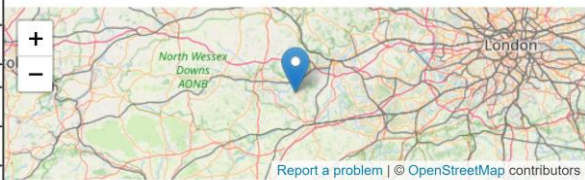
> **Note:** The GNSS can use only three different types of satellites simultaneously and GPS is always used, if available. The other two spots available can be either GLONASS, BeiDou or Galileo.

If visibility of the satellite constellation is available, this is the most accurate way to synchronise your digitiser. The Minimus$_2$ accessory pack includes a combined GNSS antenna and receiver for this purpose: see Section 2.2.2 for details.

2.15.1 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 (2D/3D)

- Number of available satellites (in use / in view)

-

2.15.2   PTP (Precision Time Protocol)

The Minimus$_2$ system currently does NOT support PTP.

2.16   Configuration and control of connected analogue instruments

2.16.1   Setting instrument type

The analogue sensor type is user-selectable and the Minimus$_2$ includes a choice of several Güralp sensors and accelerometers. If the sensor is not in the list, select "Generic velocity" or "Generic acceleration", according to the instrument's response.

A reboot is required after this change.

2.16.2   Setting instrument (sensor) gain for Güralp Fortis

The Güralp Fortis strong-motion accelerometer features a remotely-switchable gain option that can be controlled from inside Discovery. First, ensure that the physical gain switch on the underside of the Fortis is set to position "3" (as indicated by the engraving). See **MAN-FOR-0001** for more details.

To change the gain electronically, first, set the "Instrument Type" to "Güralp Fortis". Setting this option will then enable the "Instrument Gain" control. Under the "Instrument Gain", select a gain setting (options: ±0.5g; ±1g; ±2g; ±4g).

Setting the instrument type to "Fortis" will also change the miniSEED channel names to indicate that data are recorded from an accelerometer, *e.g.* "HNZ".

Analogue Sensors								
		Analogue to Digital Converter						
Input gain	x1.0 ⌄	Input range	+/- 20.48 V	Input resolution	2.441 uV/count			
		Identification						
Sensor type	Guralp Fortis ⌄							
		Response						
Fortis Range	-0.5g; +0.5g ⌄	Fortis Loop	Normal ⌄					
	-0.5g; +0.5g							
Centre Mass	-1.0g; +1.0g	Mass Centring						
	-2.0g; +2.0g	Mass Readout Z	-0.00375 V	Mass Readout N	-0.00312 V	Mass Readout E	-0.00375 V	
	-4.0g; +4.0g	Calibration						
Calibration		Amplitude	100% ⌄	Channel	Normal ⌄			

2.16.3   Setting digitiser gain

The input gain can be controlled from the "Setup" tab of the web page using the "Input Gain" drop-down box. Digitiser gain options available are: Unity, ×2, ×4, ×8 and ×12.

Analogue Sensors								
		Analogue to Digital Converter						
Input gain	x1.0 ⌄	Input range	+/- 20.48 V	Input resolution	2.441 uV/count			
	x1.0	Identification						
	x2.0							
Sensor type	Guralp Fortis	x4.0						
		Response						
Fortis Range	-0.5g x8.0	Fortis Loop	Normal ⌄					
	x12.0	Mass Centring						
Centre Mass		Mass Readout Z	-0.00375 V	Mass Readout N	-0.00312 V	Mass Readout E	-0.00375 V	
		Calibration						
Calibration	Off ⌄	Amplitude	100% ⌄	Channel	Normal ⌄			

The input range and resolution change automatically when the gain is selected and the gain in the RESP files and Dataless SEED is updated automatically.

2.16.4   Mass control

The Minimus$_2$ can lock, unlock and centre the masses of connected instruments.

2.16.4.1   *Mass centring*

Many broadband seismometers (*e.g.* Güralp 3T and 3ESPC) support remote/electronic mass centring. Change the polarity of the control signal using the drop-down menu if necessary.

		Identification						
Sensor type	Generic velocity ⌄	Status LED	Idle					
		Mass Centring						
Centre Mass		Mass Readout Z	-0.00375 V	Mass Readout N	-0.00312 V	Mass Readout E	-0.00375 V	
		Mass Locking						
Lock Mass		Unlock Mass						
		Calibration						
Calibration	Off ⌄	Amplitude	100% ⌄	Channel	Normal ⌄			
		Control Polarity						
Mass Lock Polarity	Active Low ⌄	Mass Unlock Polarity	Active Low ⌄	Centring Polarity	Active Low ⌄	Cal Enable Polarity	Active Low ⌄	
Digital Sensors				Active Low				
				Active High				
		Selection						

Mass centring can be controlled from the "Setup" tab of the web page using the Centre Mass button. Mass centring status and control can also be found in the Centring tab of the instrument Control Centre window.

2.16.4.2   Mass locking

Some seismometers require their masses to be locked for transportation. Mass locking can be controlled from the "Setup" tab of the web page using the `Lock Mass` and `Unlock Mass` buttons. Change the polarity of the control signals using the drop-down menu, if necessary.

> **Note:** The mass lock control buttons are not displayed unless the selected sensor type has a mass-locking mechanism.

2.16.5   Instrument response parameters

Calibration is a procedure used to verify or measure the frequency response and sensitivity of a sensor. It establishes the relationship between actual ground motion and the corresponding output voltage. Calibration values, or response parameters, are the results of such procedures.

Response parameters typically consist of a sensitivity or "gain", measured at some specified frequency, and a set of poles and zeros for the transfer function that expresses the frequency response of the sensor. A full discussion of poles and zeros is beyond the scope of this manual.

The gain for a seismometer is traditionally expressed in volts per ms^{-1} and, for an accelerometer, in volts per ms^{-2}. Other instruments may use different units: an electronic thermometer might characterise its output in mV per °C.

A calibration procedure is also used to establish the relationship between the input voltage that a digitiser sees and the output, in counts, that it produces. The results are traditionally expressed in volts per count. Each $Minimus_2$ is programmed at the factory so that it knows its own calibration values.

Although the $Minimus_2$ automatically receives calibration parameters from connected digital instruments (*e.g.* Güralp Certis), calibration values need to be entered manually for connected analogue sensors (*e.g.* Güralp Fortis).

To enter the calibration values for your analogue instruments, right-click the $Minimus_2$ in Discovery's main window and select "Calibration" → "Calibration Editor".

This form has one tab for each seismic component, for the mass positions and calibration channel. The instrument's response values should be entered in the here. These are:

- The **Digitiser Volts per Count (VPC)** – the ratio between the input voltage and the digitised output value ("counts"). This field will be populated automatically with the correct value for this input channel of the Minimus.

- **Analogue Instrument Gain** – this specifies the output voltage of the seismometer per unit of ground motion, as measured at 1 Hertz. This information is normally provided on the calibration document that is shipped

with the instrument. In the calibration document, this parameter is often referred to as "Velocity Output V/m/s" or "Acceleration Response V/m/s^2" depending on the analogue instrument. This value can vary slightly across the three components.
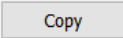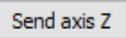
- The **ADC offset** is the quiescent output seen when digitiser input is zero. This field will be populated automatically with the correct value for this input channel of the Minimus.

- The **Coil constant** is the coil constant for the component being calibrated, in A/ms^{-2}, as given on the analogue sensor calibration sheet. This value is the same across all three components. This value is not relevant when Minimus is used with a Güralp Fortis accelerometer or Güralp Certis broad-band seismometer.

- The **Calibration resistor** is the value of the calibration resistor, in Ω, as given on the sensor calibration sheet. This value is the same across all three components. This value is not relevant when Minimus is used with a Güralp Fortis accelerometer or Güralp Certis broad-band seismometer.

- The **Normalising factor** specifies the value that the transfer function (as specified by the poles and zeros) must be multiplied by in order to provide unity gain at 1 Hz. This value is the same across all three components.

- The **Poles** and **Zeros** describe the frequency and phase response of the component. *They must be specified in Hertz.* This information is normally provided on a calibration document that is shipped with the instrument. If poles and zeros are not included in your calibration document, nominal values can be found here:: https://www.guralp.com/apps/paz/. This value is the same across all three components.
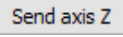
> **Note:** If the calibration document is lost, please visit the website to learn how to request a copy (https://www.guralp.com/customer-support).
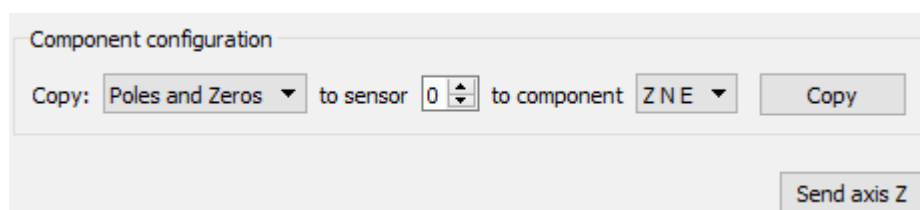
The calibration parameters for one component can be copied to any other component of the same instrument, or other instruments. This is especially useful for poles and zeros, because they are typically identical for all three components of all instruments in a class.

The drop-down menu in the "Component configuration" section allows selection of what to copy: poles and zeros, gains or everything. The destination sensor and component(s) can be selected in the subsequent drop-down menus. Click on the Copy button to copy and paste the selected values. Finally click on Send axis Z button to send the calibration values to the digitiser and save them permanently. Repeat this last step for the other axis. Note that Send axis Z only sends the calibration of the selected axis.

The overall system calibration parameters can be exported and saved in a file for future use by clicking on the Export to file button under "System calibration values".

```
┌─ System calibration values ─────────────────────────────────────────────┐
│                                                                          │
│              Poles and Zeros  ▼    Export to file    Import from file    │
│                                                                          │
│                                                                          │
│                                    Send instrument calibration to device │
│                                                                          │
└──────────────────────────────────────────────────────────────────────────┘
```

The resulting file-name will have the extension `.conf`. Values from an existing calibration file can be imported using the Import from file button. The associated drop-down menu allows specification of what to import: poles and zeros, gains or everything. Click on Send instrument calibration to device to send the calibration values to the digitiser and save them permanently. Note that this action will only send the calibration of the selected sensor. Click on the Send to device button to send the complete calibration to the digitiser.

When transmitting MiniSEED data, the responses of the instruments and digitisers are encoded in a message called a "Dataless SEED" volume. The contents of these volumes can be displayed in human-readable form, known as RESP, by clicking on the "RESP file" link of each channel in the "Data Stream" and "Data Record" tab of the web page.

Clicking on a RESP file link produces a page like this:

```
#                    << Guralp SEED response file builder v2.1-10402 >>
#
#                    ======== CHANNEL RESPONSE DATA ========
B050F03    Station:     00000
B050F16    Network:     DG
B052F03    Location:    1
B052F04    Channel:     CHZ
B052F22    Start date:  2023,184,10:44:18
B052F23    End date:    No Ending Time
#          ========================================
#          +          +-------------------------------------+          +
#          +          |    Channel Sensitivity, 00000 ch CHZ |          +
#          +          +-------------------------------------+          +
#
B058F03    Stage sequence number:            0
B058F04    Sensitivity:                      4.184100E+05
B058F05    Frequency of sensitivity:         1.000000E+00 HZ
B058F06    Number of calibrations:           0
#
#          +          +-------------------------------------------+          +
#          +          |    Response (Poles & Zeros), 00000 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:          1.000000E+00
B053F08    Normalization frequency:          1.000000E+00
B053F09    Number of zeroes:                 0
B053F14    Number of poles:                  0
#
#          +          +-------------------------------------+          +
#          +          |    Channel Gain, 00000 ch CHZ        |          +
#          +          +-------------------------------------+          +
#
B058F03    Stage sequence number:            1
B058F04    Gain:                             1.000000E+00
B058F05    Frequency of gain:                1.000000E+00 HZ
B058F06    Number of calibrations:           0
#
```

Right-click anywhere and select "Back" to return to the web page.
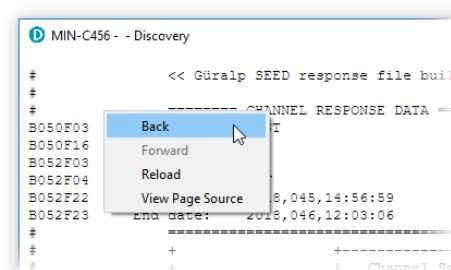
To save a RESP file, right click on it in the main list and select "Save Link":
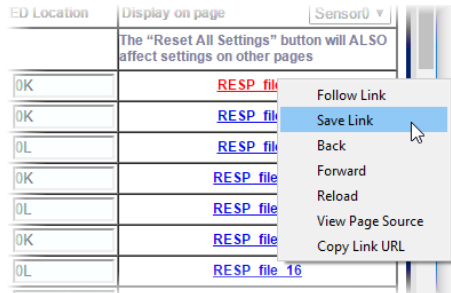
2.17 Configuration and control of connected digital instruments

Minimus$_2$ supports the Güralp Certis instrument. This can be connected either as a Digital instrument or a traditional Analogue device. The same cable is used in either case.

In the case of the digital connectivity, the serial connection conveys meta data in addition to the seismic signals. Information such as temperature, internal humidity, mass positions are all made available.

1.1.1 Inject a calibration signal

To check whether the analogue sensor(s) connected to the Minimus$_2$ is correctly calibrated, go to the Setup tab of the web page and use the drop-down menu to choose between Triangle, Square and White Noise signal to be injected into the sensor's feedback loop.

Adjust the calibration signal amplitude at 100%, 50%, 25% or 12.5% of the DAC full range.
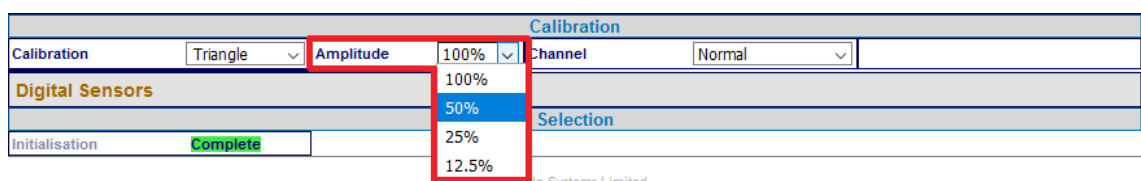
Finally, enable the calibration on all three components of the selected analogue sensor.

Note: The calibration channel, named *nVELC0* (or *nACCC0*), produces an output if and only if the calibration is in progress.

While the calibration is in progress, the webpage shows the warning message and Discovery flags the status icon in yellow.

2.18 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.

2.18.1 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 triggering sources.

Once this is selected, options will appear to enable the sending of a CAP message, registering the event under the event table, and the sample rate the trigger will use. This sample rate is recommended to keep the same as the source. Ie a 100sps instrument channel should be sampled at 100sps to perform the best STA/LTS calculations.

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

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.

When the ratio of STA to LTA exceeds the set threshold value an event is "declared", and this event ends when the ratio falls below the de-trigger threshold. The STA/LTA periods and the cut-off frequency of the high pass filter can be modified when trigger type is set to STA/LTA.

The threshold algorithm, instead, declares the presence of an event when the raw data in input passes above or below a pre-set threshold value, and ends when the event raises above this value. To trigger below a value instead of above, simply set the de-trigger threshold to be higher than the trigger threshold.

Trigger Configuration

Trigger 0 Configuration							
Trigger Tap 0	CertisZ0	Cap Enabled 0	yes	Event Table Enabled 0	yes	Trigger SPS 0	200 Hz
Trigger Threshold 0	10	Detrigger Threshold 0	6	Trigger Type 0	STA/LTA		
STA Period 0	0.4 s	LTA Period 0	60 s	HPF Cutoff 0	10 Hz		
Trigger 1 Configuration							

2.18.2   EEW Configuration

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.

2.18.3   CAP receiver

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. See Section 2.19 for information about configuring a registry server.

All CAP messages can be stored in a log-file. The full message is recorded so that it can be re-loaded later, if required.

The CAP receiver functionality is accessed using the context (right-click) menu in Discovery or clicking on "Edit" in the menu bar:

The CAP receiver window allows specification of the listening port. Each digitiser from which messages should be received must have this value specified as the "CAP Port" in its triggering settings. The value should be between 1025 and 65535. You should avoid numbers in the list at https://en.wikipedia.org/wiki/List_of_TCP_and_UDP_port_numbers.

The reception of CAP messages can be enabled or disabled clicking on the Start button at the top, right-hand side of the window.

If you wish to forward the CAP messages to a server, type its IP address into the field and tick the check-box named "Use forwarding server". An error message is displayed if the entered IP address is not valid.

To log CAP messages to a file, tick the "Log events" check-box and use the Browse button to select an appropriate location for the database file.
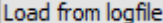
To import an existing database of events, first enable logging, then browse to the file using the Browse button and, finally, click the Load from logfile button to load the file. If no file is specified, the logging is automatically switched off and a pop-up message is displayed.

When an event is detected and a CAP message is received, the location of the digitiser that generated the trigger is identified by a pointer displayed on the map. The events and the information contained in the CAP message are displayed at the right-hand side of the window. This includes the SEED identifiers, network, station, channel and

location, along with the time, the recipients and the threshold value which was exceeded.
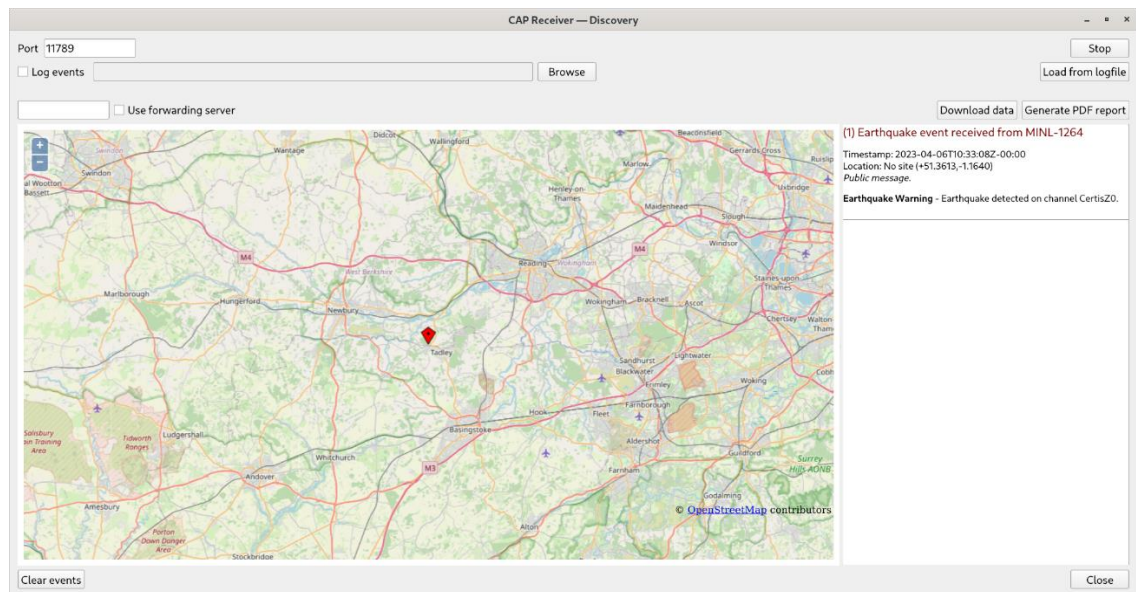
If the EEW parameters are enabled in a particular source, after the first CAP message containing the event information, three other messages with the PGA/PGV/PGD details are sent, one for each component.

Click on the [Clear events] button to clear markers from the map and descriptions from the right-hand-side list. This action does not affect the contents of the log-file.

2.18.4   STA/LTA Streams

Once a trigger has been enabled a reboot is required. Additional streams will then be available showing the calculated STA (Short term average), LTA (Long term average) and Ration of STA/LTA

The value of this ration is thresholded as configured in the above menu. It is useful to vie the streams to get a feel for the ratio values and time constants.
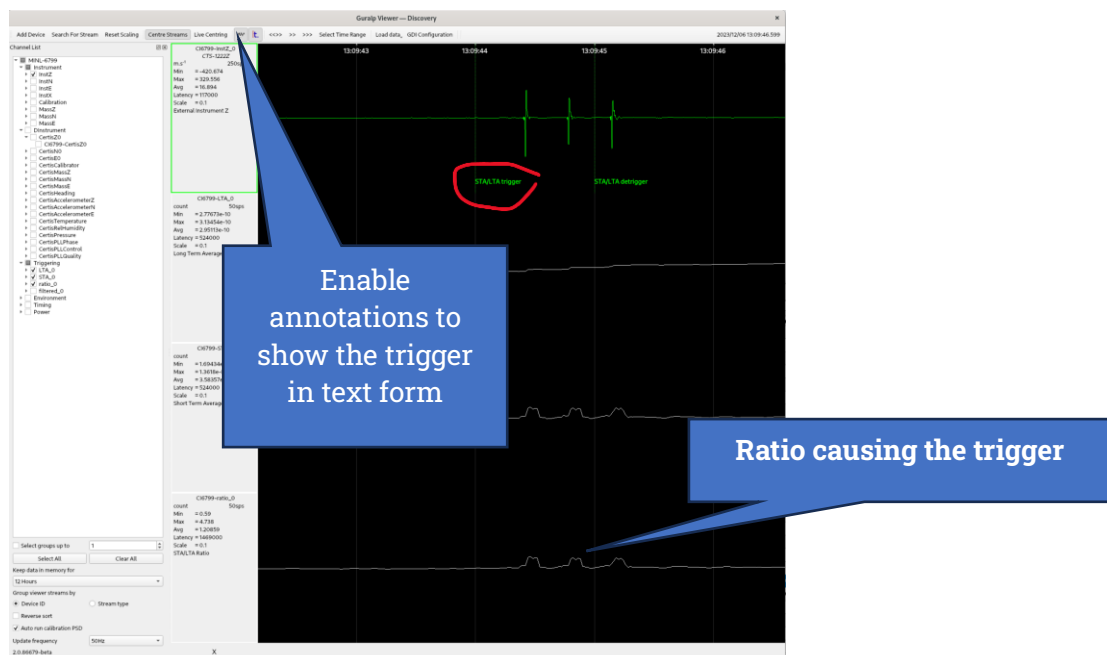
2.18.5   Seismic Event Table

The Minimus$_2$ 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.

Download Settings:	Seconds Pre	10	Seconds Post	10		
Time of Event **Duration**	**Trigger Function (Tap)** **Max Signal Diff**		**Download Source Tap**		**Download**	
Wed Apr 5 18:00:59 2023 < 1 second	STA/LTA trigger on channel CertisZ0 (CertisZ0_tr)246 m.s		CertisZ0_sd ⌄		Request Event Data	
Wed Apr 5 17:34:00 2023 < 1 second	STA/LTA trigger on channel CertisZ0 (CertisZ0_tr)255 m.s		CertisZ0_sd ⌄		Request Event Data	
Wed Apr 5 17:31:27 2023 1 seconds	STA/LTA trigger on channel CertisZ0 (CertisZ0_tr)255 m.s		CertisZ0_sd ⌄		Request Event Data	
Wed Apr 5 17:12:09 2023 1 seconds	STA/LTA trigger on channel CertisZ0 (CertisZ0_tr)197 m.s		CertisZ0_sd ⌄		Request Event Data	

2.19   Using a Registry

Discovery can maintain a list of digitisers in a local or cloud-based registry, simplifying management of medium to large networks and removing the need for static IP addresses at telemetered stations. Registered digitisers appear in the selection list in the main screen, regardless of whether they are on the local network or not.

Administrators can create their own registry servers by installing a simple program on a server (contact support@guralp.com for more details). The server itself must have a static IP address and be accessible to all connected Minimus$_2$ units, as well as the PCs running discovery. Registry server's programs are currently available for Linux and Windows. Please contact Güralp technical support for details.

For administrators not wishing to install their own registry, Güralp provide a shared registry server in the cloud at `52.34.40.123` which customers are welcome to use.

Registered digitisers must be assigned to groups, each of which has a **Group Identifier**. Instances of Discovery must also be configured with a Group ID and can only display registered digitisers from the matching group. This allows partitioning of large networks into smaller administrative domains. It also makes possible the simultaneous use of the Güralp shared registry server by multiple organisations.

To use a registry:

1. Choose whether to use the Güralp shared registry or to deploy your own. If deploying your own, install the software on your chosen server and note its public IP address.

2. Choose one or more Group IDs for your digitisers.

3. Set the Registry server address and Group ID in each Minimus$_2$.

4. Set the Registry server address and Group ID in each instance of Discovery.

2.19.1   Configuring a Minimus2 for use with a registry

The address of the registry server and the chosen Group ID must be set individually for each participating digitiser.

To do this, first connect the Minimus$_2$ to the same network as a PC running Discovery and click the   Scan Locally   button, so that the Minimus$_2$ appears in the main Discovery list. Right-click ( ) on the digitiser's entry and select "View Web Page" from the context menu:

In the resulting web page, select the "Network" tab. The Registry parameters can be found near the bottom of the resulting screen:

These are:

- **Registry Update**: the frequency at which the registry is updated with details of this digitiser can be specified here, using the drop-down menu;

- **Group ID**: the chosen Group Identifier should be entered here;

- **Registry Address**: the IP address of the registry should be entered here. To use the Güralp shared cloud server, enter `52.34.40.123`.

Once you have set the correct values, the digitiser must be rebooted before they will take effect. To do this, click the Reboot button.

2.19.2   Configuring Discovery for use with a registry

To specify a registry server for an instance of discovery, type its address into the field at the bottom left of the main screen:
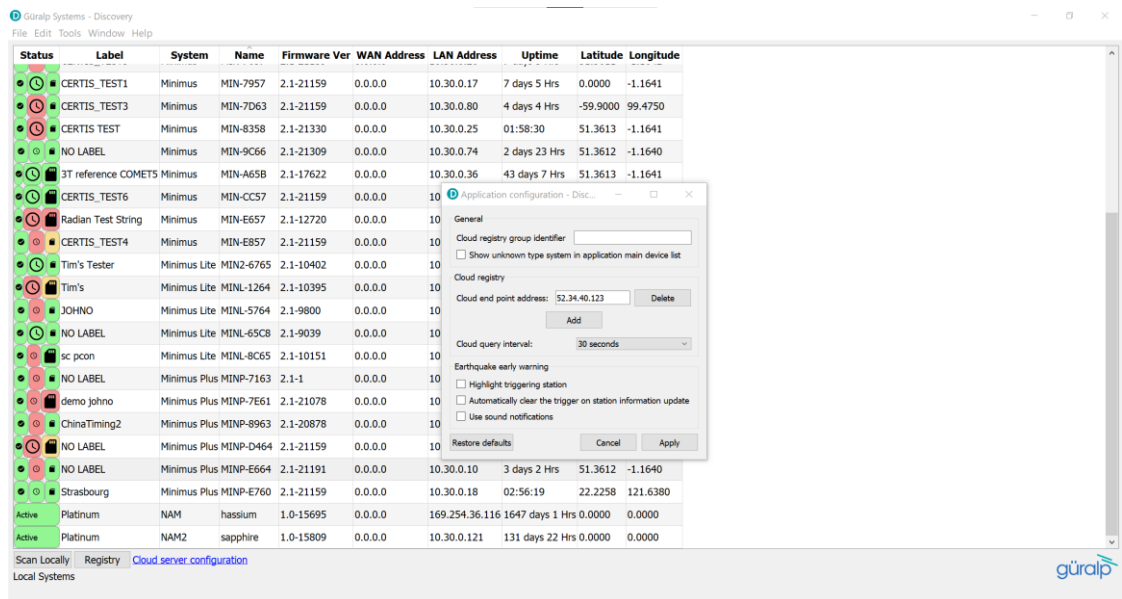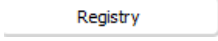
To set the Group ID in Discovery:

1. Select "Settings " from the "File" menu:
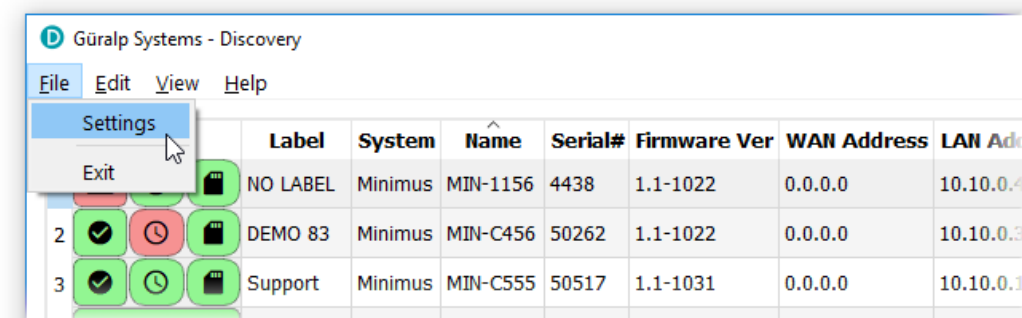
2. Type the chosen Group ID in the "Cloud registry group identifier" field and click Apply .
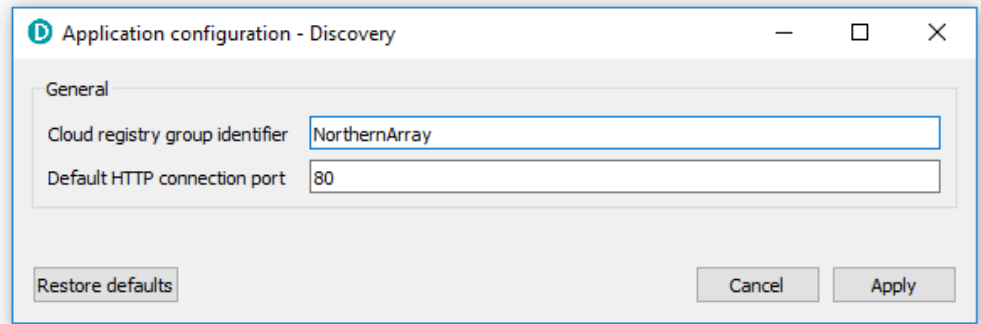
Return to the main windows and test the configuration by clicking the Registry button. All digitisers using the same Registry server and Group ID should appear in the main list.

2.19.3   Registry mode: using WAN or LAN addresses

When Discovery displays a list of devices found from a local scan, all access to those systems is initiated via the LAN address. When displaying a list of registered devices, you have the option of using either the LAN address or the WAN address. This can be useful when the WAN address has been configured but is not yet available or when a registered device is installed remotely and not available on the LAN. The feature is controlled by exactly where you right-click in the list of devices.

If you right-click anywhere other than in the LAN address column, the WAN address is used and the behaviour is otherwise exactly as previously documented. To access the digitiser via its LAN address, right-click in the LAN address column, as shown below:

When you click on the LAN address of an entry, the context menu changes:

Entries for firmware updates, system and GDI configuration and web page access all now use the LAN address rather than the WAN address.

In addition, all options on the Live View sub-menu use the LAN address:

and the calibration page editor is also invoked using the LAN address:

For these techniques to work, the digitiser and PC must be connected to the same LAN.

2.20 Updating Minimus2 Firmware

The firmware of the Minimus$_2$ is upgradeable. New releases appear regularly – mostly to add new features but, occasionally, to fix problems. Güralp recommends that the Minimus$_2$ is regularly checked for availability of firmware updates and, when convenient, these updates should be installed.

To upgrade :

1. Run Discovery.

2. Right-click on the Minimus$_2$ 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
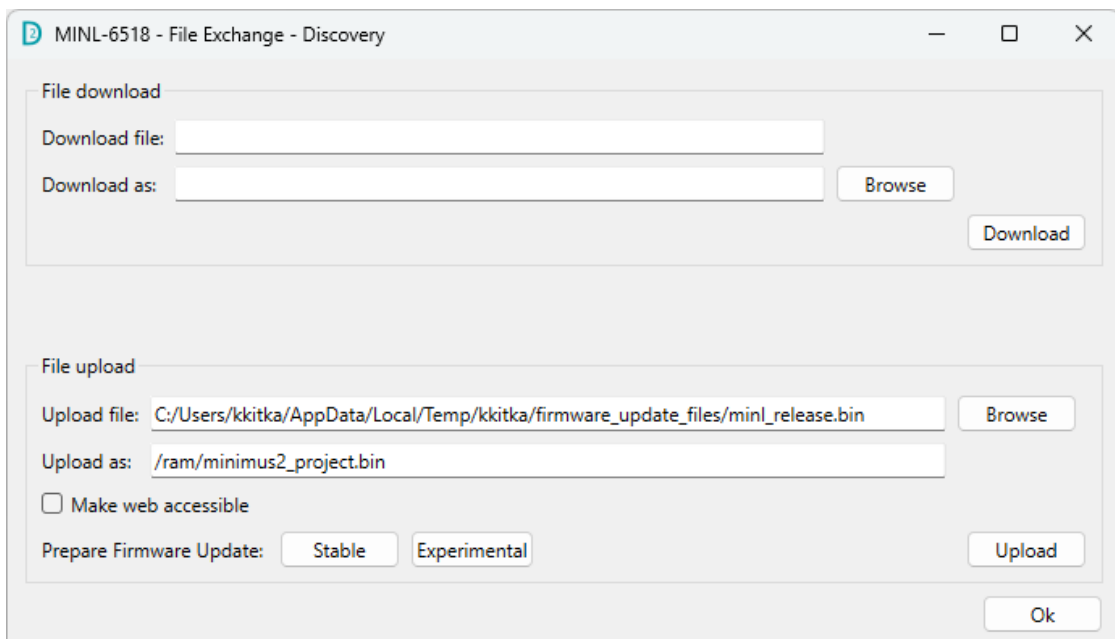
4. Do not change the upload file name but leave it exactly as it automatically appears

5. Press upload.

6. The upload takes approx. 40 seconds. The LED on the Minimus$_2$ 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 (see Section 2.21 below).

2.21　Import / Export an existing configuration

Updating the firmware can, occasionally, cause loss of configuration. We recommend that you export and save the current configuration before proceeding with an upgrade. This operation can be done through Discovery by right-clicking on the digitiser in the list and selecting "System Configuration" from the context menu:

Select "Use configuration from one of the devices". If more than one device is available, select the one from which the configuration should be downloaded. Click the `Download configuration` button and browse to a suitable location (on your PC) into which to save the configuration file.

After the firmware update is successfully completed, the previous configuration can be imported, if required, by following the instructions below.

Right-click on the digitiser's entry in the Discovery list and select "System Configuration" from the context menu. Select the "Use configuration from file" option.

Select the configuration file from where it was saved in the File Explorer and confirm. Use the check-boxes to select the devices to which the configuration should be uploaded and click on the `Upload configuration` button.

Wait until the process finishes. To apply the new configuration, the unit has to be rebooted: the `Reboot selected` button can be used to perform the required system restarts.

2.22　Scripting

The digitiser is capable of running a script file that contains commands to execute at specific dates and time. This can be used for operations such as scheduled instrument calibrations.

The script file is written on a computer as a .txt file. It is then sent to the digitiser as a file transfer from Discovery.

2.22.1　Enabling Scripting Capability

This capability needs to be enabled (once) on the digitiser. In order to do this, type the command below in the instrument's console:

```
resource add futrcmds 1
```

The console can be accessed from Discovery by right-clicking on the instrument's entry and selecting Console
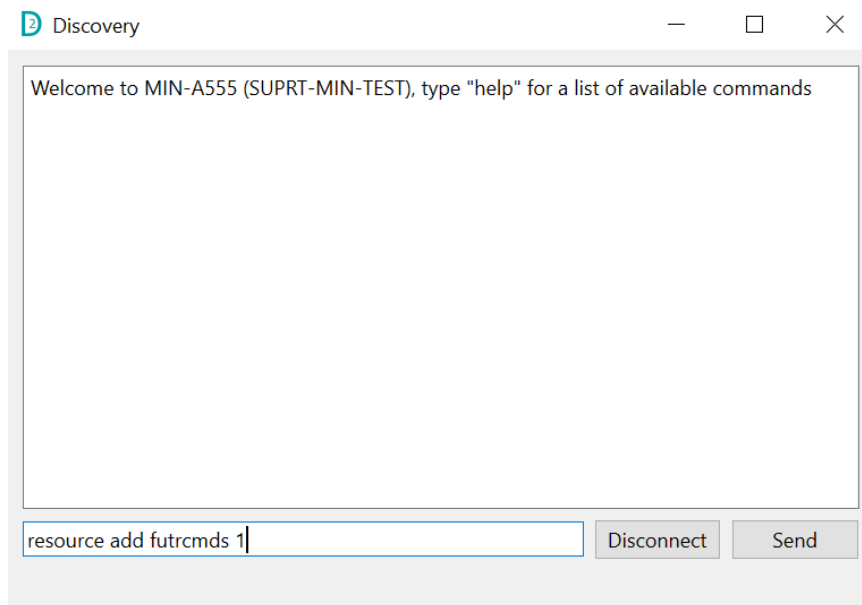
2.22.2   Preparing the Script File

Typing "`help`" in the console shows all the possible commands along with a brief explanation. Any commands available on the digitiser console can be used. The list of commands to be executed on specific dates and time has to be written to a text file with the following format:

```
2024-06-17T18:30:33Z      example command 1

2024-06-17T18:30:50Z      example command 2
```

> **Note:** The circled space is the TAB character. Using spaces instead will not work.

Time has to be specified in UTC. Please refer to the "System time" that appears on the Minimus webpage.

To edit the parameters present in the webpage, use the command "`var set`". For example,

`var set DHCP 1`

enables DHCP. The number '1' represents the enumeration of the pulldown list. Therefore,

`var set DHCP 0`

would disable DHCP.
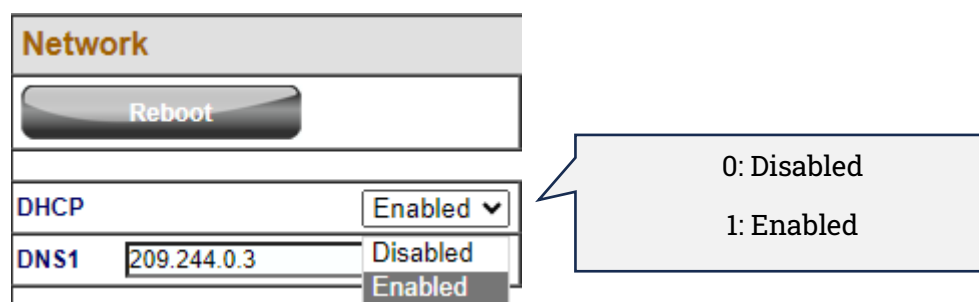
For Minimus+, where more than one sensors are available, specify on which sensor the command has to be executed by adding *"n:"* in front of the variable to change. For example, to enable white noise calibration signal generator on Sensor0 the command would be:

```
var set "0:Calibration" 2
```


As an example, the following text will create a single step calibration (positive, then negative step 11 minutes apart) on 2023-04-17 at 03:30 UTC.

```
2023-04-17T03:28:00Z      var set "0:Calibration" 4

2023-04-17T03:28:20Z      var set "0:Lookup generator gain" 0

2023-04-17T03:28:40Z      var set "0:Channel" 5

2023-04-17T03:30:00Z      var set "0:Lookup generator gain"
1106247680

2023-04-17T03:41:00Z      var set "0:Lookup generator gain" 0

2023-04-17T03:47:00Z      var set "0:Channel" 0

2023-04-17T03:47:20Z      var set "0:Calibration" 0
```

Explanation:

`"0:Calibration" 4`

> This command will set the signal type, in this example 4 will create a step on sensor 0. Other options include, sinewave, triangle wave and random noise. Note the script waits for 10 seconds before sending the next command.

`"0:Lookup generator gain" 0`

> This will set the gain of the step to 0 volts, note the script waits for 10 seconds before the next command.

`"0:Channel" 5`

> This switches the logic lines for the 'calibration enable' on all three components. Please note the script then waits 2 minutes before the next command to avoid any disruption to the analogue signals during the calibration cycle.

`"0:Lookup generator gain" 1106247680`

> This will set the gain to 30% of maximum. The percentage on the webpage (e.g. 10) is a float. In the script though it has to be expressed in hexadecimal notation (preceded by the character $), or decimal. Some examples:
>
> > 10% = $41200000 or 1092616192
> >
> > 20% = $41A00000 or 1101004800
> >
> > 30% = $41F00000 or 1106247680

`"0:Lookup generator gain" 0`

> This will return the input signal to 0 volts. On a velocity sensor this is the equivalent of a negative step.

`"0:Channel" 0`

> This switches off the logic lines of the 'calibration enable'.

`"0:Calibration" 0`

> This command will switch off the DAC creating the calibration signal and stop the recording of the special calibration channel.

2.22.3　Sending a Script File

Once the text file with the list of commands is ready, it has to be uploaded in Discovery as a file transfer. To do this, right-click on the Minimus entry and select "File Exchange".
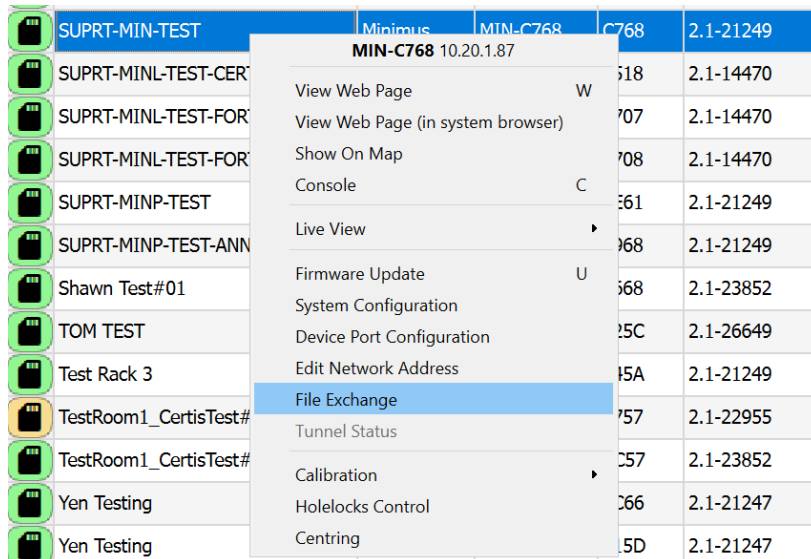
From the "File Upload" box, browse for the text file previously prepared and in the field "Upload as" type exactly `/ram/futrcmds.txt.` Click on Upload.
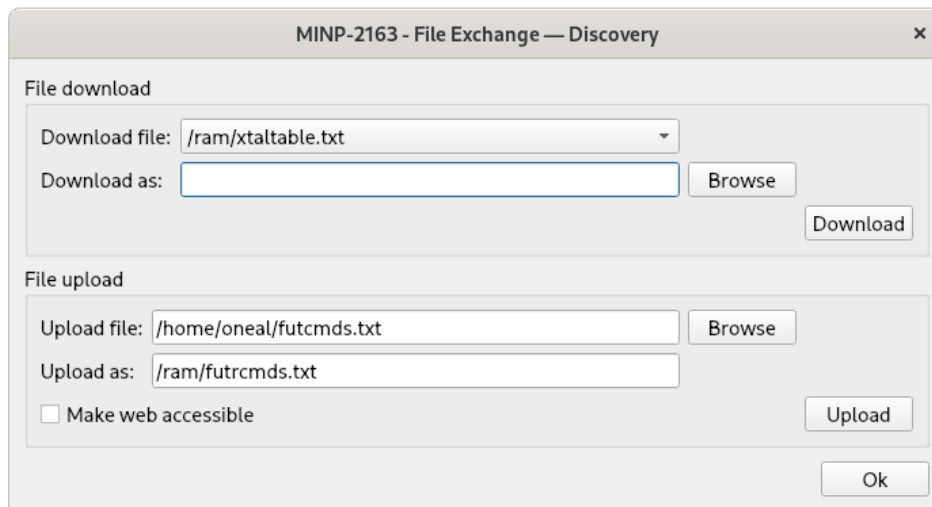
If the file has been uploaded successfully, the next command due to be executed is displayed in the Network tab as shown below. If this does not show, reboot the instrument.

System type: Minimus | Host label: SUPRT-MIN-TEST | Host name: MIN-A555 (10.20.1.82) | Serial number: 0A555

Network

Reboot	Next console command	2024-06-10T14:15:00Z var set "0:Channel" 5	
		Network Configuration	
DHCP	Enabled ∨	Static IP addr 169.254.149.165	Net Mask 255.255.0.0	Gateway 169.254.0.1
DNS1 209.244.0.3	DNS2 84.200.69.80		

2.22.4   Status of the Script Running Process

To see the status of the process, type in the console:
`futrcmds show`

Keeping in mind that the date and time refer to the system time. To visualise the system time, type in the console:
`system time`

To remove the script and cancel queued up commands, type in the console:
`futrcmds clear`

> **!** **Note**: Sending a new script file replaces the existing queued up commands. The clear command removes the entire script.

2.23   GüVü app

The GüVü app provides monitoring and control of near-by digitisers 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

2.23.1   Getting started

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.

The instrument connection screen can also be accessed by pressing the menu icon ( ) on the main instrument status window, and selecting the "Connect" option.

If you experience problems connecting, try 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 both the Minimus$_2$ and connected sensors. These features are summarised in the figure below:

Access the menu by pressing the menu icon ( ) on the main instrument status window:

2.23.2   Selecting data sources

Güralp view can provide status information about all connected sensors, including digital instruments (*e.g.* Güralp Certis) and analogue instruments.

To select the instrument source that provides information to the main status screen of GüVü, tap the menu icon ( ) on the main instrument status window, and then tap the "Select data source" option.

The data source selection screen shows a list of connected instruments. Select an instrument name: this is now the instrument that will be displayed on the main instrument status window.

2.23.3 View settings

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

- **Show all** – 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.

2.23.4 Instrument control

Several features of the Minimus$_2$ and connected instruments can be controlled and configured remotely over Bluetooth using GüVü:

- Analogue instrument centring
- Clearing and un-mounting SD card
- Rebooting the Minimus$_2$
- Enable/disable power-saving mode
- Lock/unlock sensor masses
- Station meta-data (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.

These options can be accessed by tapping the menu icon ( ) 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 .

> **Note:** Any change to the sample rates requires a system reboot to take effect.

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

2.23.4.1 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 ⏎; or clicking the left mouse button in any other setting box.

Digitizer Config							
Auto Refresh	1	Auto Reboot	On Error	Low Latency Mode	Balanced		
Host Label	SPRT-MIN	Station Code	TEST	Network Code	DG	Site Name	No site
Bluetooth PIN	0000	Bluetooth	Enabled	Filter quality	High		
Deploy Mode	Normal	Deploy					

2.23.5 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 menu icon (⊞) 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.

Lastly, click the Download download button to initiate a file transfer using your browser's standard mechanism.

2.24   Using Güralp's Power Pack Module

The PPM offers a battery charge controller that communicated with the digitiser via a serial port. This allows the digitiser to record battery capacity, voltage, current, temperature etc. This information can be viewed as a data stream much like a seismic channel. It can also be written to Miniseed files on the internal SD cards for later analysis.

The behaviour of the power system in relation to the solar panels can be better understood by viewing this data.

There is a 12V accessory output from the battery pack that can be turned on/off remotely or on a timer to power items such as a cellular modem.
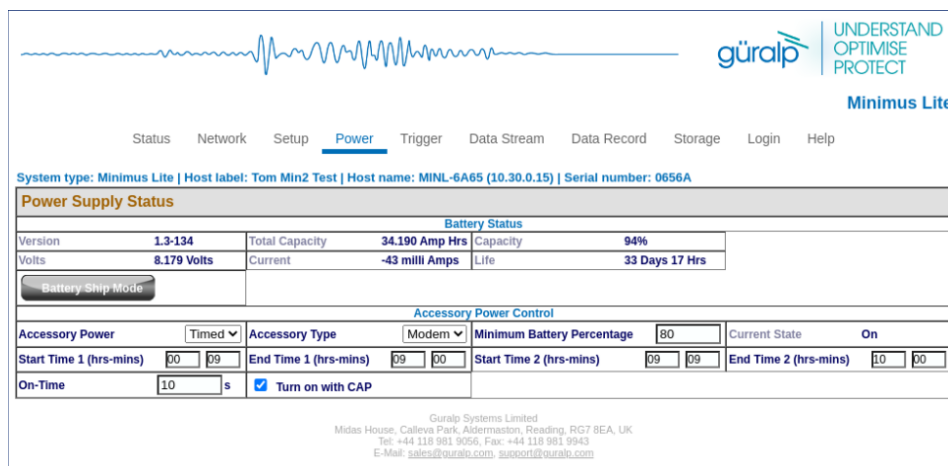
The **Accessory Power** mode (currently set to 'Timed') defines the operation of the accessory power output from the power pack module. This can be 'on' or 'off' permanently or based on some combination of time and battery capacity.

In the 'timed' mode, the output is 'on' if the system time falls between either start/end time AND the battery capacity is above the stated percentage.

If the trigger option is set, the modem comes on for the 'On-Time' when a CAP message is sent as a result of a trigger event.

When 'Modem' mode is set, the power remains on whilst a download is in progress.
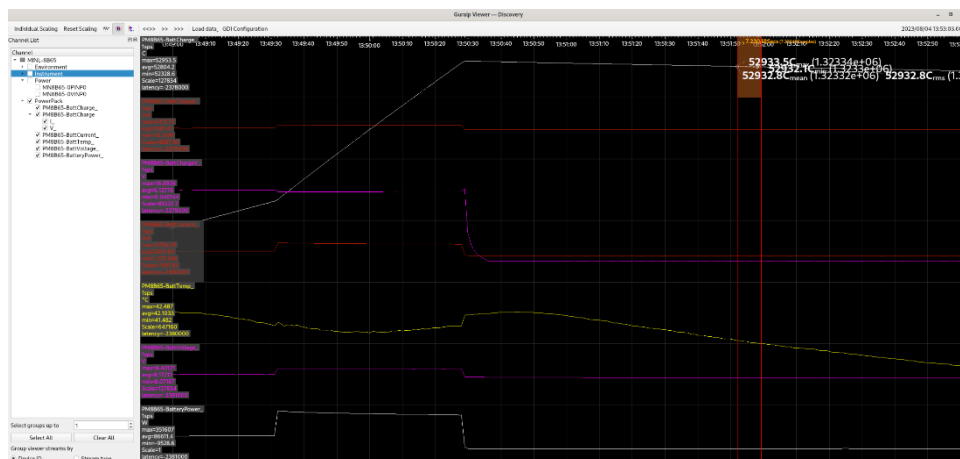
3   Advanced troubleshooting

In the unlikely event of the user experiencing problems with the operation of the Minimus$_2$, a diagnostics tool is available via the GNSS connector. This connector provides a serial console which can be accessed using a terminal emulator.

The user should first plug in the serial adapter to the GNSS connector, which is then attached to a 9-pin COM port on your PC/laptop (if a 9-pin COM port is not available, a serial-to-USB converter should be used instead and connected to an available USB port. Güralp recommend converters based on the FTDI chip-set.)

A connection is then made using a terminal emulator, such as minicom under Linux or PuTTY under Windows. The appropriate COM port should be entered as the "Serial line", and the "Speed" should be set to 115200.
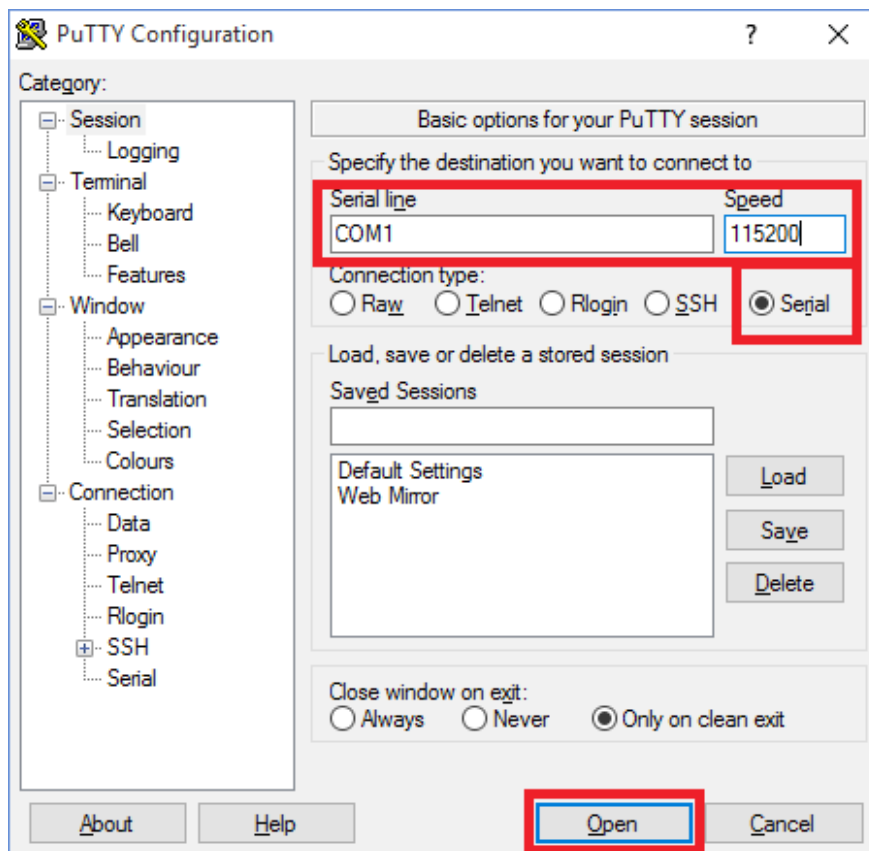
Next, select "Serial" from the bottom of the Category menu in the left-hand pane and check that the settings match those shown in the screen-shot below.
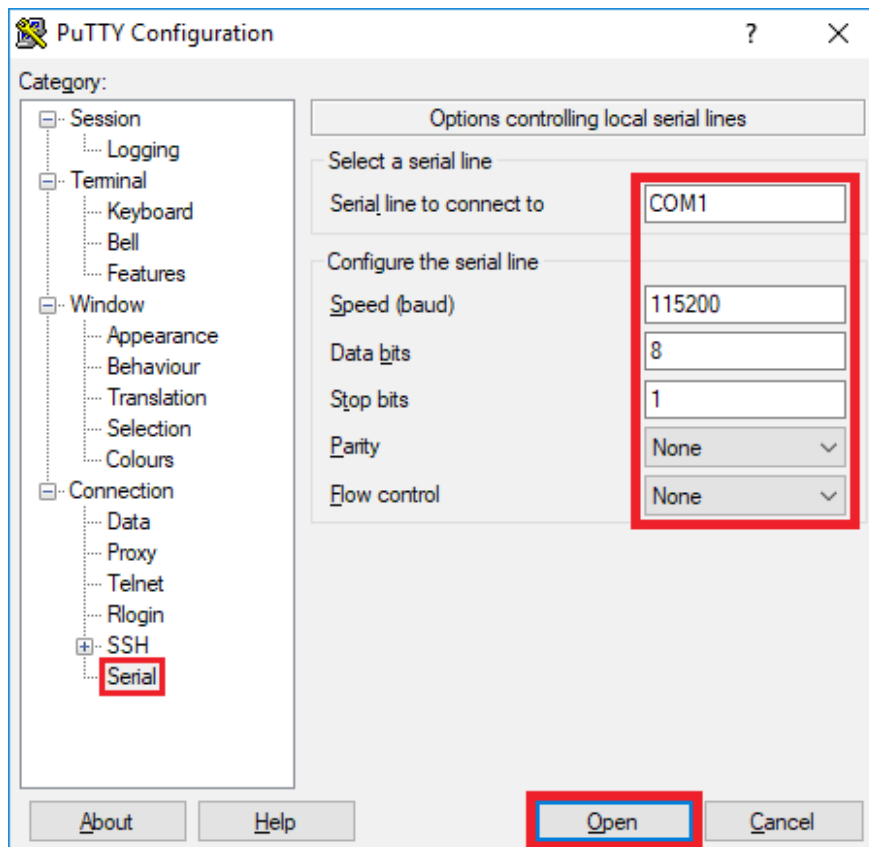
Finally click the [Open] button and a terminal window will open, connected to the console of the Minimus$_2$.

In the event of any operational issues, the Güralp Support Team may request you to interact with the console in order to diagnose and fix problems.

3.1 Reset all settings during boot phase

The Minimus$_2$ can be reset to its factory settings during its boot-up stage. This is useful in cases where the user is not able to communicate with the Minimus$_2$ via a network connection, where the unit is not responsive, or where it does not appear in the Discovery software's scan results.

To carry out a full system reset, connect to the terminal port via a serial connection (as described in Section 3). During the middle part of the boot phase, when the text

`@GURALP SYSTEMS` and the firmware version number is displayed, key [Ctrl]+[R]. This causes all settings (except Username, Password and Bluetooth PIN) to revert to their factory default values, and the Minimus$_2$ will re-boot. It may be necessary to enter this key combination several times.

Once the "`@GURALP SYSTEMS`" banner has been printed, keying [Ctrl]+[R] (at least once) will cause all settings (except Username, Password and Bluetooth PIN) to revert to their default values and cause the Minimus$_2$ to reboot.

4   Appendix 1 – Instrument/channel names

The tables in this section show the names and codes of the streamed channels along with the record names and channel codes for recorded data. The first character "x" in miniSEED channel code represents the sample rate. The possible values are shown in the table below:

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
V	≈ 0.1 Hz
U	≈ 0.01 Hz
R	≥ 0.0001 Hz to < 0.001

The "Data record names" of the seismic channels and MEMS accelerometer channels are postfixed with "A" or "B". This notation distinguishes between the two different sample rates that is possible to select for each recorded channel. For example, the recorded streams S0AccZA and S0AccZB carry digitisations of the same signal, differing only in the sample rate.

5 Appendix 2 - Digital interconnectivity and devices

The Minimus$_2$ has a serial port on the Analogue connector. This can be used for several different protocols depending on what instrument is in use.

The protocols can be selected permanently by added a resource variable to the system. The value of this variable dictates the protocol.

Setting the resource variable can be done from the diagnostics serial port either by direct connection to the system or via the console connection from Discovery (double click the digitiser in the list of devices)

From the Minimus$_2$ prompt:

MINL-1234 -> resource add uartp6 $20

The value $20 comes from the table below:

$20	Port forwarding or serial port to TCP socket
$60	Güralp digital instrument such as Certis
$70	Güralp 3T to gain access to Calibration and Poles/Zeros etc

Note: Use resource del uartp6 to disable this port.

6 Appendix 3 – Network Ports

The following network ports are used by the Minimus$_2$:

| 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	SEEDlink transmission protocol

7   Appendix 4 – Connector pin-outs

7.1   Ethernet

The Ethernet connector allows the use of 10BASE-T, 100BASE-T or 1000BASE-T transmission over networks. The metal gland shell-type connector that connects to the device is IP68-rated and ensures consistent connection in harsh installation environments. At the other end of the Ethernet cable, there is a standard 8P8C modular jack (often called an RJ45) for attachment to all common networking devices (including: PC, laptop, router, switch, and modem).

7.1.1 Pin-Outs

The image on the right is an Amphenol RJField-series 8P8C connector. It consists of a standard ISO 8877 8P8C modular socket (often called an RJ45) in a bayonet mounting compatible with MIL-DTL-26482 (formerly MIL-C-26482).
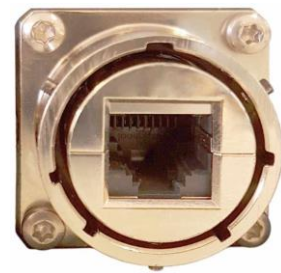
The wiring of a standard ethernet cable is shown below for configuration of different transmission types:

Pin	10BASE-T & 100BASE-TX	1000BASE-T
1	Transmit Data +	BI_DA+
2	Transmit Data -	BI_DA-
3	Receive Data +	BI_DB+
4	*not connected*	BI_DC+
5	*not connected*	BI_DC-
6	Receive Data -	BI_DB-
7	*not connected*	BI_DD+
8	*not connected*	BI_DD-
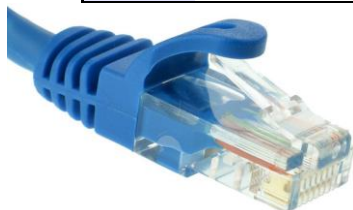
The 8P8C connector shown left accepts unmodified ISO 8877 8P8C modular connectors (often called RJ45 connectors or Ethernet "Cat 5/6" connectors).
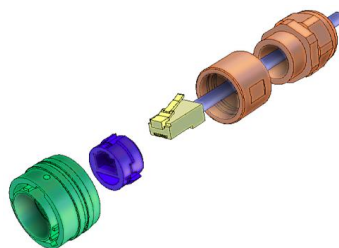
When used in hostile environments, a standard Ethernet cable can have a mating environmental shield (Amphenol part number RJF6MN) fitted.

7.2 Power

Every device comes with a dedicated power cable with a standard military-specification bayonet connector on one end and bare ends at the other.

7.2.1 Pin-Outs

This is a standard 4-pin military-specification bayonet plug, conforming to MIL-DTL-26482 (formerly MIL-C-26482).
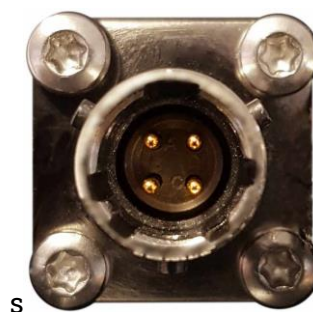
Pin	Function
A	Ground
B	10-36 V DC input
C	*not connected*
D	*not connected*
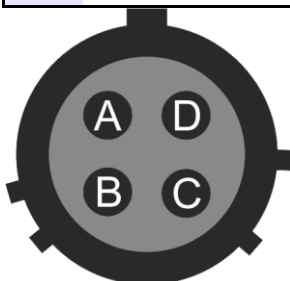
Wiring details for the compatible socket as seen from the cable end (i.e. when assembling).

7.3   GNSS/serial

This is a 14-pin LEMO EEG.1K socket. Suitable mating connectors can be found in the LEMO FGG.1K.314 range.

- To engage the mating connector, line up the red marks and push firmly until you hear a click.
- To disengage, hold the mating connector by the knurled outer sleeve and pull steadily.

Pin	Function
1	Ground
2	*not connected*
3	Ground
4	Debug (serial) receive
5	Debug (serial) transmit
6	*not connected*
7	GNSS power
8	GNSS pulse-per-second signal – RS-422 positive
9	GNSS receive – RS-422 positive
10	GNSS transmit – RS-422 positive
11	GNSS transmit – RS-422 negative
12	*not connected*
13	GNSS pulse-per-second signal – RS-422 negative
14	GNSS receive – RS-422 negative
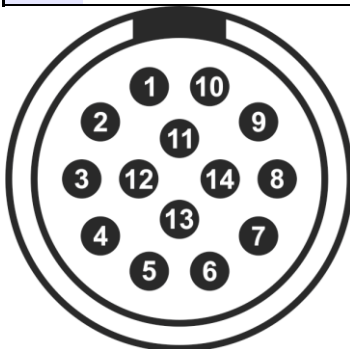
Wiring details for the compatible plug, FGG.1K.314.*, as seen from the cable end (*i.e.* when assembling).

7.4   Digital Port

This is a standard 10-pin military-specification bayonet sockets, conforming to MIL-DTL-26482 (formerly MIL-C-26482).

Pin	Function
A	Ground
B	Power
C	RS422 serial transmit – positive
D	RS422 serial transmit – negative
E	RS422 serial receive – negative
F	*not connected*
G	*not connected*
H	*not connected*
I	*not connected*
J	RS422 serial receive – positive

Wiring details for the compatible plug, ***-12-10P, as seen from the cable end (*i.e.* when assembling).

7.5   Analogue Port

These are standard 26-pin male military-specification bayonet plugs, conforming to MIL-DTL-26482 (formerly MIL-C-26482).

Pin	Function	Pin	Function

A	Vertical Acceleration/Velocity – differential non-inverting input		**P**	Calibration signal (all channels)
B	Vertical Acceleration/Velocity – differential inverting input		**R**	Calibration enable – vertical channel
C	N/S Acceleration/Velocity – differential non-inverting input		**S**	Calibration enable – N/S channel
D	N/S Acceleration/Velocity – differential inverting input		**T**	Calibration enable – E/W channel
E	E/W Acceleration/Velocity – differential non-inverting input		**U**	Centre
F	E/W Acceleration/Velocity – differential inverting input		**V**	Aux sensor input – differential non-inverting (or single) input
G	Vertical mass positions		**W**	Unlock
H	*not connected*		**X**	Lock
J	N/S mass positions		**Y**	Logic – ground*
K	*BUSY* line		**Z**	Sensor RS232 transmit
L	E/W mass positions		**a**	Sensor RS232 receive
M	Auxiliary sensor input – differential inverting input		**b**	Power – ground*
N	Signal – ground*		**c**	Power – positive

* "Power – ground" and "Logic – ground" are connected together internally and also connected to the digitizer case.
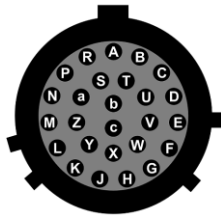
Wiring details for the compatible socket, ***-16-26S, as seen from the cable end (*i.e.* when assembling).

8 EU Declaration of Conformity

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Declare under our sole responsibility that the following product

Equipment name: Minimus$_2$ with GPS
Model Number: MIN2-0001 and appropriate variants

Is in conformity with the

Radio Equipment Directive 2014/53/EU
Electromagnetic Compatibility Directive 2014/30/EU
Low Voltage Directive 2014/35/EU
Restriction of Hazardous Substances (RoHS) Directive 2011/65/EU

by applying the following harmonised standards and technical specifications:

EN 55011, EN 55016:2009 +A1:2010 – Conducted Emissions
EN 55011, EN 55032 :2009 +A1:2010 – Radiated Emissions
EN 61000-4-2:2009 – Electrostatic Discharge Immunity
EN 61000-4-3:2006 +A1:2008 +A2:2010 – Radiated RF Immunity
EN 61000-4-4:2012 – Electrical Fast Transients Immunity
EN 61000-4-5:2014 – Voltage Surge Immunity
EN 61000-4-6:2014 – Conducted RF Immunity
EN 61000-4-8:2010 – Power Frequency Magnetic Field Immunity
IEC 61010-1 3rd Edition - Low voltage Safety
2011/65/EU – RoHS

Signed for and on behalf of
Guralp Systems Ltd
on 25 November 2022

Systems Director

Revision History