KONTUR

PIONEERING SUBSURFACE INSIGHT

Mk6 Series

User Manual

Document Version: 1.0

Declaration of Conformity

Statement CE

The Kontur AS Mk6 series ground penetrating radar with the *ETSI frequency profile* complies with the following regulations:

- ETSI EN 301 489-33 v2.2.1
- ETSI EN 302 066 v2.2.1

Statement FCC

Kontur US, Inc. Mk6 Air (**FCC ID: 2BFSC-M6A10**) and Mk6 Ground (**FCC ID: 2BFSC-M6A20**):
This device operating with the *FCC frequency profile* complies with Part 15 of the FCC Rules and FCC waiver DA13-1739. Operation is subject to the following conditions:

(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation, and
(3) This device must only be operated by eligible parties for purposes of law enforcement, firefighting, emergency rescue, scientific research, commercial mining, or construction, and
(4) This device requires coordination through the FCC before it may be used.

Any changes or modifications not expressly approved by Kontur AS may void the user's authority to operate the equipment.

Note:
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules.
These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.
This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Statement Industry Canada

The Kontur AS Mk6 AIR/GROUND series device with the *FCC frequency profile* complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

(1) This device may not cause interference, and
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

This ground penetrating radar shall be operated only when in contact with or within 1 m of the ground. It shall be operated only by law enforcement agencies, scientific research institutes, commercial mining companies, construction companies, and emergency rescue or firefighting organizations.

Regulations & Safety

The Kontur AS Mk6 series ground penetrating radar comprises a radar transmitter and receiver. Regulations regarding the use of radars vary greatly from country to country. In some countries, the unit can be used without obtaining an end-user license. Other countries require end-user licensing. Consult your local communications governing agency for licensing information. Before operating this radar, determine if authorization or a license to operate the unit is required in your country. It is the responsibility of the end user to obtain an operators permit or a license for this ground penetrating radar for the location or country of use.

Radio Frequency Exposure

The peak transmit power of the radar is approximately 10 mW into an antenna element with a maximum gain of -5 dBi, which is much less than the FCC limit for RF exposure based on the SAR-based exemption rule of 153 mW effective radiated power below 300 MHz and 612 mW effective radiated power at 20 cm distance to an active radiator.

Contents

Table of Figures

1. Introduction

This user manual includes the Kontur ground penetrating radar sensors. These products are designed and manufactured by Kontur AS.

For further information please visit www.kontur.tech.

This document explains how to assemble the hardware and use Examiner Collect software. GPR and signal processing theory is not covered by this manual. Some guidelines for configuring the waveform will be provided.

In addition to this manual, further resources are available from Kontur and will have been provided on completion of your purchase. For specific requests, please contact support@kontur.tech.

Training is available on all Kontur products.

2. Kontur Technology & Component overview

The Kontur system is a three-dimensional step-frequency continuous wave ground penetrating radar (SFCW GPR). This product transmits electromagnetic waves through an antenna array and measures the echo from layers of the ground and objects buried within the subsurface. Measurements of the subsurface are calculated using the travel time from when the signal is transmitted until the echo is received. A depth estimate is obtained by multiplying this time with the wave velocity of the signal.

The Kontur system is the fastest step-frequency radar on the market. By using a digital frequency source instead of traditional phase-locked loop technology, the unit can generate waveforms from 30 MHz up to 4.5 GHz[1] with as much as 2235 frequencies with waveform lengths of 0.3-10 microseconds.

This step-frequency technique has a coherent receiver which means that the whole waveform length in milliseconds is used as 100% efficient integration time. By comparison, impulse based GPR's use stroboscopic sampling with significant loss of energy.

Below is an overview of the system. An external positioning device is optional and is supported by Kontur systems. These Include GNSS / Total Station etc.

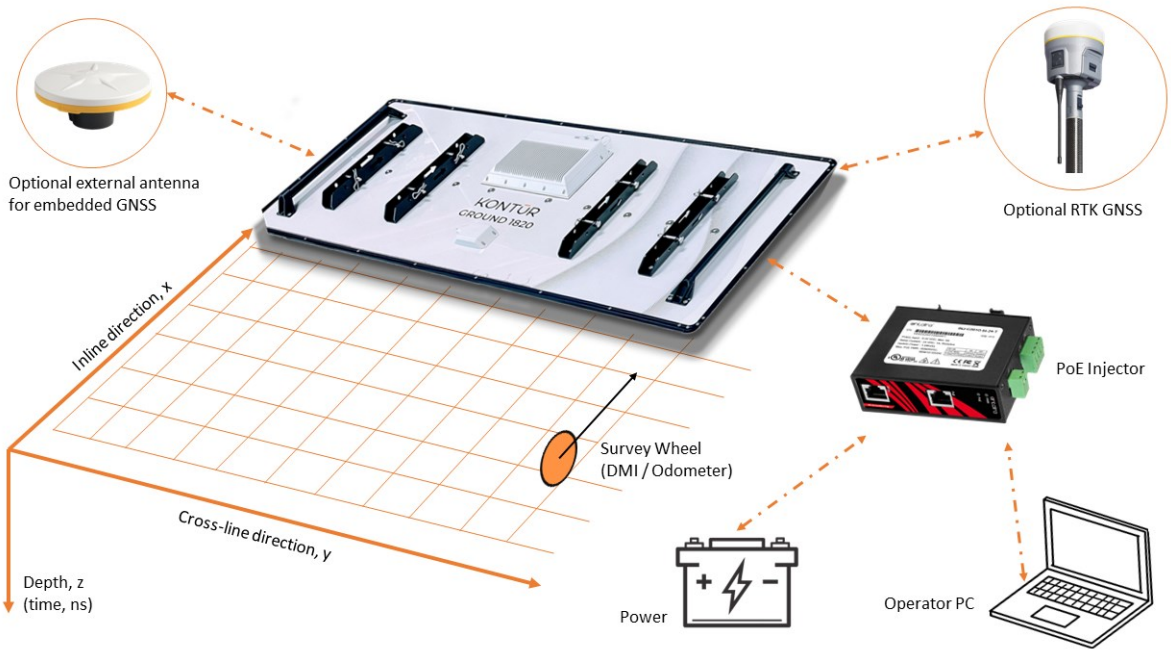


Figure 1 – System Component Overview

[1] Total bandwidth dependent on sensor model and local regulations.

2.1 Step-frequency

The step-frequency waveform provides optimum source signature with a uniform frequency spectrum.

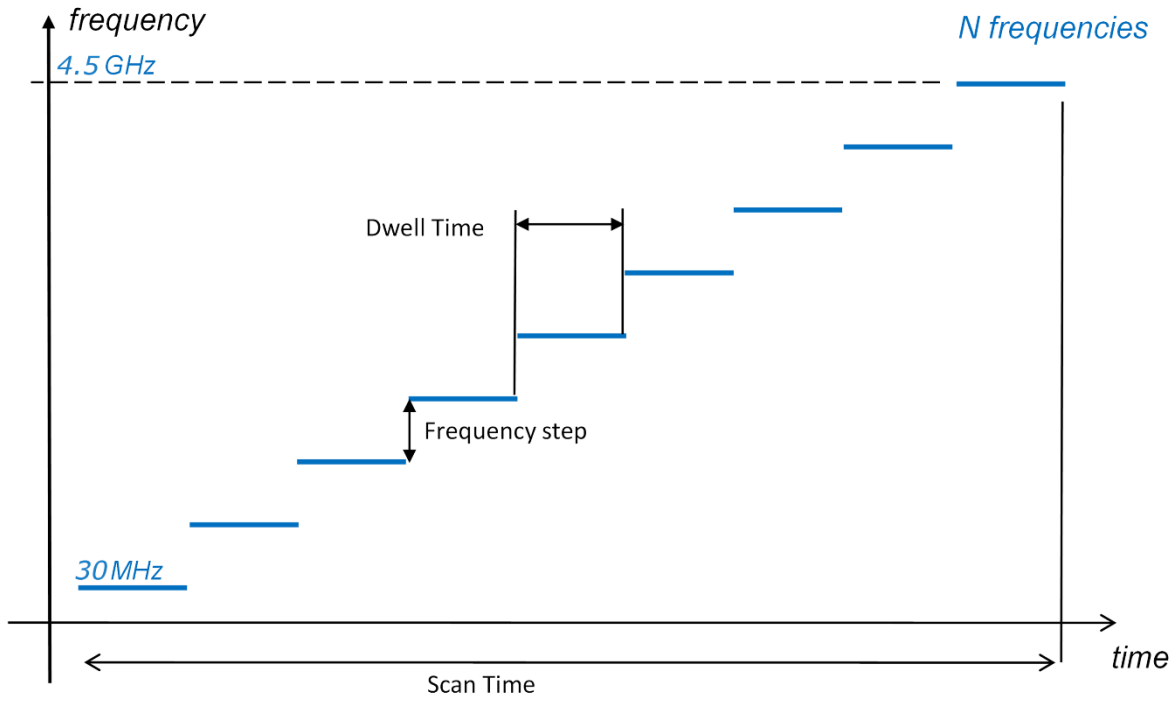


Figure 2 – Step-frequency waveform

The Kontur system sequentially transmits one complete waveform on each transmitting element while receiving on the corresponding receiver. Transmission of one complete waveform on one transmitting element is called an A-scan. The recorded frequency domain data contain one complex value for each frequency in the waveform.

The radar system performs real-time, time domain conversion through Fast Fourier Transform. Allowing the user to view radargrams from the sensor during data collection. Raw data can be stored in the .3dra data format either as time-domain or frequency-domain for post-processing.

Collected survey data in .3dra format is handled by Examiner Specialist, an industry leading software analysis and reporting platform from Kontur.

The radar is controlled from a laptop computer through an Ethernet cable. The system is recommended to be configured with an external antenna for the embedded GNSS/External GNSS/Total Station. This will allow accurate recording of position data through the serial port (RS-232). The embedded GNSS unit in the sensor is NTRIP capable and can be combined with the accompanying external antenna for better satellite coverage.

3. Mounting Options

Both air- and ground-coupled Kontur sensors have flexible mounting options depending on the task.

Kontur provides standard mounting options. Custom mounting options can be created. All sensors can be mounted to a trailer, fixed directly to a vehicle, and for walking with the system a pushcart can be used.

Kontur AIR is typically mounted directly to the collection vehicle to take advantage of faster data collection speeds.

Contact us for further discussion and examples of mounting options to suit the needs of your project.

Figure 3 – Kontur AIR Mounted to Vehicle

Figure 4 – Kontur GROUND with Trailer

4. Hardware

Kontur products are supplied with flight cases for storage and transportation.

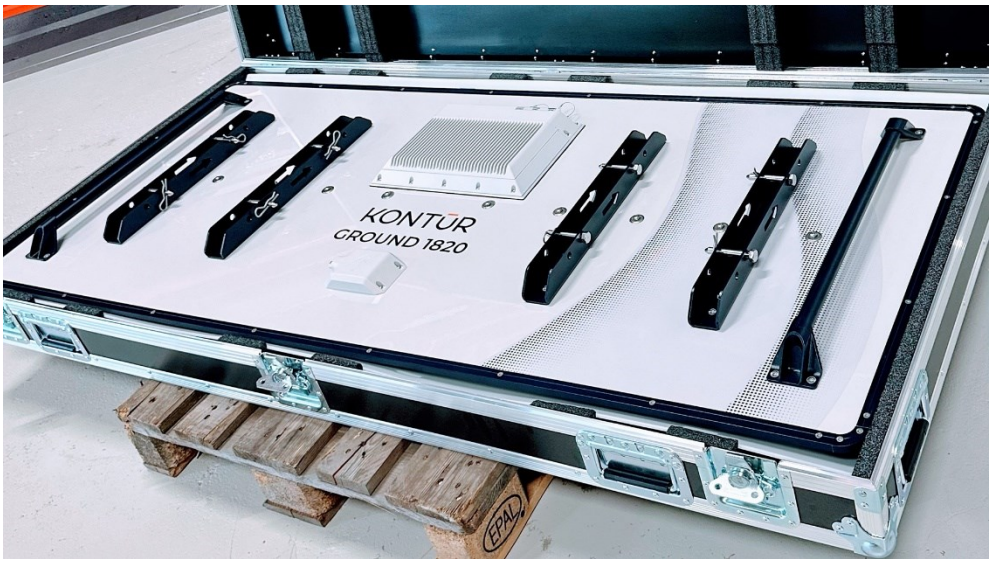


Figure 5 – Kontur GROUND & Flight Case

Figure 6 – Accessories Case

5. Antenna Radar Unit, ARU

The Antenna Radar Unit is the heart of the GPR system. It contains the RF hardware including the digital signal generator and is the interface unit for all other hardware. The ARU is powered through a Power-over-ethernet (PoE) injector.

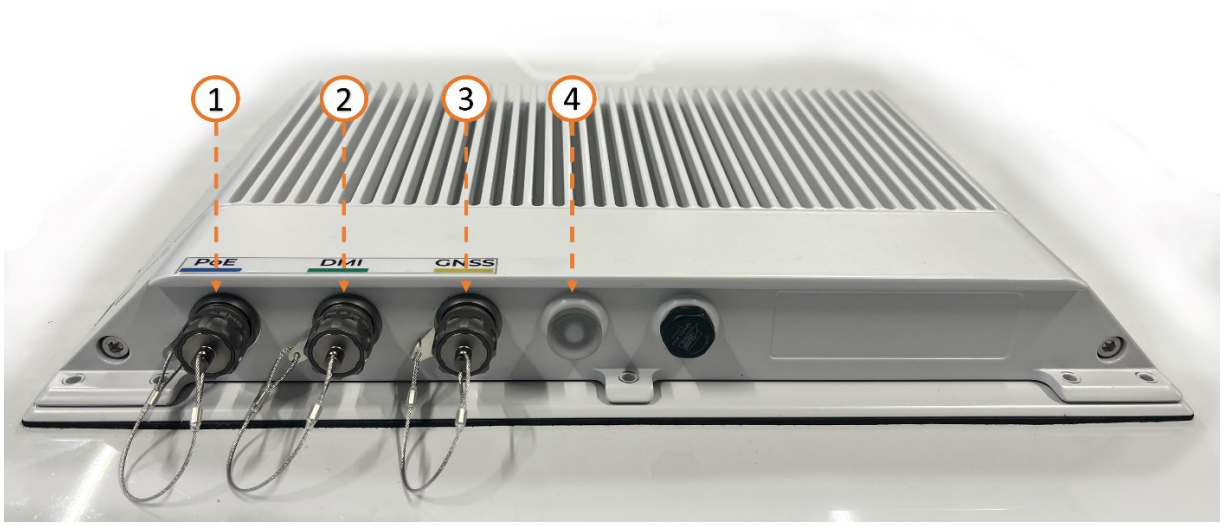


Figure 7 – ARU Connector Panel

Item	Name	Description
1	PoE Input	Connector for power and control signal to PoE injector.
2	DMI	Connector for DMI (trigger input).
3	External GNSS Input	Connector for optional ext. GNSS, e.g., a Trimble R12
4	LED Indicator	LED indicating sensor status.

Figure 8 – Connector Panel Description

To the right of the above-mentioned inputs and LED window, there is a vent to balance air pressure between the sensor internals and its surroundings without allowing moisture to enter.

6. Powering the sensor

All Kontur Mk6 sensors are powered through a Power-over-Ethernet injector, as pictured in Figure 9 below. This unit, along with all necessary cables, is included in the accessories case that followed the sensor.

Figure 9 – PoE Injector

The PoE injector needs to be powered by a 12-48V DC source that has a power output of minimum 60W. A suitable AC/DC adapter is supplied with the system and is included in the accessories case.

Before connecting the sensor to the injector, remove the dust cap from the connector (see Fig.10) and insert it in the port marked *PoE* on both the injector and sensor. The sensor will start automatically when connected to a powered PoE injector.

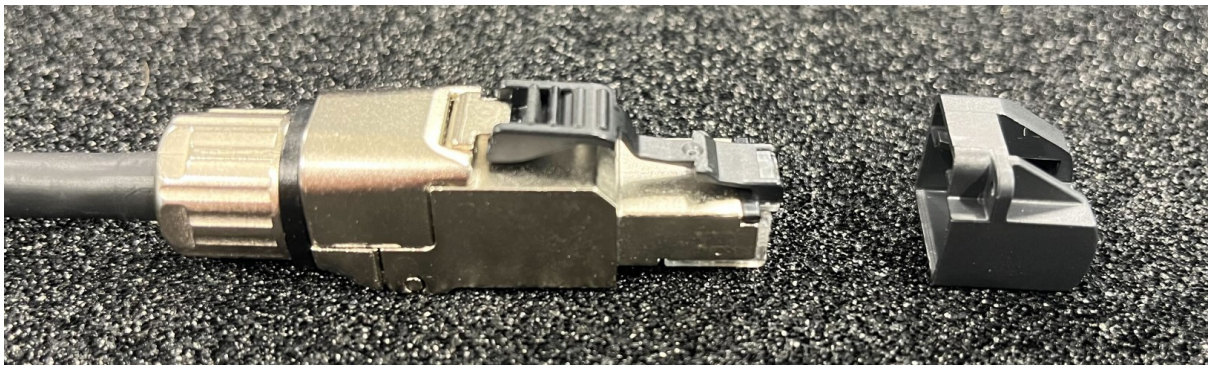


Figure 10 – Removable dust cap on control cable

Connect the injector to power supply, then connect the control cable to the injector before finally connecting the control cable to the ARU.

The ethernet cable from the client computer connects to the port marked *DATA*.

7. Distance Measuring Instrument (DMI)

The DMI is an optical encoder that measures the movement distance and generates trigger pulses to the ARU. The DMI outputs quadrature TTL pulses to allow detection of forward or reverse travel direction. The DMI should be calibrated, and offset position checked before each survey. See *Client System Settings* below for Instructions on how to calibrate and position the DMI device.

Using a DMI is the recommended method for taking measurements at set intervals during the survey.

The DMI input Lemo connector has the following configuration:

Pin	Signal
4	Quadrature A (TTL)
5	Quadrature B (TTL)
1	+5V DC to DMI, max 50mA
9	GND

Figure 11 – DMI Lemo connector configuration

The relationship between DMI Tick count and the quadrature pulses is shown in Figure 12. One tick is counted for each rising or falling edge of pulse trains A and B.

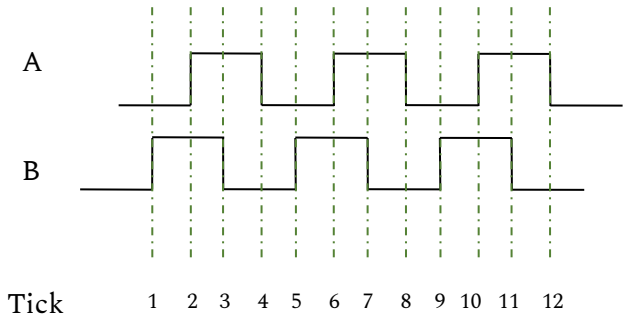


Figure 12 – DMI Pulses

7.1 DMI Connection Diagram

Kontur can supply DMI encoders from Kübler.
Kübler connection diagram:

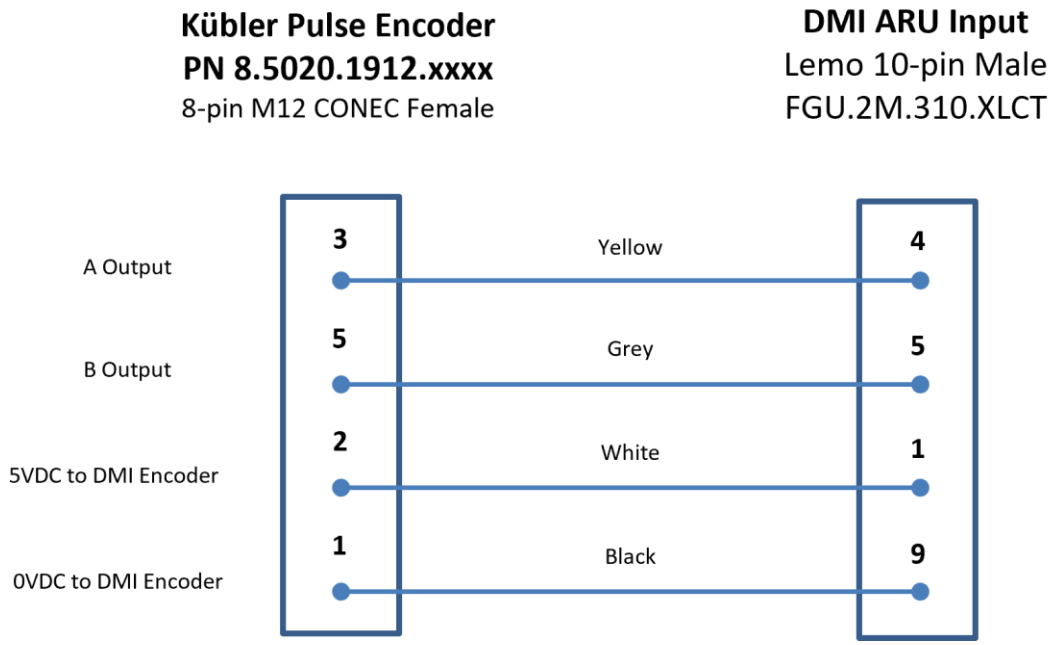


Figure 13 – Kübler DMI Pin Diagram

8. Control Computer

The control computer is usually a laptop with the sensor client downloaded from the ARU web portal. The control computer is used to, among other, configure the radar waveform, calibrate the DMI, control data acquisition and manage the collected data. It is connected to the PoE injector through an ethernet switch or directly using an ethernet cable.

8.1 Control Computer Specifications

It is recommended to use a recent mid-range PC with SSD storage. For harsh survey site environments, a rugged PC should be considered.

8.2 TCP/IP Settings

When the control computer is connected to the injector through a switch or an ethernet cable, it is necessary to use fixed TCP/IP address.
The sensor has the following TCP/IP address: 192.168.8.20
The control computer should have an address of the form: 192.168.8.*X* , where *X* is in the range of 1-254 with the exception of .20 that the sensor uses.

See *Chapter 19* or the accompanying Quick Start Guide for details about setting LAN properties.

9. Connecting peripherals to the sensor

The ARU has an input panel to connect to the PoE injector, the DMI and an external GNSS antenna.

PoE Port: Connect the ARU to the injector. This connector powers the sensor and transmits data back and forth to the client computer through the injector. **Please use hand force only to screw the connectors on the ARU, use the dust caps while collecting and reseat the caps on the connectors after the collection is complete.**

DMI Port: Connect the DMI (Distance Measurement Instrument), described in *Chapter 7*. The ARU can also be triggered by an external pulse generated by other equipment. If considering a centralized trigger / pulse option, please consult Kontur support for guidance.

GNSS Port: Connect the GNSS cable from external GNSS unit.

After all applicable cables are connected, the sensor will start automatically, and the status LED will initially be red when powered. During the booting process, the LED will flash green. The status LED will continue to flash while the sensor is starting up. When the status LED has stopped flashing and is continuously illuminated green, the sensor will be ready to use.

If there is an error during boot or use, the LED will flash red.

During updating of firmware, the LED will flash orange.

During collection of data, the LED will be solid blue.

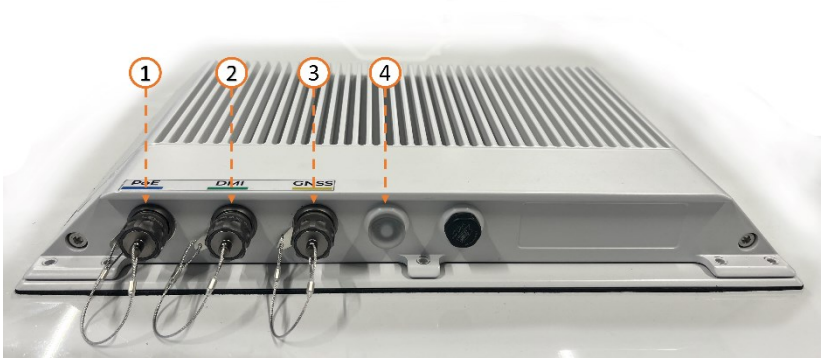


Figure 14 – ARU input connectors

Item	Name	Description
1	PoE Input	Connector for power and control signal to antenna.
2	DMI (Trigger input)	Connector for DMI.
3	GNSS	Connector for optional ext. GNSS, e.g., a Trimble R12
4	Status LED	LED indicating sensor status

Figure 15 – Input panel description

External Antenna for embedded GNSS Port: Aside from the inputs on the ARU itself, there is a connector port for the external antenna, see Figure 16 on the next page. This antenna is included in the accessory case and connects to the embedded GNSS in the sensor.

Figure 16 – Embedded GNSS connection box

This external antenna for the embedded GNSS allows for better coverage and slightly higher precision. In the System Settings in the client, you can tick a box for using a separate external antenna and input offset in X-, Y- and Z-direction for more accurate positioning. In the same settings, you can input NTRIP login and settings to receive corrections directly to the sensor, removing the need for another external GNSS unit for high precision positioning accuracy.

9.1 External GNSS Settings

The sensor is equipped with an RTK-enabled embedded GNSS device, but using an external GNSS receiver is also an option, connecting to the port marked GNSS.

Suggested settings for the external GNSS device:

RTK = Real Time Kinematic
WGS84 coordinate system (required)
RS232 interface (required)
8 bits (required)
No Parity (required)
1 stop (required)
115200 baud (rate must match the ARU, and can be changed in the client)
NMEA Sentence – GGA with 5Hz refresh rate

The above is a common export and should be selectable from the external GNSS device menu.

10. Examiner Collect

10.1 Starting the Kontur sensor control software

After ensuring the sensor is connected to the control computer through the PoE injector, and the control computer has the correct IP settings (see *Chapter 19*), check that the ARU is ready for use (the status LED is illuminated solid green) and then open a browser (e.g., Microsoft Edge). Enter 192.168.8.20 in the address bar.

When the connection is established successfully, the following page is displayed:

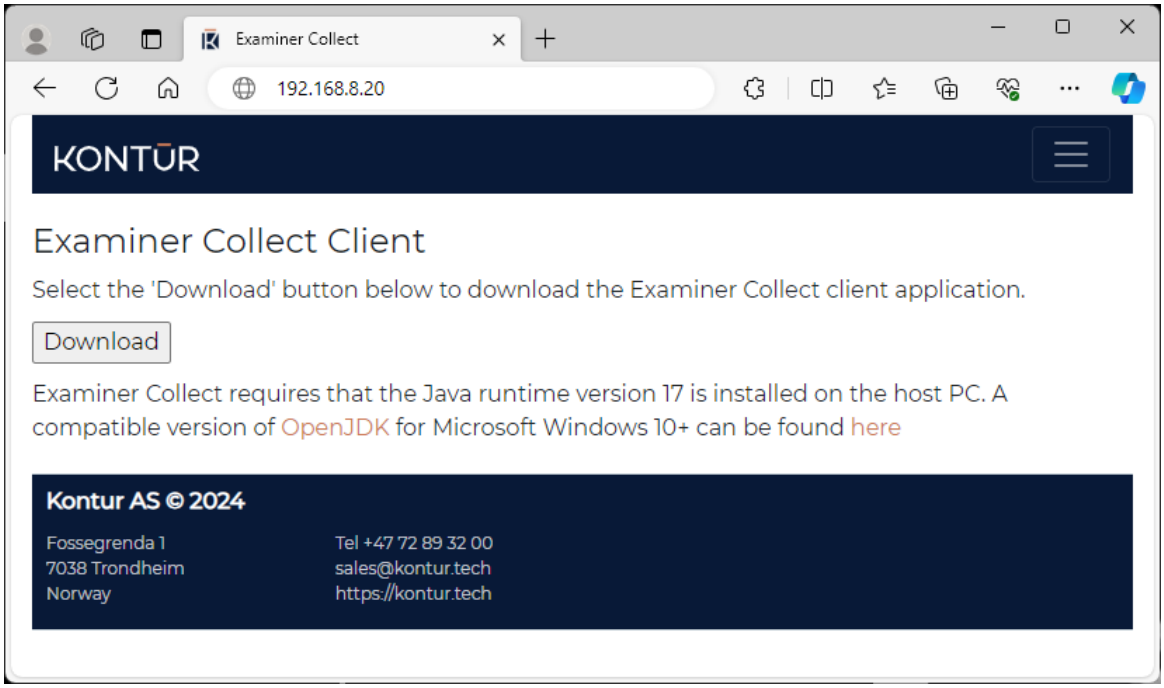


Figure 17 – Kontur sensor launch page in browser

Click on the [Download] button to download the Examiner Collect client launcher. On this page, there is also a link to a Windows-compatible OpenJDK version for those who do not have a Java installation on their computer. This information is also available in the Quick Start Guide that was supplied with the system.

The first time the Examiner Collect application is started on a computer, the window below is displayed.

Figure 18 – Collect application launch window

The list of sensors will be empty, and you will need to "Add Collector". This opens a dialog box where you input the IP for the connected sensor:

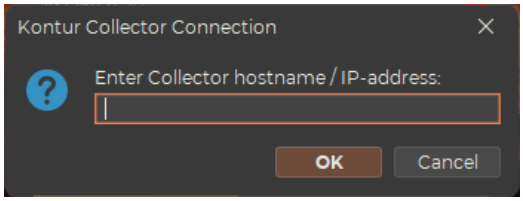


Figure 19 – Sensor IP input box

When you have added the sensor through inputting the correct IP, it will show up in the launch window as a list of sensors that have been connected to the computer at any one point in time.

Figure 20 – List of sensors

The icons to the right of the IP address indicate different states of the listed sensors.

Icon	Description
Red exclamation mark 	Collector IP or hostname is not reachable, check network settings and PoE status.
Green check mark 	Collector is ready and is accepting connections.
Red broken heart 	Software version mismatch between Examiner Collect and Collector.
Yellow lock 	Another instance of Examiner Collect is currently connected to the Collector. You can take over this session.
Red lock 	Another instance of Examiner Collect is currently connected to the Collector and it is running an acquisition. It is not possible to take over session.

10.2 Collector Window

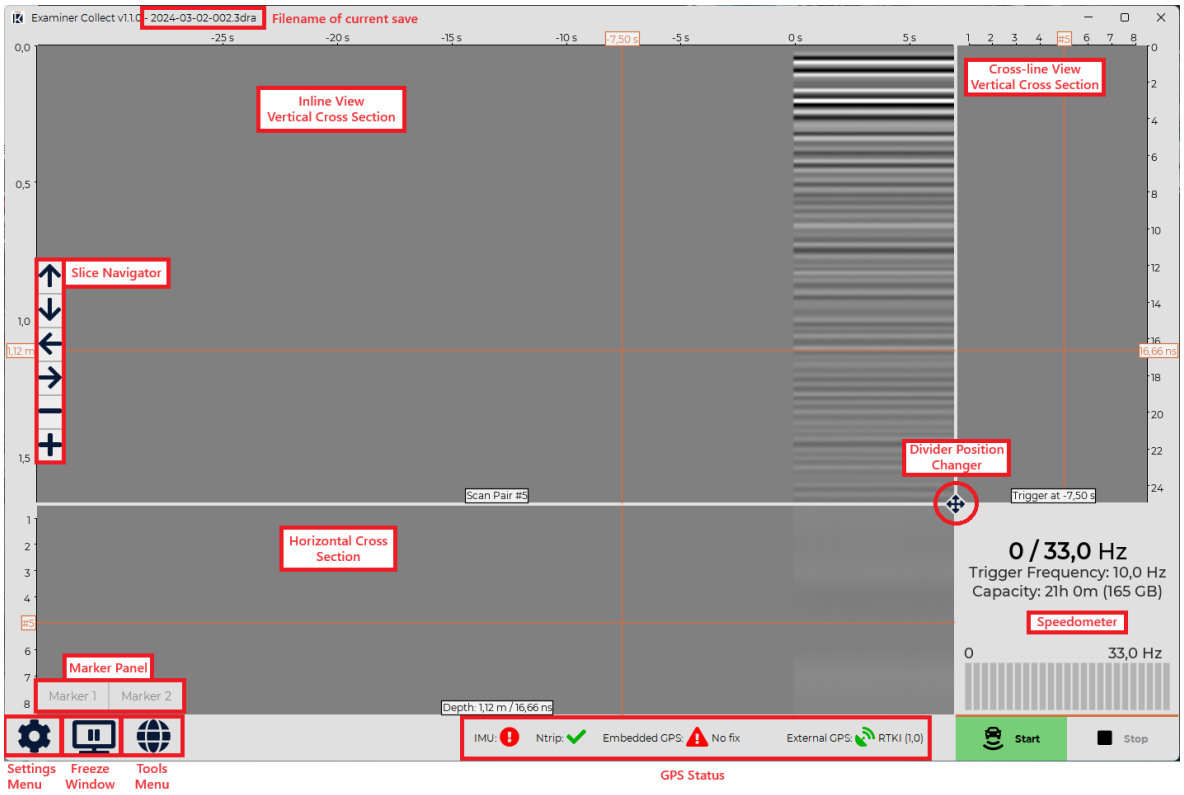


Figure 21 – Examiner Collect (Sensor Client Control Window)

Examiner Collect consists of the following elements:

- Inline View. Displays the surveyed area in a vertical cross section in line with survey direction.
- Cross-line View. Displays the surveyed area in a vertical cross section perpendicular to the survey direction.
- Horizontal Cross Section. Displays the surveyed area from a bird's eye perspective.
- Speedometer with survey limits and capacity in selected storage location.
- Settings Menu button.
- Pause Button, to pause the window from moving during surveys.
- Tools Menu button, where you will find the Navigation Assist and GPS Deviation Map tools.
- GNSS Status of both embedded and external GNSS units.
- *If selected in display settings,* Slice Navigator, to move the blue slice tool in the displays.
- *If selected in display settings,* Marker Panel with customized hotkeys for markers.

For a brief description of available shortcut keys, press F1:

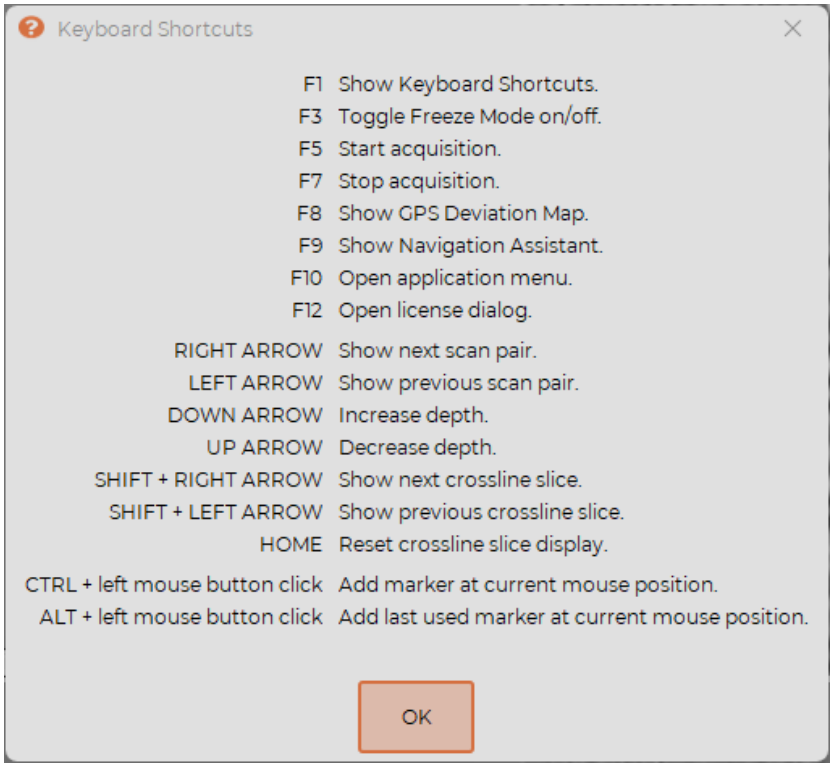


Figure 22 – Keyboard Shortcuts in Examiner Collect

10.3 Inline view

The *Inline* view displays one Radargram from a selected channel (antenna) in real-time. The horizontal and vertical dimensions of the view are distance and depth/time.

Lost scans show up as vertical red lines, which will occur when travelling faster than the speed determined by the survey settings.

If the control computer lacks processing power to display the collected data, some scans will show up as vertical green lines. These are still collected and viewable in Examiner Specialist, though not in the live view of the acquisition.

When backing up, i.e., stopping and moving the sensor in the opposite direction, a horizontal blue line will appear. This line will show the position of the sensor with respect to the collected data. The sensor will not acquire data if the blue line is visible. When going forward again, the sensor will start acquiring data when the blue line catches up with the last acquired scan.

10.4 Horizontal View

The *Horizontal* view displays one Radargram from a selected depth in real-time. The horizontal and vertical dimensions of the view are distance and channel number.

10.5 Crossline View

The *Crossline* view displays a full antenna array scan in real-time. The horizontal and vertical dimensions of the view are channel and depth. During normal operation, the antenna array scan displayed is the most recent one received from the sensor.

10.6 Speedometer

The speedometer will show current speed and maximum collection speed for the survey. This is displayed both numerically and with a graphical speedometer which will change color depending on the travelling speed. A warning will sound when approaching the maximum speed to alert the user to slow down.

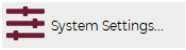
When using a DMI, the maximum survey speed and current travel speed will be displayed in km/h or mph. Unit can be chosen in display settings.

The speedometer will also display a survey capacity in time/distance based on selected storage location and survey settings.

When using Time or External trigger source, the Speedometer will display Hz.

For most scenarios, using a DMI and selecting Distance as the trigger source is recommended.

11. Examiner Collect System Settings

This section describes the System Settings menu. To display this menu, click  and 

at the bottom left corner of the screen.

11.1 DMI Settings

The DMI calibration is performed by measuring the number of DMI ticks the ARU receives from the encoder.

1) Determine the start point and the end point on a flat and straight road. Provide sufficient distance between the start point and the end point. The distance can be between 1 and 100 m, however 25 m or more is recommended.

2) Place the sensor at the start point. After establishing the reference position for the sensor and aligning it to the start point, click on [Start DMI Calibration].

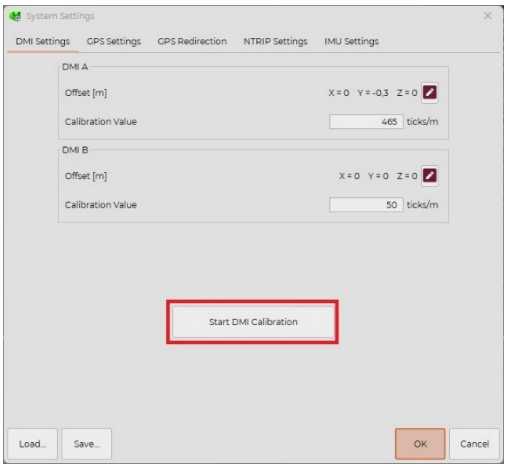


Figure 23 – Start DMI Calibration

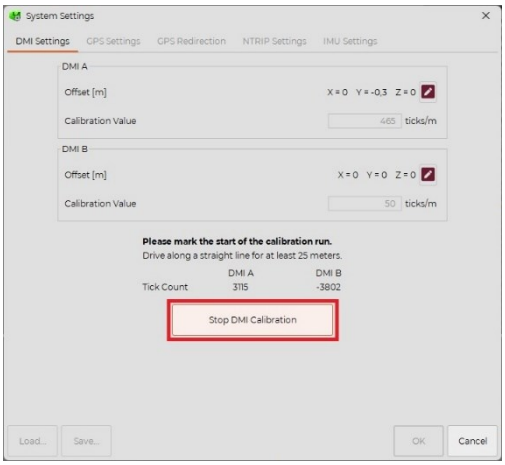


Figure 24 – Stop DMI Calibration

While driving, check that the values on [Tick Count] are increasing. When reaching the end point, click [Stop DMI Calibration]. Enter the distance between the starting point and the end point in [DMI Calibration Distance] and click [OK].

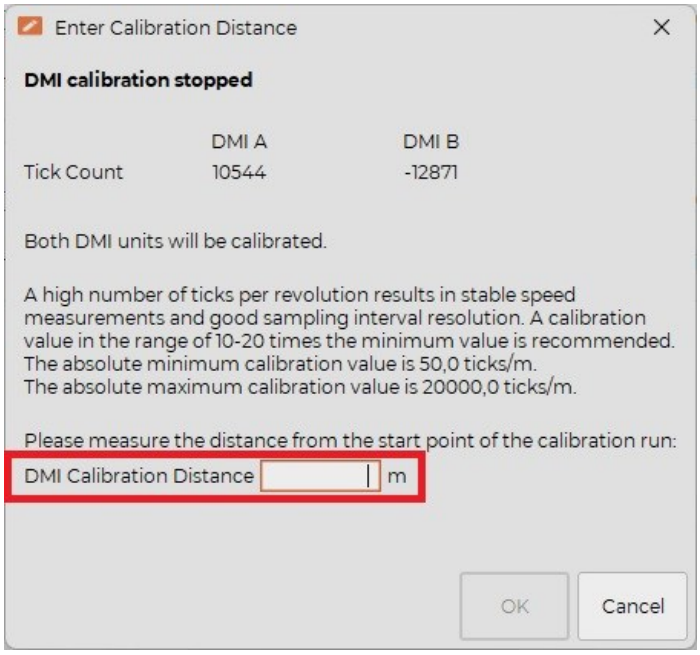


Figure 25 – DMI Calibration Distance Dialog

The calibration value (ticks/m) for DMI A is now established. For better accuracy, repeat this procedure to check that the calibration value is approximately the same each time. Enter the average value in the field.

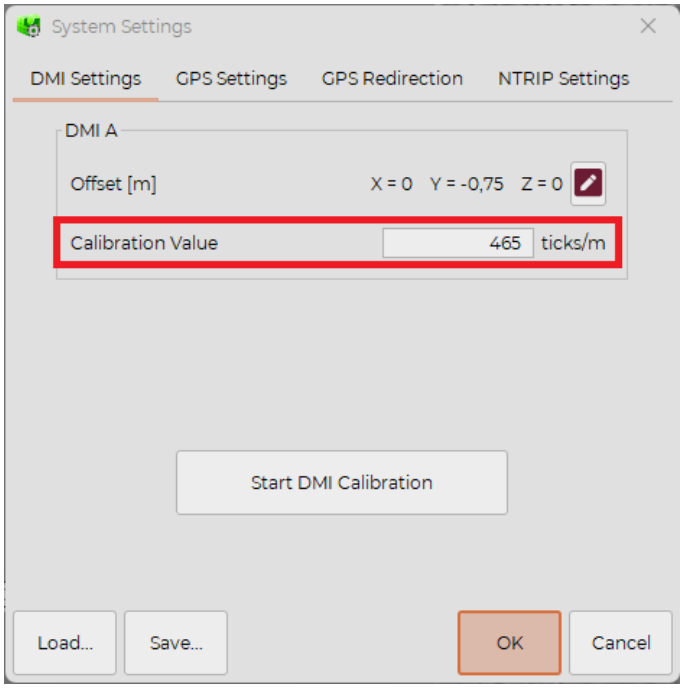


Figure 26 – DMI Calibration Result

The DMI offset position can be modified by clicking and entering the X, Y and Z coordinates based on offsets from the center of the sensor.

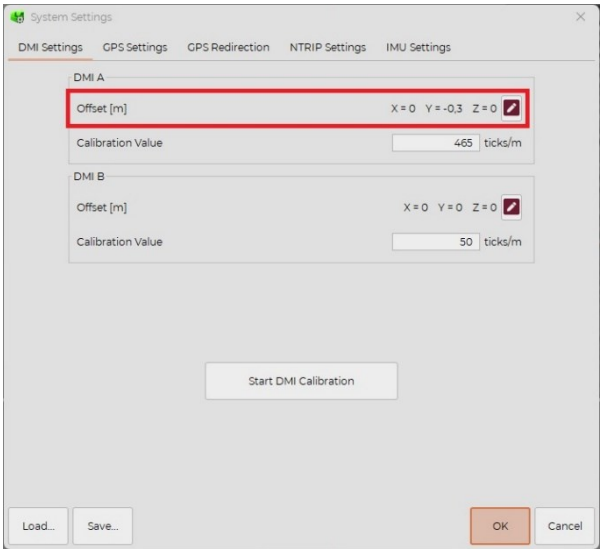


Figure 27 – DMI Offset

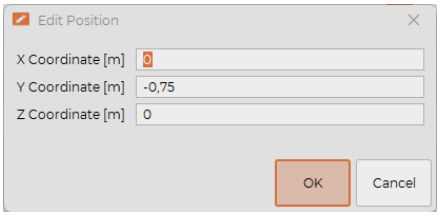


Figure 28 – DMI Offset Input

11.2 GPS Settings

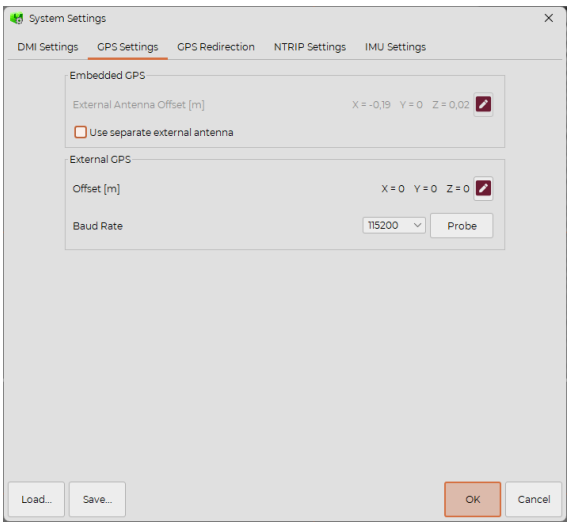


Figure 29 – GPS Settings

Embedded GPS

If you are using the separate, external antenna for the embedded GNSS, you can edit the offset position of this antenna based on offsets from the center of the sensor. The offset it not editable without checking the *Use separate external antenna* option.

External GPS

To modify the location of the external GNSS unit position, click  and enter the X, Y, and Z coordinates of the position. See Section 13.3 for offset conventions.

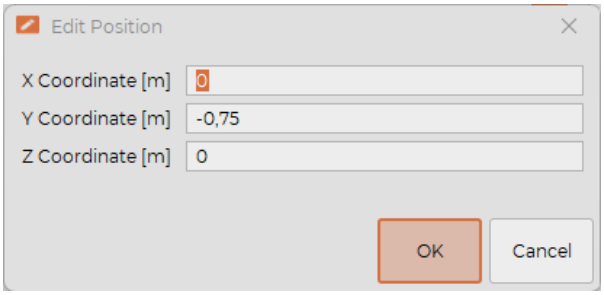


Figure 30 – Offset Position Input

GPS signal status is shown at the bottom of the screen.

Figure 31 – Status bar

Icon	Description
	NTRIP Connected / IMU Calibrated
	GNSS Connected but has no fix. (Few or no satellites available)
	GNSS Connected and has GPS or DGPS fix quality
	GNSS Connected and has RTKI or RTKF fix quality
	NTRIP is not connected / IMU is not calibrated
	Dead Reckoning (GNSS has lost fix, but calibrated IMU is calculating position until fix comes back)

11.3 GPS Redirection

Examiner Collect can take serial data from the embedded and/or external GNSS and output it to an IP address on two separate ports.

The intention is that the user can have third-party software running on the same computer as the Collect client or on a separate computer that utilizes the serial data. There are free programs for both Linux and Windows that can act as a TCP/IP server and redirect the network data to a virtual com port.

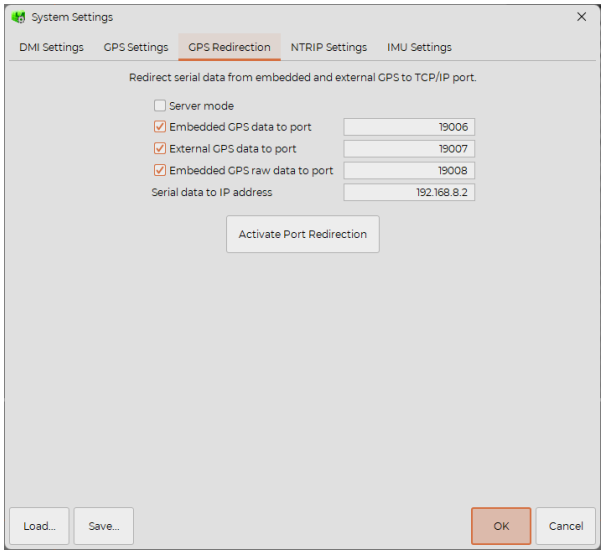


Figure 32 – GPS Redirection

11.4 NTRIP

Using the embedded GPS, with or without the external antenna, enables using NTRIP (Networked Transport of RTCM via Internet Protocol) as correction source.
As such, you will be able to get a high degree of position precision without a separate external GNS unit with a correction source.

In the NTRIP settings, you can fill in the Host Name, Port, Mount Point, Username and Password for your NTRIP account. This will require internet connectivity on the control computer.

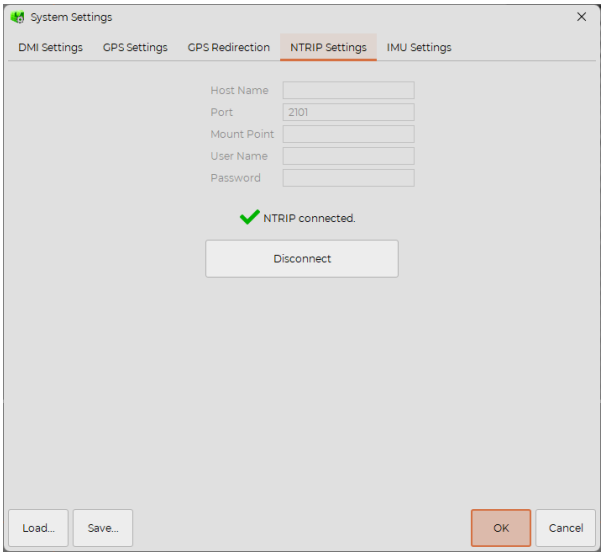


Figure 33 – NTRIP Settings

11.5 IMU Settings

With release of firmware version 1.1, IMU (Inertial Measurement Unit) functionality has been introduced to the sensors.

The IMU allows for increased accuracy during data acquisitions where GNSS coverage is inconsistent, after it has been calibrated.
The calibration status is indicated on the status bar, with a red exclamation mark or a green check mark, depending on status.

This calibration can be done manually through the calibration wizard available in IMU settings, by following the step-by-step instructions until a green check is marked on all points.
The IMU will, even without manually calibrating, attempt to achieve calibration if the unit senses the conditions in the wizard met through regular use.
If all conditions for calibration are met through regular use, the IMU will display a green check mark in the status bar.

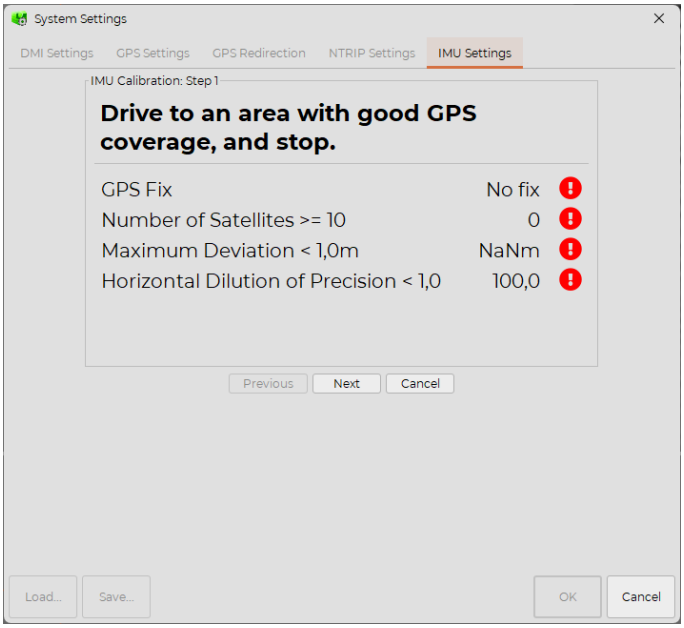


Figure 34 – IMU Calibration

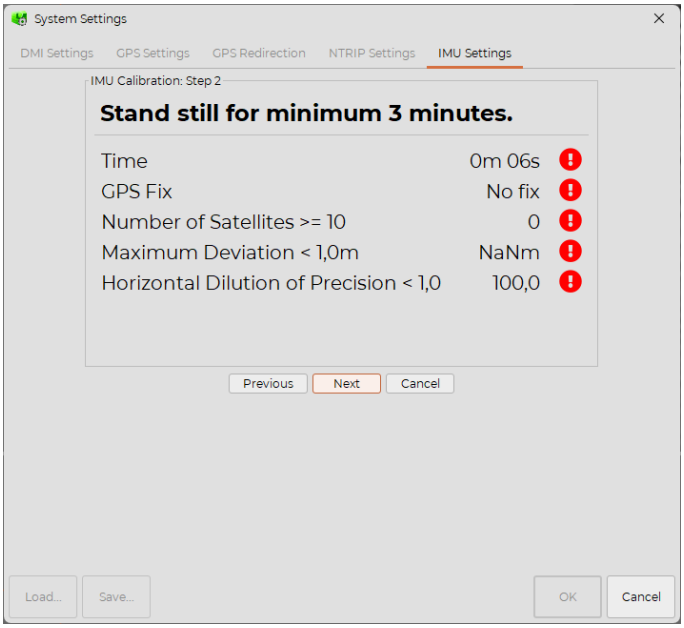


Figure 35 – IMU Calibration

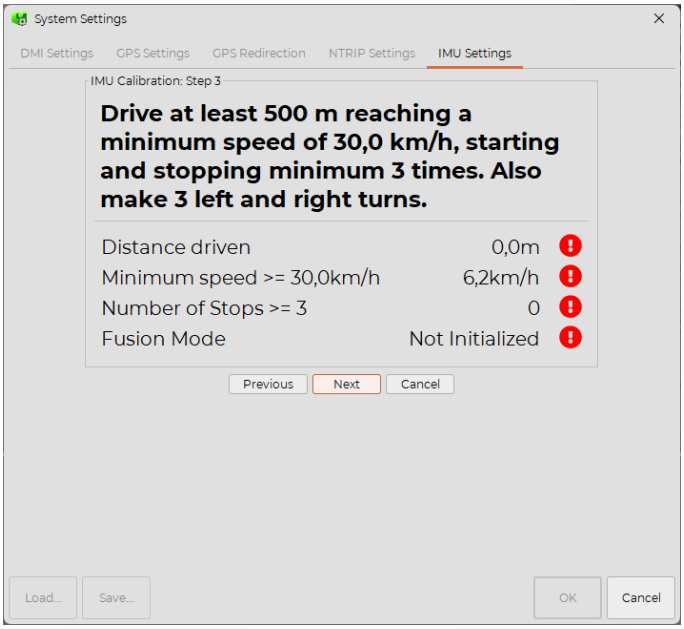


Figure 36 – IMU Calibration

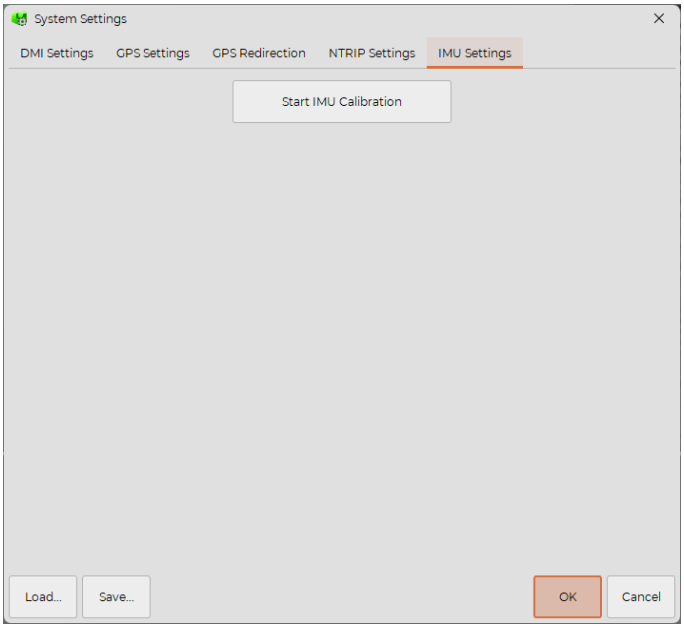
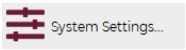


Figure 37 – IMU settings

11.6 Saving and Exporting the System Settings

To save the system setting, click the [Save...] button located on the bottom left corner of the 

dialog box. The configuration file will be saved. To edit the file in a text editor, the .txt-extension needs to be added in the name of the file. To load configuration data, click [Load...] button and select the system settings file that you have created.

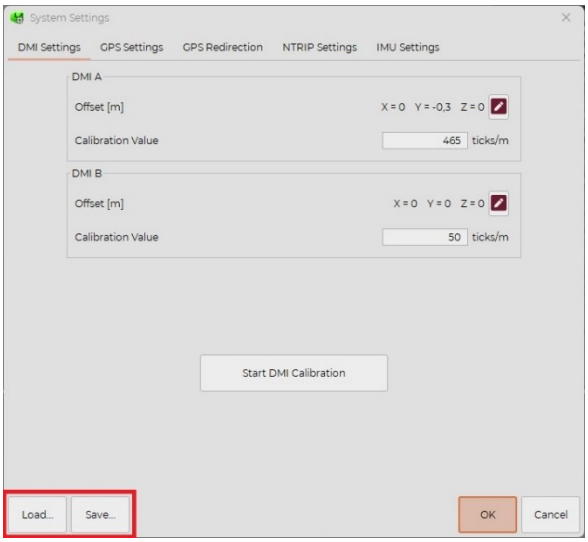


Figure 38 – Saving System Settings

11.7 Positioning conventions

The coordinate system used for positions is defined as follows:

The Origin (X = 0, Y = 0, Z = 0) is at the center of the sensor.

The Positive X direction is in the forward survey direction (fwd (+) and backward (-)).

The Positive Y direction is along the antenna array from left to right, when looking at the antenna array in the forward survey direction (left (-) and right (+)).

The Positive Z direction is downwards (upward (-) and downward (+)).

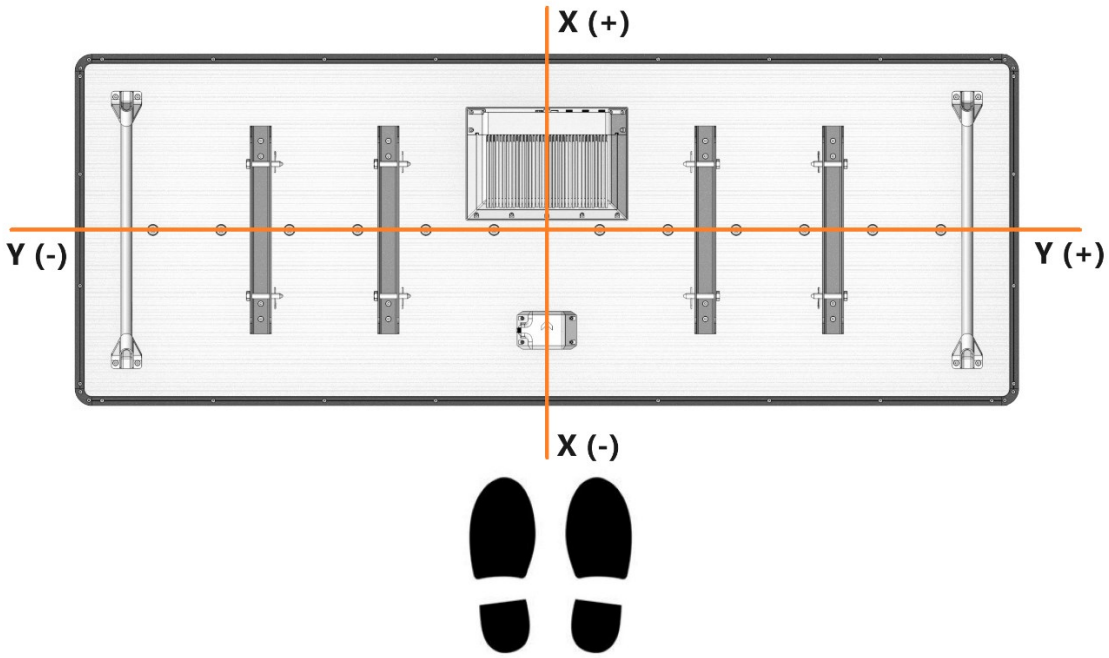
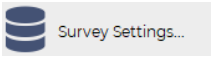


Figure 39 – Coordinate system used for positions / offsets

12.Examiner Collect Survey Settings

This section describes the Survey Settings dialog. To display this dialog, click  and 

at the bottom left corner of the screen.

12.1 General Settings for Data Acquisition

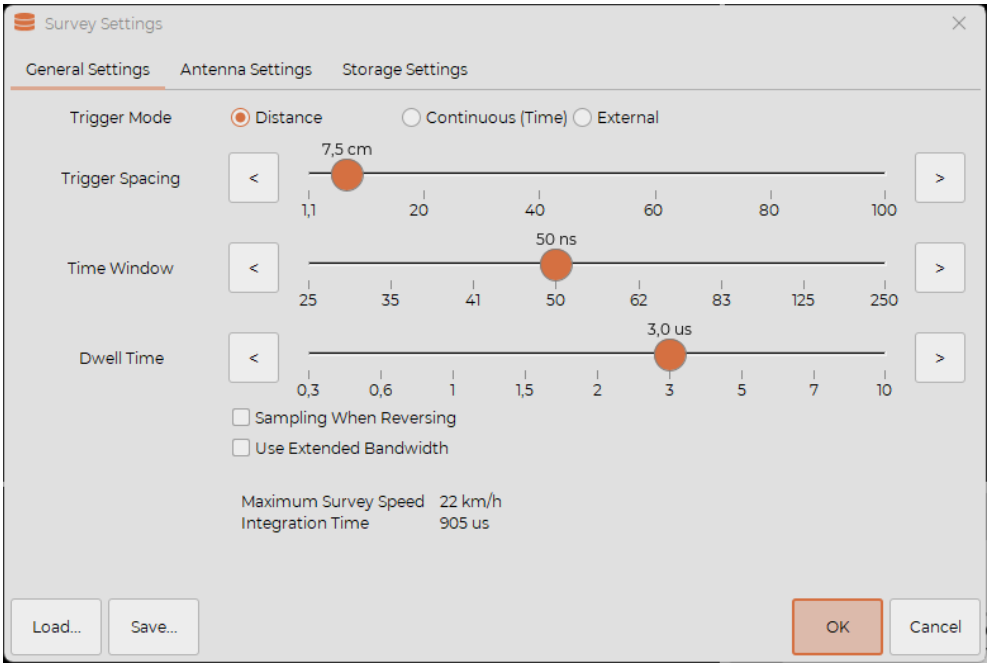


Figure 40 – Examiner Collect Acquisition Settings

Trigger Mode: Recommended mode is Distance (Quadrature DMI unit connected to ARU). Select Continuous (Time) to trigger system by internal clock or select External if using an external single pulse.

Trigger Spacing (**Trigger Frequency**): Set the data sampling interval. The system measures all elements in the sensor once per sampling interval. By reducing the sampling interval, more measurements are done per meter, but the maximum acquisition speed will be reduced.

If the Trigger Mode is set to "Continuous", this field becomes "Trigger Frequency" (Hz). The trigger frequency determines how many times per second all elements in the sensor are measured. If the value is set at 1Hz, then all channels in the sensor will be measured once per second. To acquire more data per second, increase this value.

Time Window: Set the acquisition depth in ns. Set the depth large enough to cover the depth of interest in the ground. A larger value results in lower maximum acquisition speed.

Dwell Time: Set the time transmitting each frequency. Larger value can eliminate more interference, but the maximum acquisition speed will be reduced.

Sampling When Reversing: Check this to acquire data in the reverse direction (e.g., acquiring data while reversing).

Use Extended Bandwidth: Check this to use the full frequency bandwidth available. By unchecking, you will be able to collect at higher speed, but with slightly lower quality in shallow layers. See product sheet for full frequency specification.

Maximum Survey Speed: Maximum acquisition speed. This value changes depending on the above settings. (If the Trigger Mode is set to "Continuous", this field becomes "Maximum Trigger Frequency".)

Integration Time: The time required to send and receive all frequencies on all antenna elements (i.e., one complete scan). This value changes depending on the above settings.

12.2 External Trigger Input

A trigger input signal can be given through the ARU connector marked DMI, pin 3, with ground on pin 9 or 10.

5V TTL

Input logic high: 2.0 V – 5.5V
Input logic low: -0.5V – 0.8V
Max input current: 10 µA.
The trigger pulse width should be at least 520ns.

The GNSS cable connector is a Lemo FGU.2N.310.XLCT.

12.3 Antenna Settings

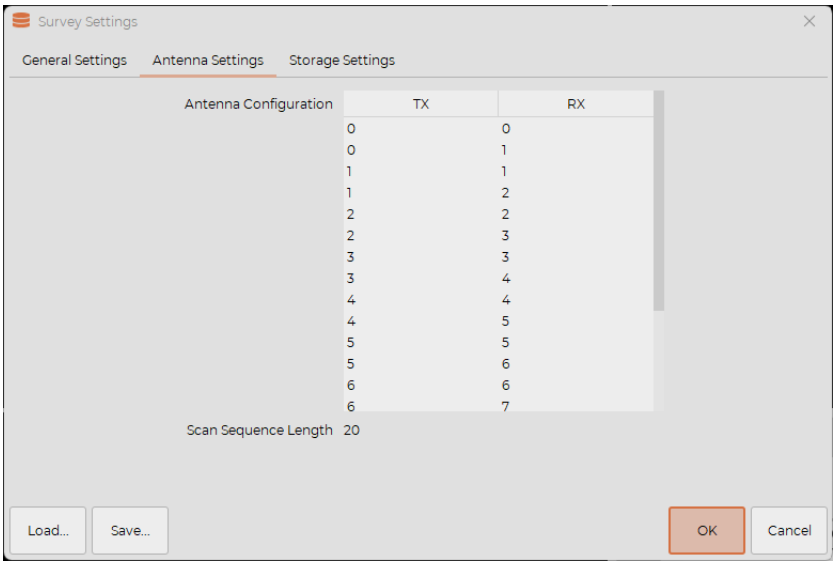


Figure 41 – Antenna Configuration & Scan Sequence

By default, the antenna configuration contains the maximum number of different channels. A channel consists of a pair of transmitter element (TX) and receiver element (RX). Different configurations can be specified by editing the survey settings configuration file manually. The survey speed will increase if the number of channels is reduced.

The following image shows the physical elements in an Air Sensor (AIR 1820). The number of elements and sequence differs depending on the sensor model.

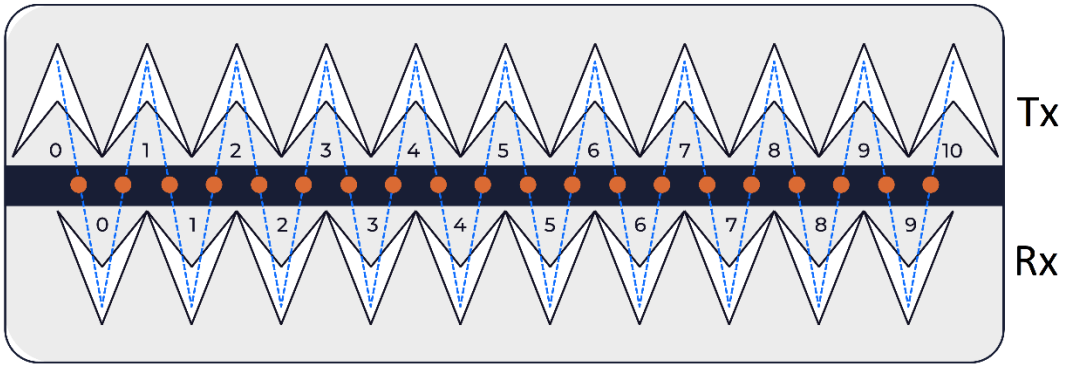


Figure 42 – Kontur Air Element Layout

The default antenna configuration for the AIR 1820 specifies all channels marked with ● in the above image.

To increase the survey speed or create a custom scan pattern, reduce the number of TX elements used. For example, to skip every other TX element, save and edit the survey settings configuration file by deleting the rows “tx-rx = 0,0”, “tx-rx = 2,1”, “tx-rx = 2,2” etc.

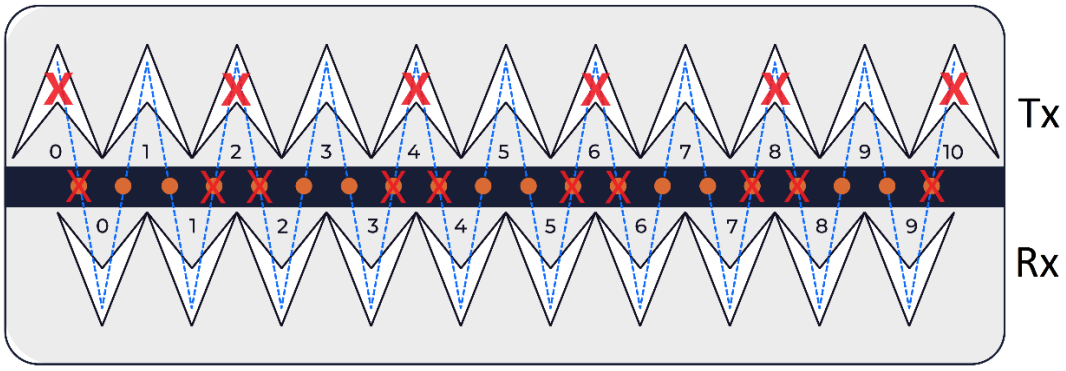


Figure 43 – Custom Scan Pattern Diagram

After saving the survey settings configuration file, load the configuration using the load option shown above. The antenna configuration list in the Antenna Settings tab should reflect the changes made in the configuration file.

12.4 Storage Settings

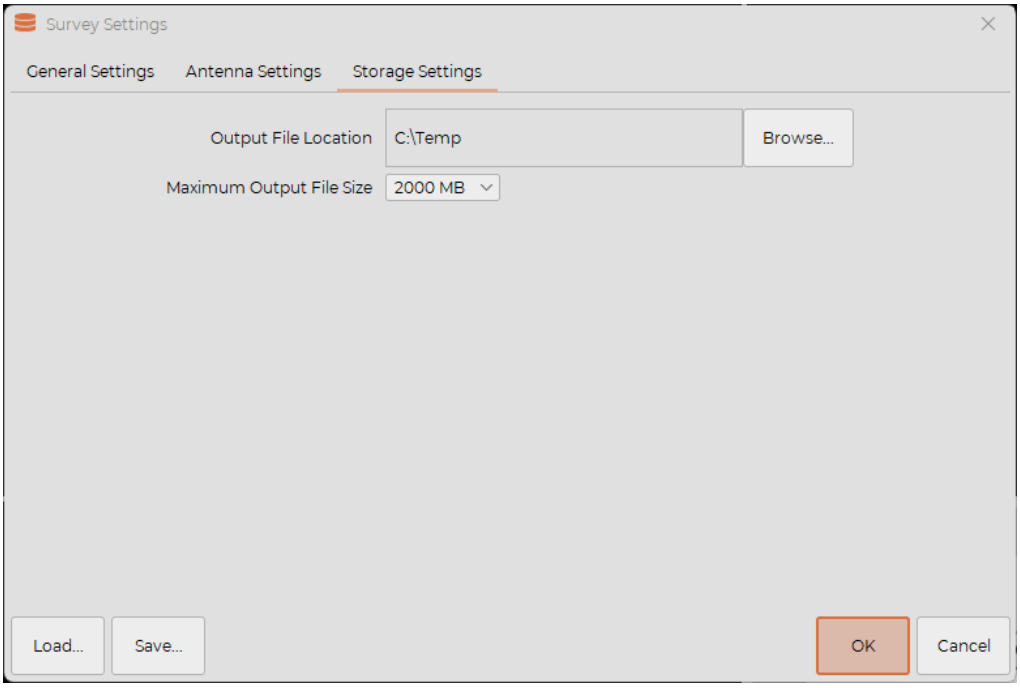


Figure 44 – Storage Settings

Output File Location:

Destination folder where the radar data files (.3dra) will be stored. Click [Browse...] to change to a different destination.

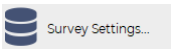
NB: The output file directory should reside on a local disk drive. External USB (Universal Serial Bus) disk drives are not recommended.

Maximum Output File Size:

Set the maximum file size for .3dra files. Select [No Limit] for unlimited file size. Select [250MB], [500MB], [1000MB] or above to limit max file size. Default size for files is set at 2000 MB to avoid many small or a single large file that is more complicated to transfer and process.

As soon as the current .3dra file reaches the file size limit, a new .3dra file is created with sequential file name.

12.5 Saving and Loading the Survey Settings

To save the survey settings, click [Save...] button located on the bottom left corner of the 

dialog box. The configuration file will be saved, add .txt file extension to use as a text file. To import the configuration data, click [Load...] button and select the file.

13.Markers

Markers can be used to insert annotations in the data. These will appear in the data as annotations when importing the project into Examiner.

Click ⚙ at the bottom left corner of the screen and select Marker Categories....

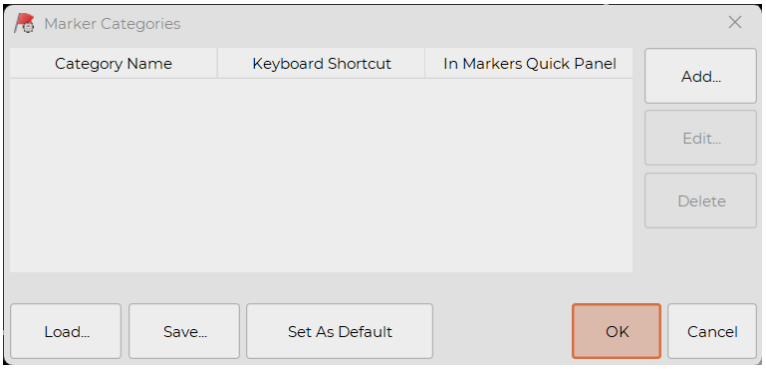


Figure 45 – Markers Menu

To create new marker, click [Add...].

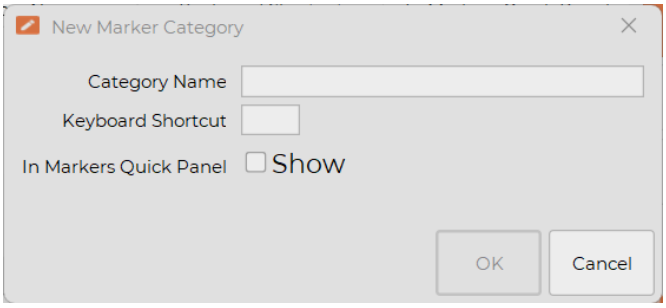


Figure 46 – Adding New Marker Category

Category Name: Descriptive category name.

Keyboard Shortcut: Keyboard shortcut for the marker category. Any key can be assigned, except special keys (Shift, Alt, etc.).

In Markers Quick Panel: Check [Show] to display the corresponding marker on the marker panel. Click the OK button to save the marker category.

To modify the marker category, click on the marker category to be modified from the list and then click [Edit...] to display the editing window.

To delete the marker category, click on the marker category to be deleted from the list and then click [Delete] to display the editing window. The following message displays. Click [Yes] to delete it.

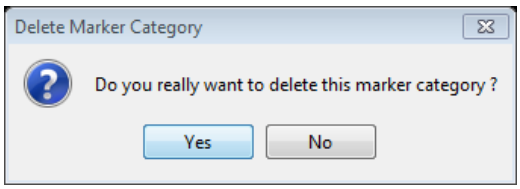


Figure 47 – Confirm marker category deletion

The set of marker categories can be set as default and loaded at each start-up. To do this, click [Set as Default], then the following message displays. Click [Yes] to save the marker categories as the default categories.

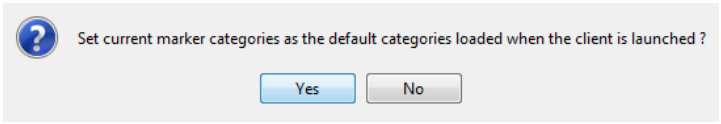


Figure 48 – Confirm setting default marker categories

The marker categories can be exported to a text file. Click [Save...] to save as a text file. Click [Load...] to load a marker categories file.

14. Display and Audio Settings

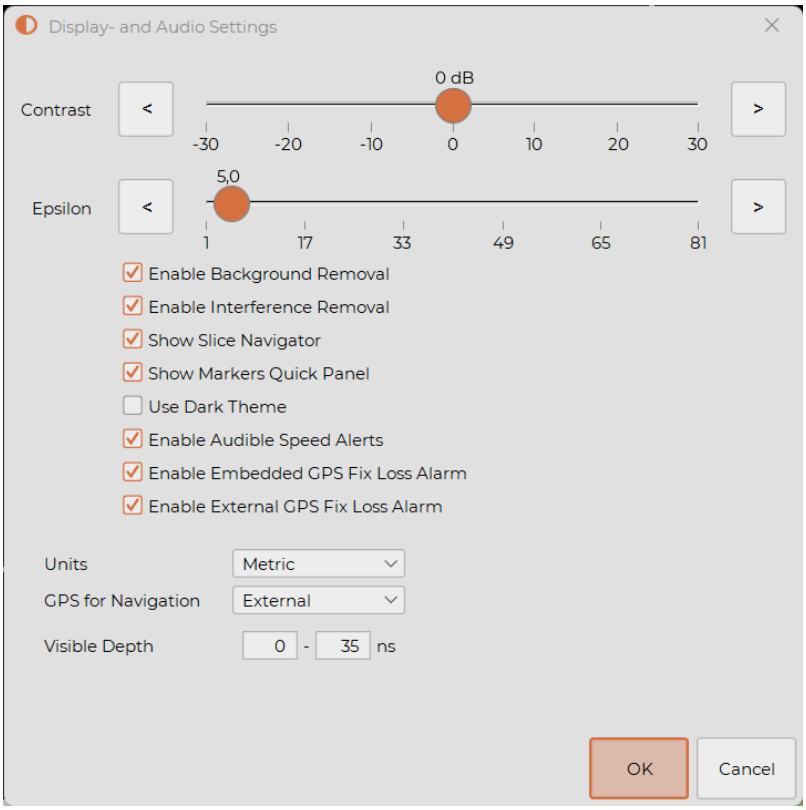


Figure 49 – Display- and Audio Settings

Contrast: Contrast of the data views

Epsilon: Dielectric constant used for depth calculation. Changing this value results in a changed depth axis.

Background Removal: Check [Enable] to display data with background removed.

Interference Removal: Check [Enable] to display data with interference signals removed.

Units: Select the unit, [Metric Units] or [Imperial Units].

Slice Navigator: Check [Show] to display the slice navigator.

Markers Quick Panel: Check [Show] to display the marker panel.

Audible Speed Alerts: Check [Enable] to receive a warning sound (beep) when the speed approaches (slow beeps) and exceeds (faster beeps) the maximum acquisition speed.
Embedded GPS Fix Loss Alarm: Check [Enable] to receive a warning sound (beep) when the fix quality of the embedded GNSS in the sensor decreases.
External GPS Fix Loss Alarm: Check [Enable] to receive a warning sound (beep) when the fix quality of the external GNSS decreases.

GPS for Navigation: Choose which GNSS (Embedded/External) to use for Navigation when acquiring data. This also affects the Navigation Assist that is explained in *Chapter 15.1*.
Visible Depth Range: Input desired top and bottom depth of visibility in the vertical cross-section viewports.
Dark/light Theme: Check to use a darker colored interface to reduce eye strain in low light environments.

15.Client Survey Collection Tools

15.1 Navigation Assist

The Navigation Assist opens a new window which will display your vehicle's trajectory and surveyed area during acquisition.

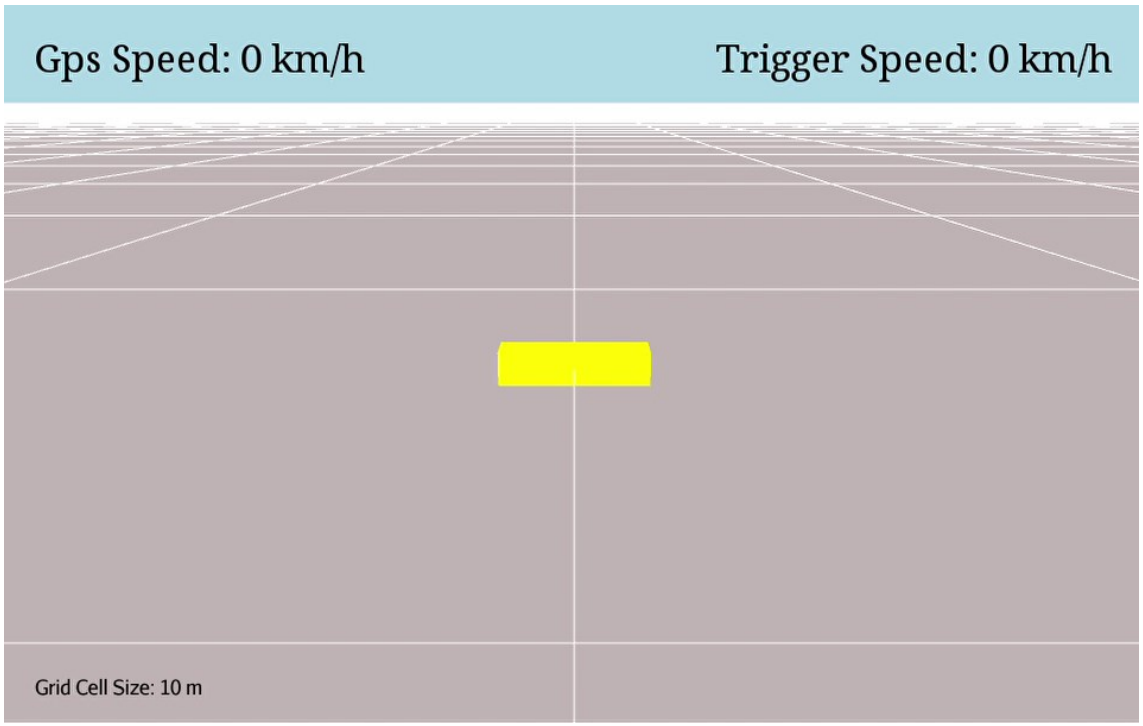


Figure 50 – Navigation Assist

Initially you will be presented with the above display. The yellow box represents the sensor, with the GNSS positioned in the center of this box, as long as the correct offset position is entered in the corresponding setting.

When you start your acquisition and start moving in a direction, the display changes, with a compass appearing in the bottom right corner, indicating your heading. Additionally, you will be able to compare your trigger speed and the recorded GNSS speed to ensure accurate calibration of DMI setup.

As you move in your calibrated forward direction, the yellow box will generate a blue trail where you have collected data, along a red center line. *See figure 50.*

Please be aware that the refresh rate for the navigation assist is dependent on the refresh rate of the GNSS. For a smooth trajectory while moving, a refresh rate of 5Hz is recommended.

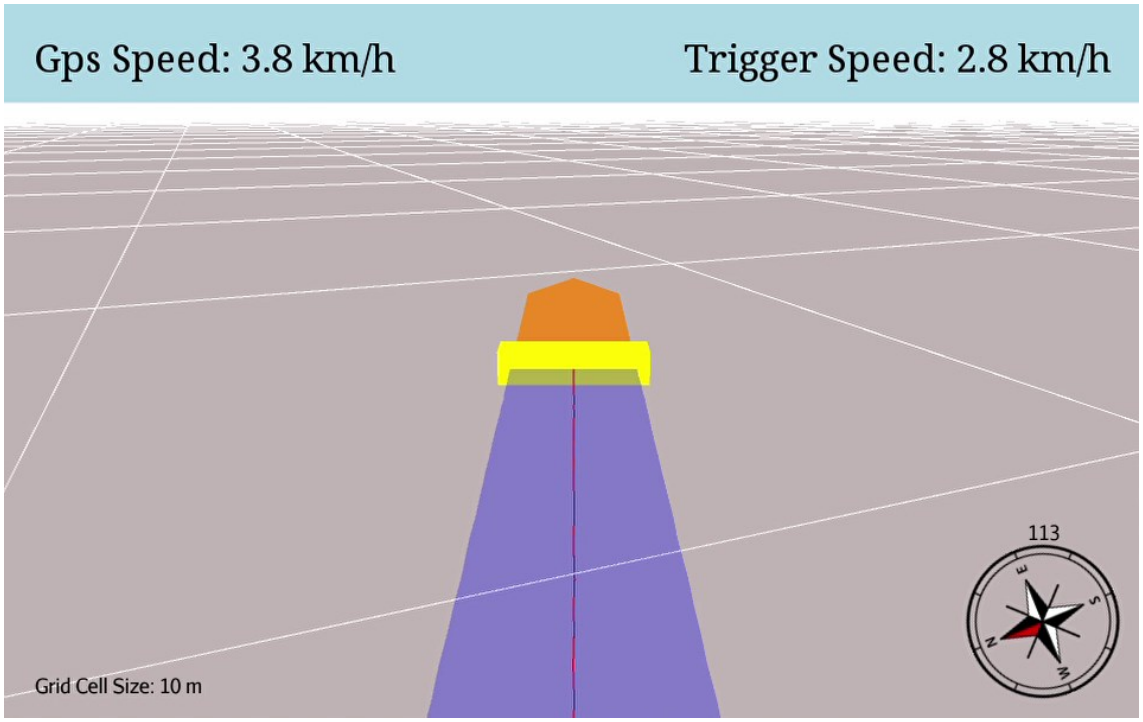


Figure 51 – Navigation Assist when collecting data

The client will not produce graphical data when there is no collection of data, so there is no overlap during reversing with the system running. It will display the position of the sensor along the previous collections however, allowing precise grids to be collected by driving forward and reversing over the area where you are collecting data.

By overlapping an acquisition with a previous one, the interface will display the overlap in a darker shade of blue.

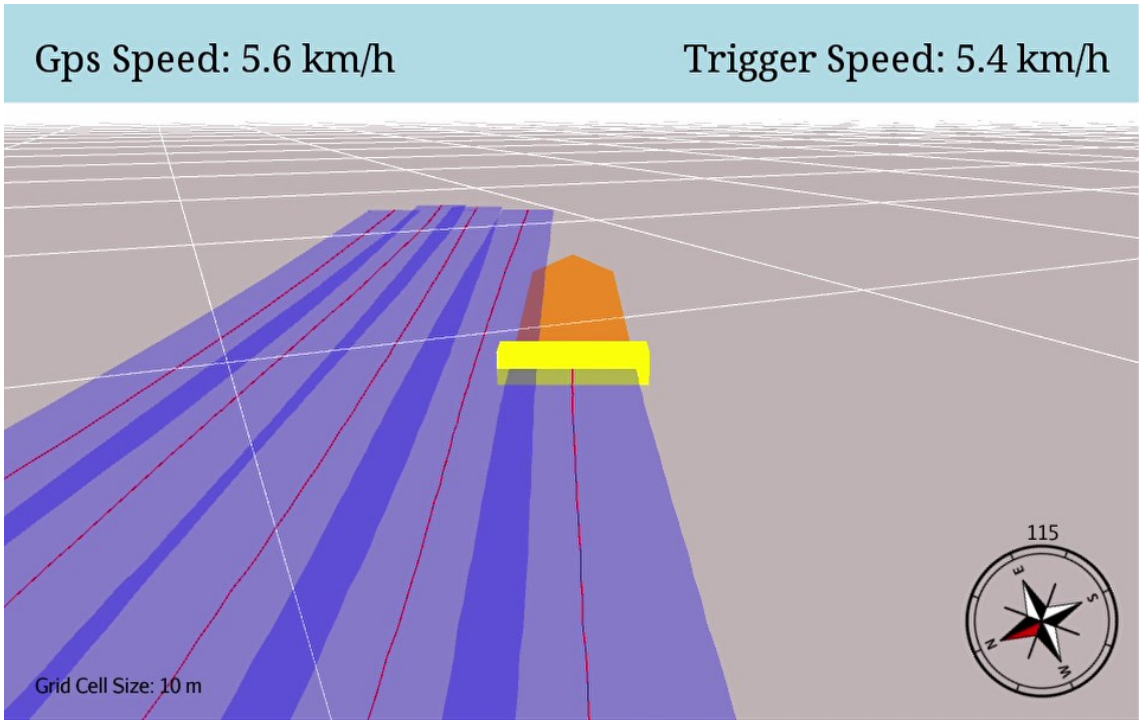


Figure 52 – Navigation Assist with overlapping data

Additionally, you can rotate and control the display of the data for a more complete overview of the collected data. Pressing the F1-key will show the keyboard shortcuts for the "camera controls".

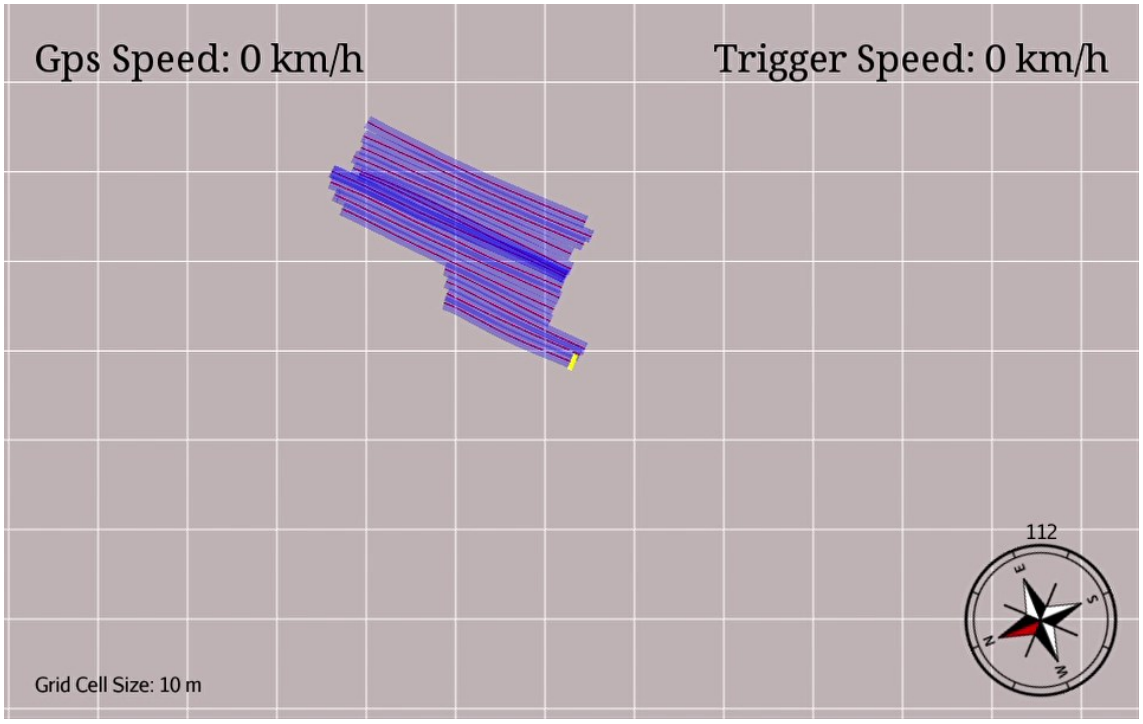


Figure 53 – Navigation Assist, overhead view

If the data from the acquisitions are available in the storage location you have chosen in the Survey Settings menu, these will be displayed in the Navigation Assist window, even after turning the system off and returning to the same location later.

15.2 GPS Deviation Map

Choosing Deviation Map in the new *Tools* menu will present you with the following window:

Figure 54 – GPS Deviation Map

The Deviation Map also gives the center position and calculated deviations for both the embedded and external GNSS Unit, along with a calculated distance between the mean positions of the two units.

In this window, you will be able to track the accuracy data of both embedded and external GNSS. It will display a scatter plot of points that the selected GNSS has plotted on a bullseye scale with a scale that adapts its range between its outermost points.

With this data, you can get a calculated deviation of the GNSS to ensure precision before acquiring data.

16. Other Settings

16.1 Reset to default

Click ⚙ at the bottom left corner of the screen and select Reset Settings to Default.

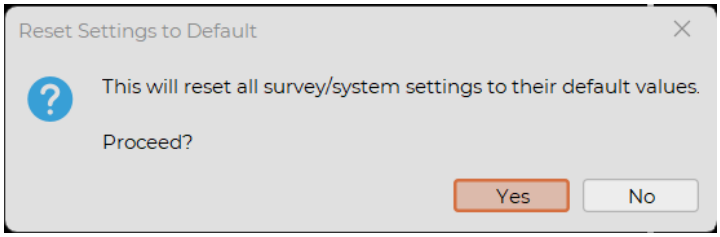


Figure 55 – Reset Confirmation Prompt

The following window pops up. Click [Yes] to reset settings to default values.

16.2 System Information

Click ⚙ at the bottom left corner of the screen and select System Information... to view the system information. This dialog displays information about the connected sensor.

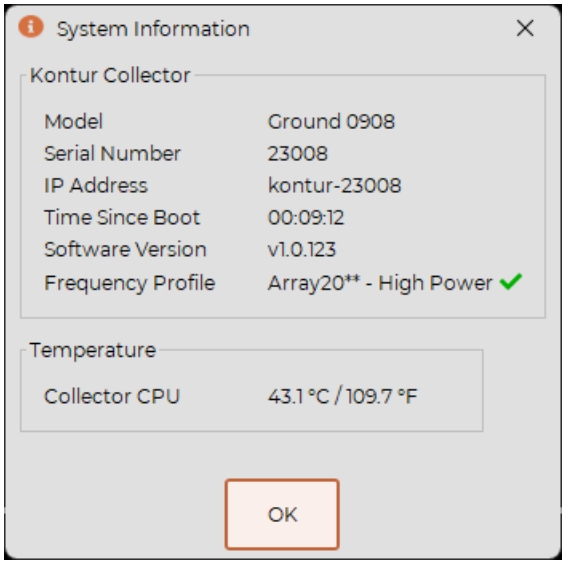


Figure 56 – System Information

The frequency profile field specifies the output frequency spectrum configuration. E.g., ETSI states that the GPR (Ground Penetrating Radar) output spectrum is set according to European ETSI regulations.

17. Survey

17.1 Starting a Survey

Move the sensor to the start point and click on the [Start] button to start the survey.

17.2 Operations

As soon as the survey is started, the speedometer turns to green and the [Start] button is disabled while the [Stop] button is enabled.

17.3 Speedometer Display

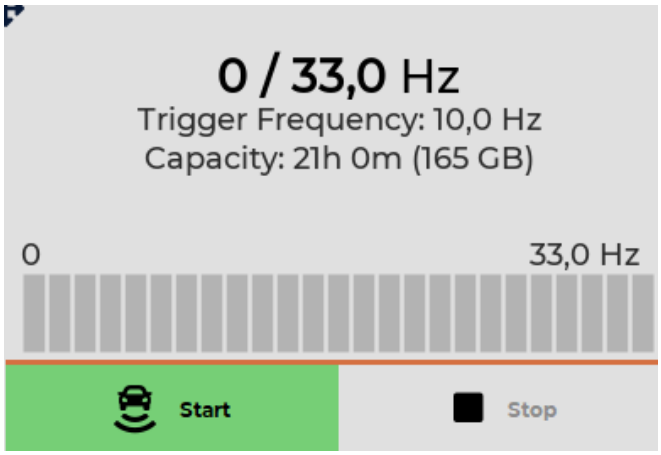


Figure 57 – Speedometer (Hz)

If the maximum speed is exceeded, the system will not have time to collect data at requested trigger distance. The sampling interval increases whilst driving over the maximum speed limit shown. When opening the file in Examiner – such "lost" triggers will be interpolated. Lost triggers are visualized in the inline view as a red vertical stripe.

The speedometer turns yellow when the maximum speed approaches approximately 80% of maximum limit of current survey parameters. When speed exceeds the maximum speed, the speedometer turns red (an alarm will sound if the audible alert has been enabled).

17.4 Inserting a Marker

The marker categories created in Section 15 are used when inserting a marker.

A marker can be added several ways:

- Right-clicking in data to display marker context menu (initial position of mouse determines x-position of marker)

- Pressing CTRL and left-click in data to open Add Marker dialog (initial position of mouse determines x-position of marker)
- By pressing ALT and right-click in data add last used marker (initial position of mouse determines x-position of marker)
- By shortcut key (position of crosshair determines x-position of marker)
- By clicking on marker panel (position of crosshair determines x-position of marker)

Use the shortcut keys (or use the buttons on the marker panel, or right-click on the screen and select the correct marker category). The marker will be inserted at the x-position that the marker was issued (either by mouse click or by crosshair position). The marker is displayed in the inline view and horizontal view as a dotted line with the shortcut or category name displayed at the bottom of the inline view.

17.5 Pausing the Survey

To freeze the display during the survey, click  at the bottom left corner (the crosshair will turn yellow). It is possible to add markers in pause mode. To resume the survey, click  at the bottom left corner.

17.6 Changing the Cross-section

Drag the blue (or yellow if paused) crosshair lines to change display the cross-section. The cross-section view can also be changed by the slice navigator if the navigator is active. Activate slice navigator in the Display and Audio Settings dialog box.

	Decrease depth of horizontal slice.
	Increase depth of horizontal slice.
	Change inline slice to previous channel/scan pair.
	Change inline slice to next channel/scan pair
	Show previous cross-line slice.
	Show next cross-line slice.

17.7 Completing the survey

Click [Stop] to stop the data acquisition and complete the survey. The file will be saved automatically to the specified folder. The date and sequence number are assigned to the file automatically. The last saved file name is displayed in the Examiner Collect title line.

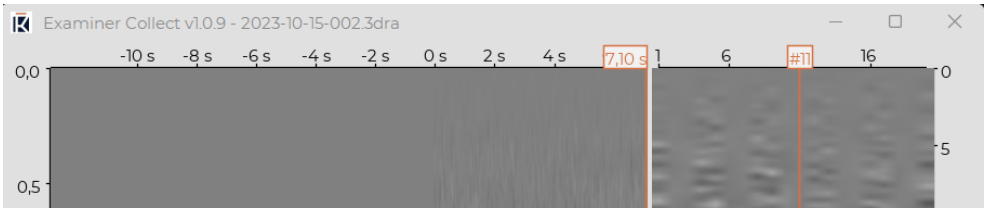


Figure 58 – File name in title line

(For example, if the survey was performed on October 15, 2023, then the file name will be "2023-10-15-xxx.3dra".) where “xxx” is a sequence number assigned automatically.
To exit the software, click [X] on the upper-right corner.

18. Maintenance

Light maintenance tasks can be performed by the user.

18.1 Cleaning of connectors

The ARU connectors and cables may be cleaned either using compressed air from a can or isopropanol-based electronic cleaning spray. Never use water to clean connectors. During field work, avoid putting connectors on the ground or in water to minimize the probability of getting sand or dust inside the connectors. Inspect connectors for corrosion at regular intervals.

18.2 Cleaning sensor hardware

The sensor and ARU can be cleaned with a wet cloth with an ordinary cleaner. Never use high-pressure jet water washer on the unit. Do not store the sensor inside the container if it is wet or humid

19. Configuring IP on Control Computer

The sensors are delivered with a default static IP address setup to 192.168.8.20. The computer used for control and display needs to be configured with a static IP address on the same subnet, e.g., 192.168.8.5, and connected directly to PoE injector using a standard network cable.

19.1 Configuring an IP Address in Windows 11

In Windows 11, you can use the settings app of Windows by searching for Settings in the start menu. Under [Network & internet] on the left-hand menu, you will be able to see the connections.

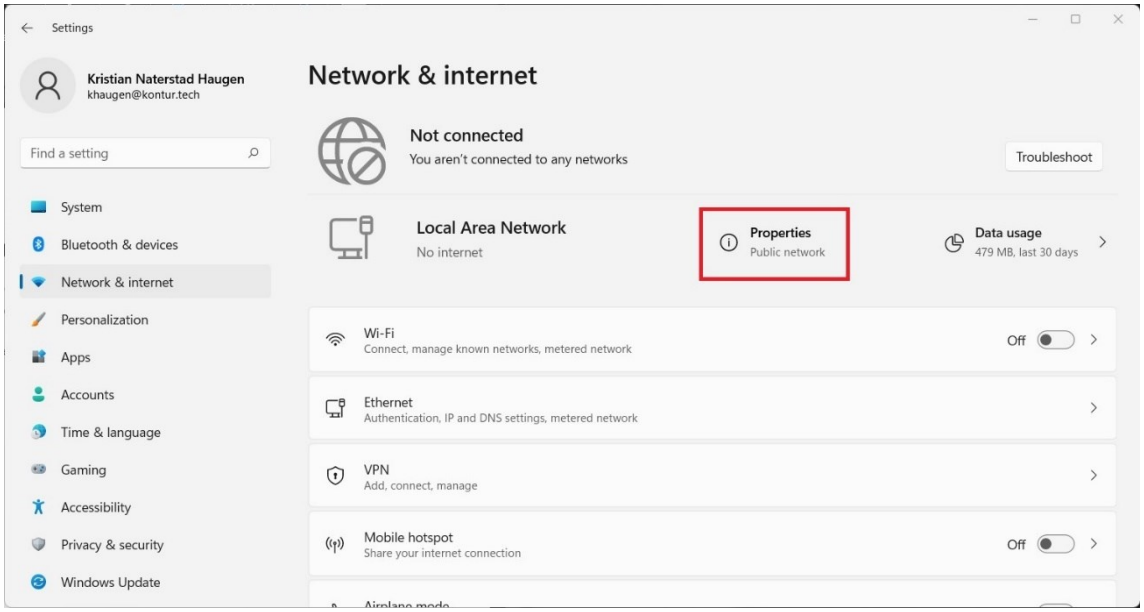


Figure 59 – Network Settings

By clicking [Properties] on the connection that the sensor is connected to, you will be presented with the following window.

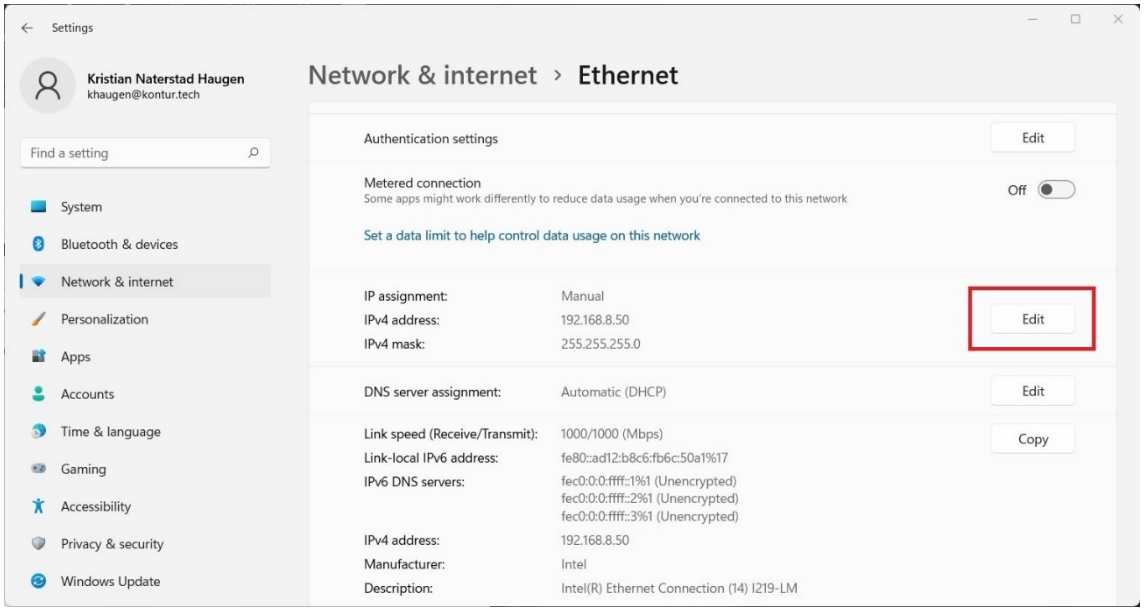


Figure 60 – Ethernet Properties

Here you can see the IP assignment of the connected computer, and by pressing [Edit], you will be able to change the assigned IP. Your computer may display "Automatic (DHCP)" as the IP assignment, and you will need to change the dropdown menu from Automatic to Manual and then turn on IPv4 before manually entering the IP address.

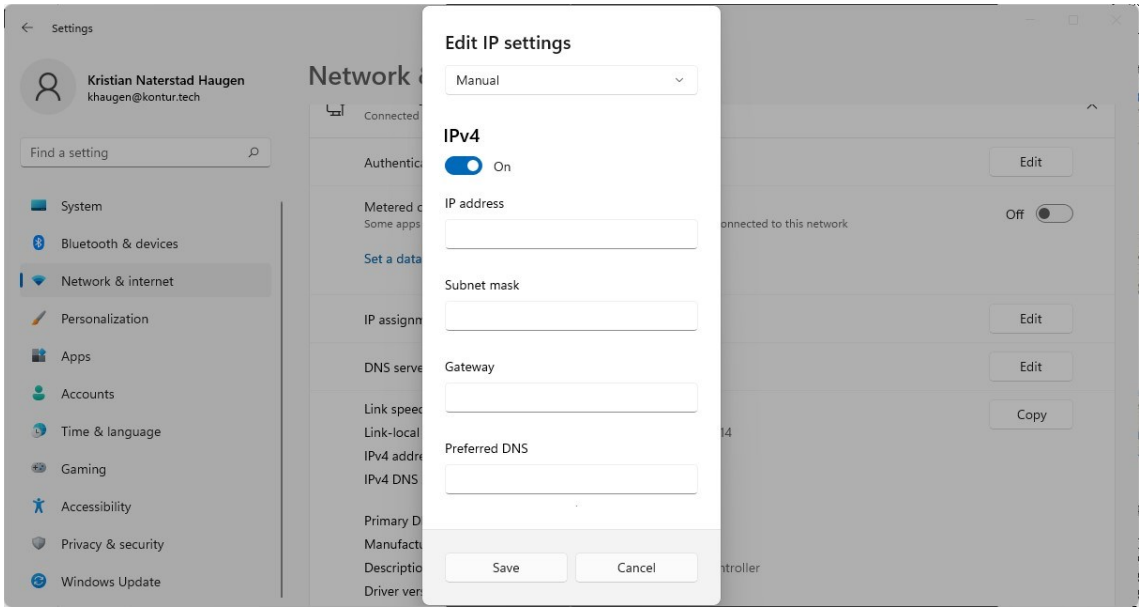


Figure 61 – Configure IP Settings

In this window you can enter the IP address 192.168.8.5 and the Subnet mask 255.255.255.0. The Gateway and Preferred DNS (Domain Name System) fields can stay empty. Press [Save] and close the Settings app, and the sensor should be reachable by the connected computer.
In Windows 10 you might be presented with an input for *Subnet Prefix Length*, which should be set to 24.

19.2 Configuring an IP in legacy Windows

How to configure an IP address that connects to a sensor:

1) Go to [Control Panel] → [Network and Internet] → [Network and Sharing Center] and select [Local Area Connection] (Or whichever name is given to the connection that the sensor is connected to).

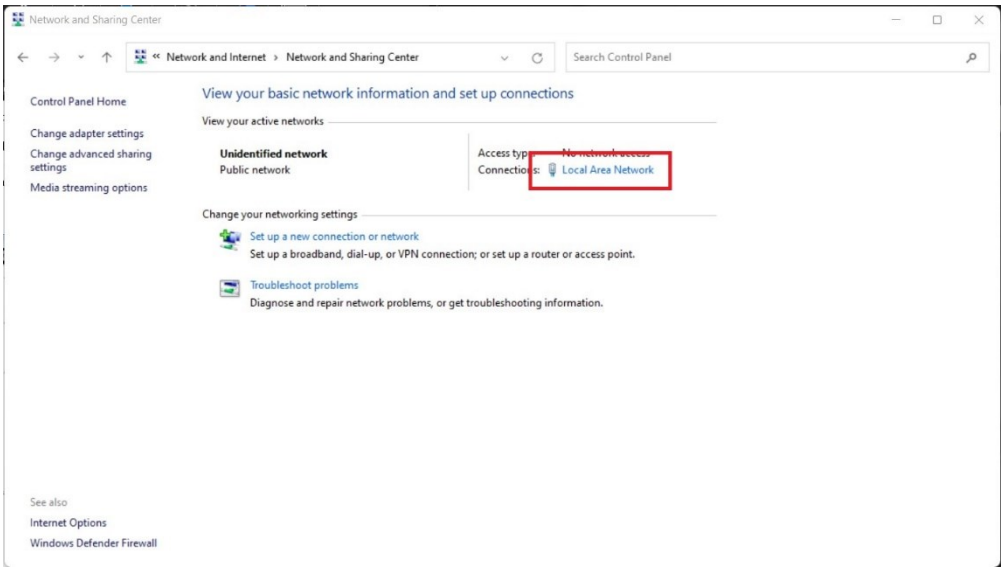


Figure 62 – Legacy Network Settings

2) Select [Properties].

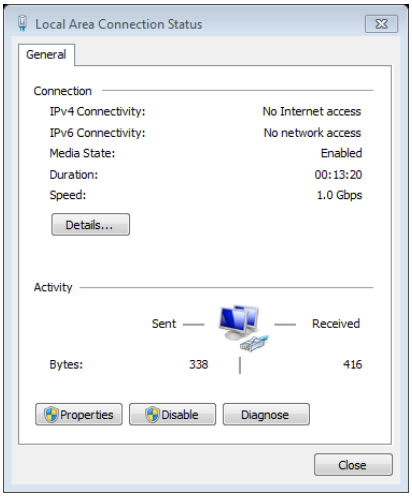


Figure 63 – Legacy Ethernet Properties

3) Select [Internet Protocol Version 4 (TCP/IPv4)] and press [Properties].

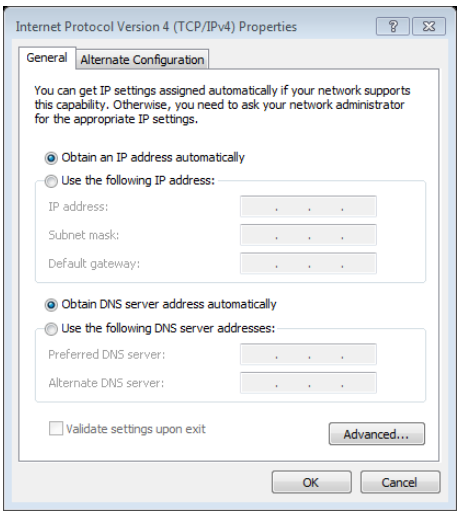


Figure 64 – Legacy IP Settings

4) Select [Use the following IP address:] and type in 192.168.8.5 to the IP address field. (The Subnet mask will be set to "255.255.255.0" automatically).

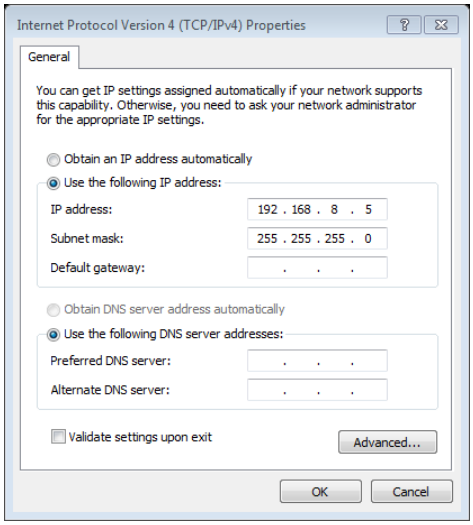


Figure 65 – Legacy IP Settings

5) Click [OK] and close the window and click [Close] to close [Local Area Connection Properties].