PinPointR

User manual

Content

About this manual

The ImpulseRadar PinPointR is a state-of-the-art, self-contained Ultra-Wide Band (UWB) Ground Penetrating Radar (GPR) system. The dual frequencies and mechanical design combined with the various accessories like the GPS mounting kit make the system suitable for different kind of locating and mapping applications.

For information on other applications and/ or configurations, please contact your local ImpulseRadar representative, or contact our sales team at sales@impulseradar.se

This manual is structured as follows:

- Section 1 – Hardware   systems and accessories
- Section 2 – Software   data acquisition and control
- Section 3 – Appendices additional notes and technical information

We welcome your feedback concerning this manual and its content. Please send your comments or suggestions to us at info@impulseradar.se

Hardware overview

The ImpulseRadar PinPointR is a dual-channel GPR system based on a modern real-time sampling (RTS) technology platform, offering state-of-the-art data acquisition capabilities. The PinPointR system incorporates two separate GPR-channels, co-located at the same mid-point, as well as an in-built GPS as standard.

GPR unit	Centre Frequency
• PinPointR	400 MHz and 800 MHz

The PinPointR is a push-cart system supported by several accessories, as shown in **Figure 1** below.

Figure 1 System overview

Data collection is managed over an Ethernet Wi-Fi link and a suitable Android device running the ImpulseRadar ViewPoint App (ViewPoint). With ViewPoint, the operator may collect single line data, albeit with two frequencies, or a few different types of multi-line projects. Whether a single line of project-based data has been collected, datasets may be directly imported into the ImpulseRadar CrossPoint software (CrossPoint) for processing and evaluation in a Windows environment.

For information on other applications or configurations, please contact your local ImpulseRadar representative, or contact our sales team at sales@impulseradar.se

GPR unit

The GPR unit has a field-rugged design equipped with both a low and high-frequency channel, making it possible to detect shallow and deep utilities simultaneously. Power is supplied via a removable and

rechargeable Li-ion battery, which is conveniently located on the top of the unit. **Figure 2** shows the location of the on/off button and the connector sockets for odometer and external GPS.

The unit also includes a high-quality differential GPS receiver. There is no external connection to this component, although markings on the housing indicate the approximate internal location.
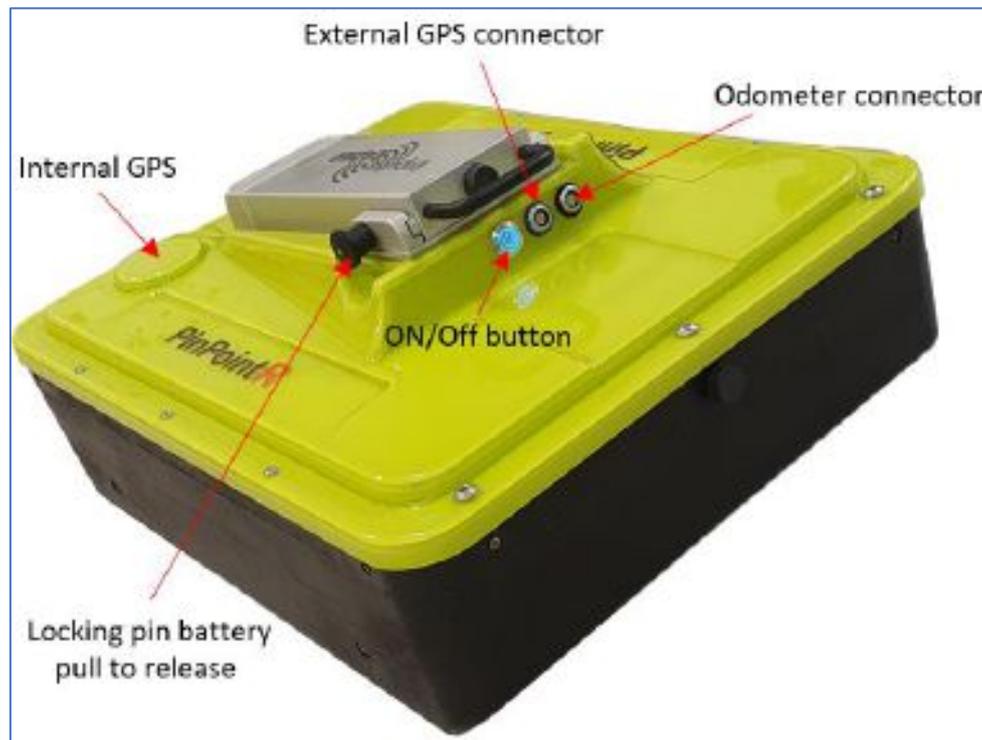
Figure 2 PinPointR GPR unit with a battery attached

Connector panel

Refer to the arrangement shown in **Figure 2**:

- **Silver** – On/off button. Press and hold the button for approximately two seconds to switch on the unit. Once on, the button glows blue. A subsequent press will switch off the GPR unit.
- **Blue** – External GPS. It allows the connection of an external GPS to provide higher precision positioning. Communication is via a serial RS232 link using the NMEA 0183, V2 protocol, and GGA data string.
- **Black** – Measuring Wheel. It allows the connection of the odometer cable (wheel encoder) from the push-cart.

All cable connectors are of high-quality from Yamaichi. To insert or remove a cable connector, hold the connector sleeve then gently push or pull the connector straight without turning. Each connector has a key slot to prevent damage if incorrectly connected into the wrong socket.

Battery

The PinPointR is powered via a removable and rechargeable Li-ion battery, which is a nominal 8.7 Ah/ 96.57 Wh, providing approximately 7-hours of continuous operation.

Note: *ImpulseRadar Li-ion batteries are approved according to UN38.3 and can, therefore, be safely hand-carried on passenger aircraft or shipped by air cargo.*

The battery fits securely to the top of the GPR unit. To insert, position it on the mounting plate and slide it gently into place until you hear the locking pin engage (click). To remove, pull the locking pin out, then gently slide the battery out and off from the mounting plate, as shown below in **Figure 3**.

Figure 3 *Exchange the battery*

Push-cart

The PinPointR push-cart allows the GPR unit to be manoeuvred easily over a range of surfaces. It incorporates several useful features including a height-adjustable tray for the GPR unit itself, as well as a foldable handle assembly, and a foot brake.

The GPR unit is mounted in a tray that is suspended under the push-cart hood by adjustable support straps, as shown in **Figure 4** below. This arrangement allows the unit to be positioned on or very close to the ground's surface and 'float' freely vertically while following the contour of the ground, but also move over bumps and other small obstacles. When you receive the PinPointR system, the GPR unit will already be fitted into the tray, but it is possible to remove it. However, this should only be necessary should the tray become worn through prolonged and direct contact with the ground, or in the rare instance that the GPR unit fails. Should this be necessary, follow the removal procedure outlined below in conjunction with **Figure 6**.

Figure 4 PinPointR push-cart features

The PinPointR push-cart incorporates a foldable handle assembly, so when the system is not in use, it can be folded for easier storage and transportation, as shown above in **Figure 4**. When unfolded for use, the handle assembly is fixed in place using a retaining screw. Depending on the model you have, this screw may be a threaded steel bolt that is fully removable, or on newer models, the screw is held in place within the handle assembly by a spring mechanism, as shown in **Figure 5**.
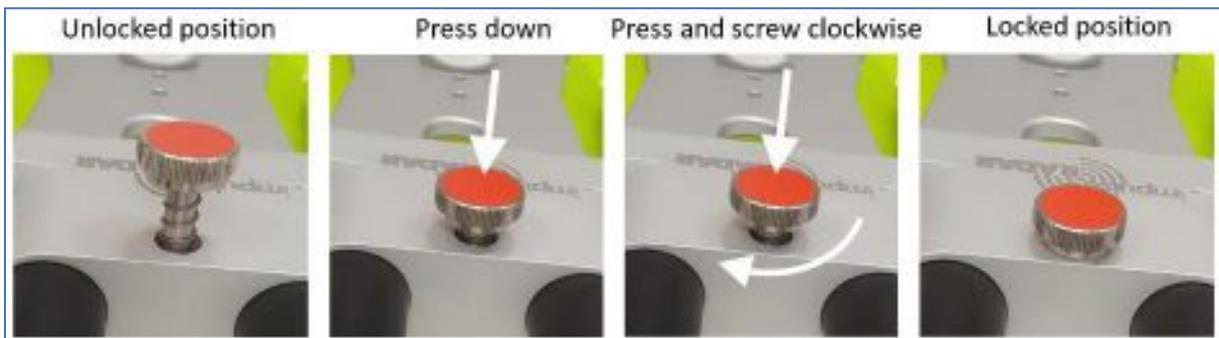
Figure 5 Retaining screw adjustment

Note: To ensure the proper operation of the spring-loaded retaining screw; you are advised to periodically lubricate the retaining screw and the threaded insert into which in screws. How often will depend on environmental factors, but should form part of general preventative maintenance for all mechanical parts of the push-cart.

The push-cart also incorporates a simple brake mechanism on the rear-right wheel, which is easily engaged or disengaged using your foot.

Note: for safety, you are advised to engage the wheel brake any time the system is not under your direct control, especially when working on a gradient.

GPR unit removal procedure

The following sequence is illustrated below in **Figure 6**.

1. Grip the wheel encoder connector as the picture shows and pull it out.
2. Remove the two rear and the front straps from the snap connectors and lift the cart-hood.
3. Disconnect the M5 screws that hold the GPR unit to the tray and slide the GPR unit out from the skid tray.
4. Close the push-cart hood and refit the rear and front straps into the snap connectors.
5. Adjust the front and back straps to obtain the desired height.
6. Connect the odometer cable again to the socket with the black bezel.

Note: before lifting the push-cart hood, remember to disconnect the odometer cable first. Also, it is essential to loosen the front strap to avoid tension on the strap connection point.

Figure 6 GPR unit fitting and height adjustments

Odometer (wheel encoder)

When the push-cart is moved over the survey area, the distance travelled is measured using an odometer (wheel encoder), via a connection to the rear-right wheel. This odometer is also used to trigger the GPR measurement process. Depending on the model you have, the odometer mechanism may be via a belt drive (o-ring) or direct-drive. Older models use the belt-drive, where the odometer is located above the centre of the wheel shaft and connected to it via a rubber o-ring. For newer models using the direct drive, the odometer is mounted centrally and directly to the wheel axel, so no o-ring is necessary.

If necessary, the o-ring can be replaced for belt-driven models by removing the wheel, as shown in **Figure 7**. For this purpose, a spare o-ring is cable-tied to the encoder cable under the push-cart hood.

Note: when refitting the wheel, use blue Loctite or equivalent to help secure the M6 retaining screw.
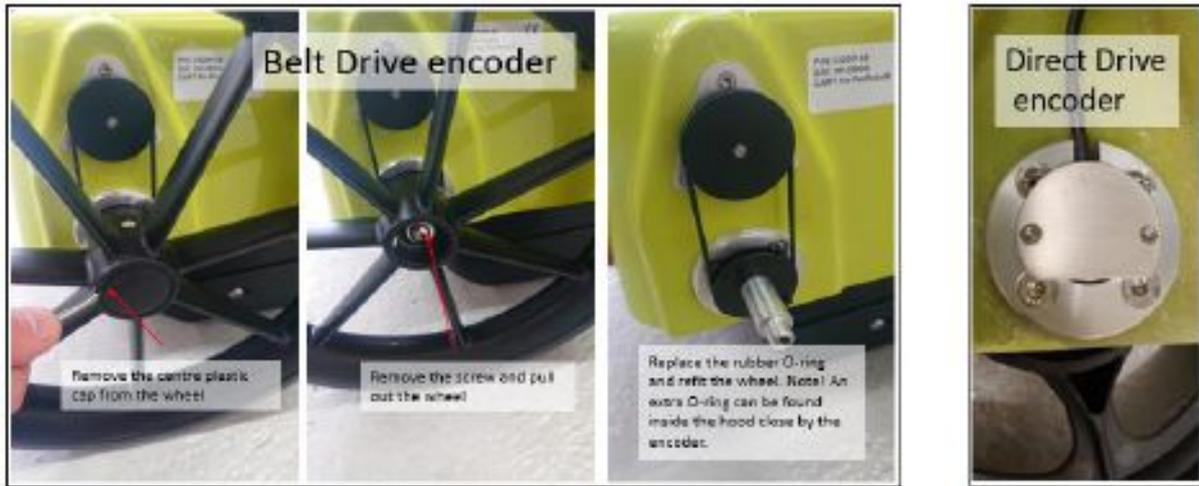
Figure 7 *Belt or Direct Drive encoder and wheel assembly*

GPS mounting kit

An optional GPS mounting kit is available for the push-cart to support the connection of external GPS receivers, as shown in **Figure 8** (GPS receiver not included). This kit contains extension poles, support arms, and an RS232 serial cable to facilitate the connection between the GPR unit and an external GPS receiver.

The GPS cable plugs into the GPR unit via the external GPS socket (blue bezel), while the other end is terminated with a standard 9-pin D-sub connector (male). When connecting an external GPS receiver, it must have an RS232 serial output via a wired connection. The GPS receiver should have its own RS232 serial cable that plugs into it, while the other end is terminated with a standard 9-pin D-sub connector (female).

With the male and female D-sub connectors are joined, a wired RS232 serial link is established between the external GPS receiver and the GPR unit.

Refer to Appendix **C – GPS** for a description of the external GPS cable and pin-outs.


Figure 8 *GPS mounting kit assembly*

Software overview

The PinPointR is set-up and controlled wirelessly via the ImpulseRadar ViewPoint App once installed on a suitable Android Tablet ("Device"). While it is feasible to operate the PinPointR using an Android Smartphone, it is not recommended due to the small screen size, which will affect your ability to identify and mark targets in the field. Refer to **Appendix A – Specifications** for a list of specification requirements.

An Android device that meets or exceeds the minimum specification requirements will generally offer better performance in terms of data recovery and on-screen functionality. That said, low-end Android-based smartphones can provide a quick and simple means of collecting radar profiles, or as a back-up in an emergency. Nevertheless, performance may be compromised if the specification is less than that stated above.

Since there is less standardization among Android Devices than say PC's, there may be variations in the way software is installed and operated on and between different Devices. Consequently, you may notice subtle differences between your Device and the notes that follow. If you require clarification or need further support, please contact us at our headquarters, or contact your local ImpulseRadar reseller; you may also email us at support@impulseradar.se

Note: the screenshots and following sequences are based on a Samsung Galaxy Tab Active Pro.

Wi-Fi and connectivity

The GPR unit incorporates a built-in Wi-Fi module that acts as a wireless access point (WAP) to which a Device can connect. The GPR unit's network name or SSID (Service Set Identifier) comprises the GPR unit serial number to help identify it amongst others, as shown below in **Figure 9**.

Figure 9 Example of GPR unit SSID and Wi-Fi network connection

After the first successful connection of a Device to a GPR unit, the Device connection settings will default to' auto-reconnect', and it will automatically try to connect to that GPR unit whenever it's within Wi-Fi range. This setting will remain as the default unless the 'auto-reconnect' function is disabled, or you tell the Device to 'Forget' the GPR unit Wi-Fi SSID, as per the options shown below in **Figure 10**.
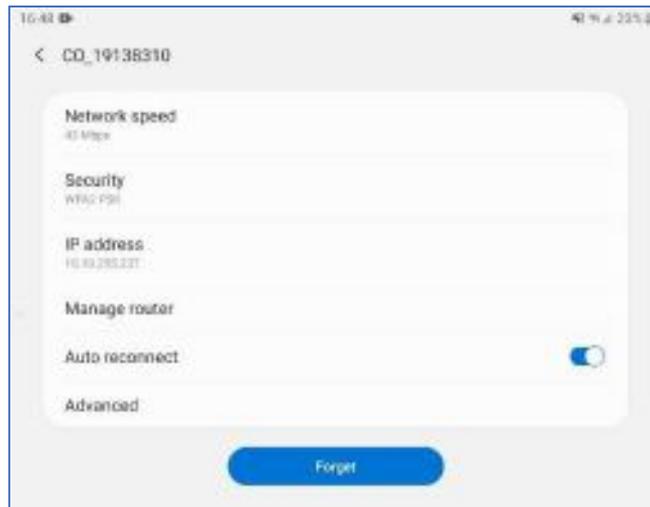
Figure 10 Device connection settings

Avoiding Wi-Fi and connectivity issues

Unless using the GPR unit in a remote area, it is highly likely that other wireless networks will be active and visible to the Device. If the Device has previously connected to another wireless network within the vicinity of use, then it is likely that it too will be set to 'auto-connect'. Therefore, it is vital that the **'AUTO-CONNECT'** setting for all other wireless networks is **DISABLED**. To do this, you need to access the main 'Settings' menu on your Device and follow the sequence until you reach the 'Manage networks' sub-menu, as shown below in **Figure 11**.

Menu sequence: Settings > Connections > Wi-Fi > Advanced > Manage Networks
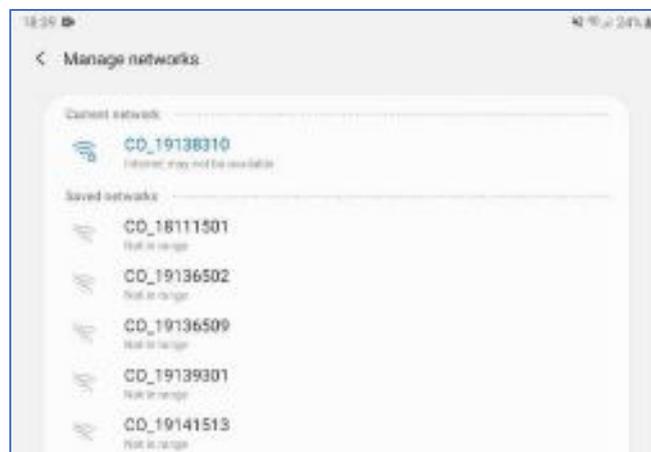
Figure 11 Manage networks

GPR unit Wi-Fi lock

When the Device has established a Wi-Fi connection with the GPR unit, and the ViewPoint App is active, then the Device is prevented from connecting to other wireless networks. However, if the Wi-Fi connection to the GPR unit is disconnected (not just a poor signal), then the Device's Wi-Fi function will be unlocked, and it will be able to connect to other wireless networks again. Should you be in the vicinity of a previously saved network that has the 'auto-connect' setting enabled, then the Device will attempt to connect to that wireless network instead of the GPR unit. Hence the importance of deactivating 'auto-connect' on saved networks.

ViewPoint monitors the Wi-Fi connection between the Device and the GPR unit to which it is connected; should the Wi-Fi connection be lost during measurement, then a warning will be presented. You will be prompted to wait for the Wi-Fi to reconnect or stop the measurement and save all the files. However, if the Device manages to connect to another wireless network when this occurs, then ViewPoint won't be able to reconnect to the GPR unit.

Multiple Devices

Nowadays, you are likely to have more than one Device in your possession, or within the vicinity of the GPR unit during measurement. You may also have more than one Device set-up to collect data from a particular GPR unit. Such situations raise concerns about which Device will connect and stay connected to the GPR unit if more than one is within range. Since only one Device can be connected at any one time, then multiple Devices attempting to connect simultaneously could lead to interruptions in data acquisition. The GPR unit Wi-Fi lock generally takes care of this; however, it's possible to force a connection if it is necessary to change a device.

In some instances, it may be possible for a GPR unit to connect to more than one Device at the same time, although not consistently. The resulting connection will be unstable as the GPR unit tries to connect then disconnects to each Device repeatedly. Under such circumstances, there will be blatant interference in the data in the form of many missed traces, and at the start screen, buttons will blink. This blinking effect is a warning, and you should investigate the connection settings to fix the problem.

Multiple GPR units

If you have more than one GPR unit, we recommend allocating one primary data acquisition Device to each, to avoid the potential issues described above. Furthermore, once the Device is connected, you should disable the settings for any other GPR units on that Device.

Key Wi-Fi actions

- Allocate a primary Device for each GPR unit.
- Disable the "auto reconnect" option for all Wi-Fi except the Wi-Fi of the GPR unit in use.

If you have another Device nearby when measuring, e.g. an Android Smartphone in your pocket, then you must disable Wi-Fi on this or any other nearby Devices in your possession.

ViewPoint Installation

Security note

As part of the Android operating system, there is a security restriction that prevents the installation of applications from outside the Google Play Store. Since ViewPoint is not available on the Google Play Store, you will need to make some adjustments to your device system settings to proceed with the installation, as follows:

1. Navigate to Settings > Personal > Lock screen and security
2. Check the option "Unknown sources"
3. At the message prompt, select "OK"

You may now proceed with the installation of ViewPoint.

If your Device has an internet connection, you can download the ViewPoint installation file directly from the Resource area of the ImpulseRadar website at https://impulseradargpr.com/resources. Alternatively, if your Device incorporates a USB-A port, you can install ViewPoint directly by connecting

the USB-A thumb drive supplied with the PinPointR system. Another method is to save the ViewPoint installation file to a PC first, by downloading it from the ImpulseRadar website or transferring from the USB thumb drive supplied. Then, using the USB cable provided with your Device, connect it to the PC. Use the PC's file explorer menu to transfer the installation file to the Device's 'download' folder, or 'installation file' folder.

Whichever method you chose, the installation process is as follows:

1. Locate the installation file <ViewPoint-X.XXX.apk>[1] and start it to initiate the installation

2. The recommended file system for this App is "ES File Explorer"

3. When prompted, allow permission for ViewPoint to access photos, media, and files on your Device, so that radargrams can be saved and opened. Also, grant permission for ViewPoint to access your Device's location. This permission allows ViewPoint to manage Wi-Fi and Bluetooth communication, which is necessary for ViewPoint to be able to connect correctly to the PinPointR system. ViewPoint will keep asking for the permissions until all the permissions asked for are granted. If you deny the consent and check the "never ask again" option, then ViewPoint will not operate correctly and will exit back to the home screen of the Device.

[1] X.XXX will be numerical according to the latest software release.

Wi-Fi pairing and password initialization

Follow the process below to connect your Android device to a PinPointR system. Refer to **Figure 12** for supporting screenshots.

1. Switch on the PinPointR system

2. On your Device, navigate to Settings > Wi-Fi > and look for the PinPointR system ID, which will appear as 'CO_XXXXXXXX' (where XXXXXXXX is the serial number of the system)

3. Select this Wireless Access Point (WAP), and you will be prompted to enter the **password**, which is '**impulseradar**'

4. Press 'Connect' to complete the process

Once connected, a 'no-internet' warning may appear, which can be disregarded. If the warning dialogue permits, authorize the network and do not show the warning again.
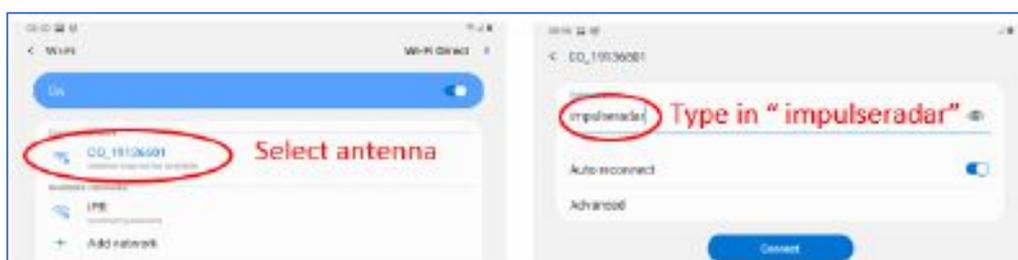
Figure 12 *Pairing a PinPointR system to a Device*

Using ViewPoint

From the home screen of your Device, press the ViewPoint icon to enter the application's start screen. The start screen, as shown below in **Figure 13**, provides access to the various functions of ViewPoint.

From **Figure 13**, the left-hand image shows an example of Device connection with all functions available. This screen includes the system battery status, which can be monitored from within ViewPoint as shown. The right-hand image shows the limited functionality available when ViewPoint is disconnected from the PinPointR system.

Note: Generally, the ViewPoint version number can be found on the start screen below the ImpulseRadar logo, as shown in Figure 13. However, this may also appear to the right of the logo, depending on the Device or its screen orientation.
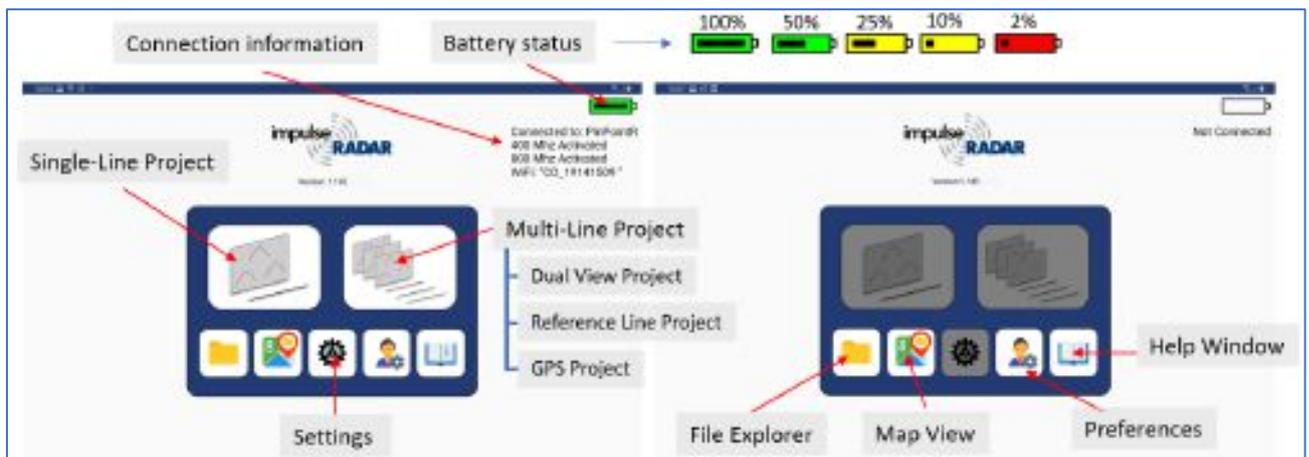
Figure 13 PinPointR start screen when Device connected (L), Device not connected (R)

Switching between different GPR units

ViewPoint will detect if connecting to a GPR unit that is not the same as the previous GPR unit it was connected to and will prompt you to restart ViewPoint.

Preferences and Settings

The preference and settings menu, as shown below in **Figure 14** and **Figure 15**, contain the parameters needed to control the PinPointR system during data acquisition. Once set, these parameters remain unchanged for all subsequent data acquisition. The menu for settings can be displayed in a basic version but also a more advanced mode. ViewPoint starts in basic mode, but you can activate the advanced settings with the slide bar.

Description of GPR unit settings:

- **Trig Source** – defines how data collection is controlled. By default, this will be 'wheel' using the direct-drive wheel encoder. Make alternative selections from the wheel option menu. Time or Manual triggering is also available. In Manual mode, you must tap the on-screen trig button for every A-scan.

- **Distance Interval** – defines the distance between every A-scan[1], when Trig Source is set to wheel, or Manual (sometimes also called point distance).

- **Time Interval** – defines the time between every A-scan[1] when Trig source is set to time.

- **Soil Velocity** – defines the velocity used to calculate the depth scale.

- **Number of Samples** – defines the time window or maximum penetration depth, and the adjacent Max Depth for the two channels is calculated based on the Soil Velocity.
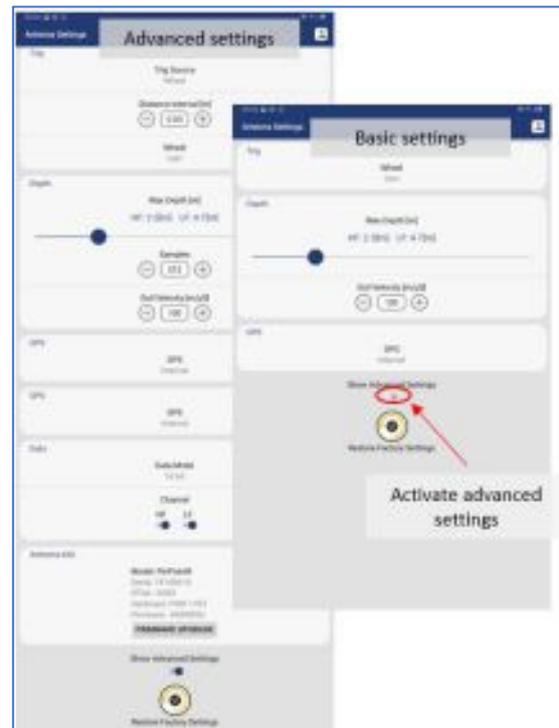
Figure 14 Settings parameters

- **Data Mode** – defines how many bits are used while storing the resulting radar data. The default is 16-bits, and this is also what we recommend. 32-bits can be selected, but it is only for unique occasions that it is useful to save data in 32-bit format. The precise number of useful bits depends on the point distance, survey speed, and GPR unit centre frequency. Note that using 32-bits during surveys requiring high speed only increases the risk of dropping data in Ethernet-link, use 16-bits and not unnecessary long time-windows to reduce the load on data transmission in these cases.

- **GPS** – defines whether to use the internal module or an externally connected system. If External is selected, you must adjust for the correct baud-rate, which can be obtained from the user manual for the GPS system used. EXT + TP is intended for use with an external while gathering precise time-stamping on each A-scan with the help of the internal GPS. If no external GPS is present, when this option is selected, a time-sync file will still be created. See also later paragraph on GPS-symbols.

- **Wheels** – defines the type of wheel connected to the system for distance measurement. The standard wheel is the Direct Drive Cart. PinPointR users that have the older Belt Drive Cart need to select that type of wheel encoder manually.

- **Antenna info** – Hardware type and menu trough which upgrade of FPGA / firmware may be done, see later paragraph.

- **Restore factory settings** – If internal settings have been corrupted or after a firmware upgrade, it's advisable to restore to factory settings, all essential system parameters will be reset to the initial state.

Note: The wheel type will be Direct Drive Cart as default. If a Belt Drive push-cart is used, this needs to be changed manually by the operator.

Description of user preferences:

- **Default Project Name (Single Line)** − By default, the name is the serial number of the GPR unit. The operator can edit/delete and change the name as they wish.

- **Measurement System** − Defines whether metric or Imperial values are used. When set to Imperial, the units will be in feet (ft.) and 10ths of ft.

- **Vertical scale** − Set time or depth for the vertical scale.

- **Operator Name** – Info will be stored in the PDF report.

- **Company Name** – Info will be stored in the PDF report.

- **Corporate Logo -** Display any *.png logo in the PDF Field Summary.

- **Marker Table Grouping** − Select if markers will be sorted by its type or by id in the PDF Field summary.

- **Map View** − When activated a background map is viewed together with the radargram during a survey.

- **Markers** − Select available marker standards (APWA, AS5488, JUPEM, or Custom).

- **Auto-zoom** − If auto-zoom is activated, the vertical scale is adjusted to fit the data area on the screen every time a new survey is started.

- **Language** − Select language − English, Swedish, or French.

- **Restore User Preferences** − Set the user preferences to factory default.

Figure 15 user preferences

Projects

From the start screen, you may select either a 'Single-Line Project' or 'Multi-Line Project.' As the names imply, this gives the option of collecting radar profiles in either single or multi-line profiles.

Single-line projects for individual profiles or multi-line projects if you want to record several profiles within the same project. In multi-line mode, the operator can select between Dual-View, Reference Line, or GPS projects, as shown in **Figure 16**. Regardless of the project type, you must select a project folder to which the
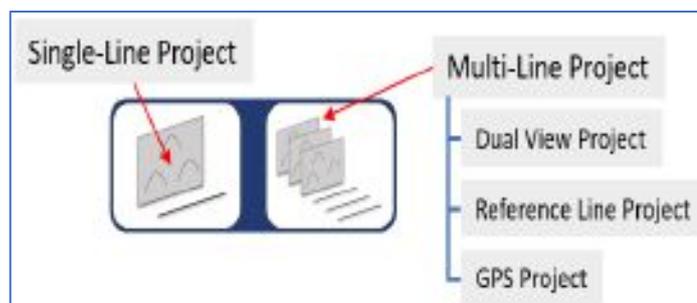

Figure 16 Project modes

data will be saved. **Figure 17** below shows the three options available.

During the initial installation of ViewPoint on a Device, it creates a folder on the Device's internal storage called 'XOver Data', under which ViewPoint project folders and files are saved and organized.

After a survey, it is possible to zip a project directly ViewPoint's file explorer, which offers a quick and easy way to compress data for transfer. Navigate to the desired project folder then press and hold the folder icon until the zip dialogue opens. Select 'zip project', and a confirmation window will open, giving you the option to include a field summary report, and to generate a KMZ file. Select your preference and confirm. The zip file will appear under the parent folder of the relevant data folder.

Running a single line project and associated functionality

Figure 18 illustrates and describes the functions within the header toolbar for controlling data acquisition.
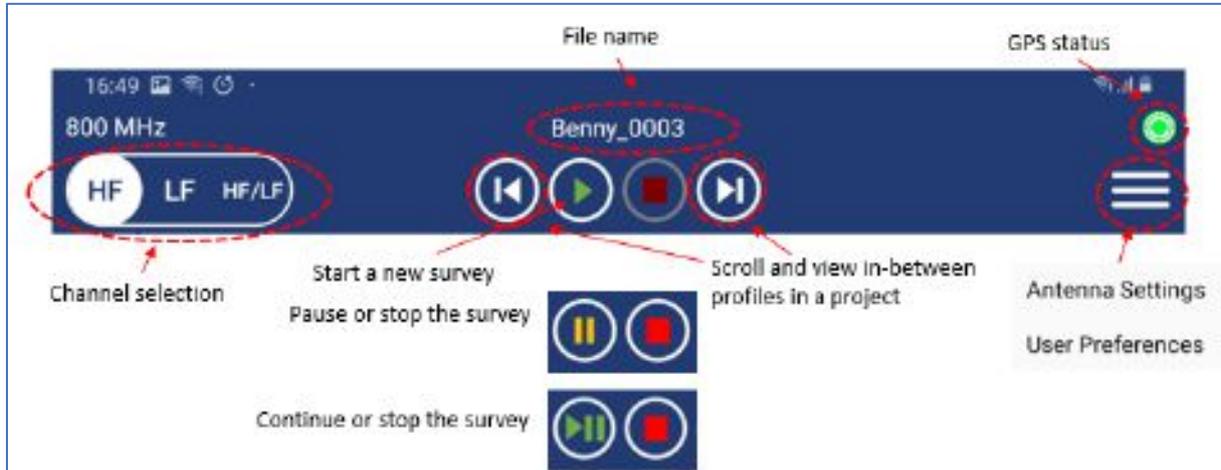
Figure 18 Measurement toolbar controls

Figure 19 below describes additional functionality available during and after a survey, even if ViewPoint is disconnected from the GPR unit. When ViewPoint is used in standalone, all functions except the back-up cursor and crosshair lock are available.
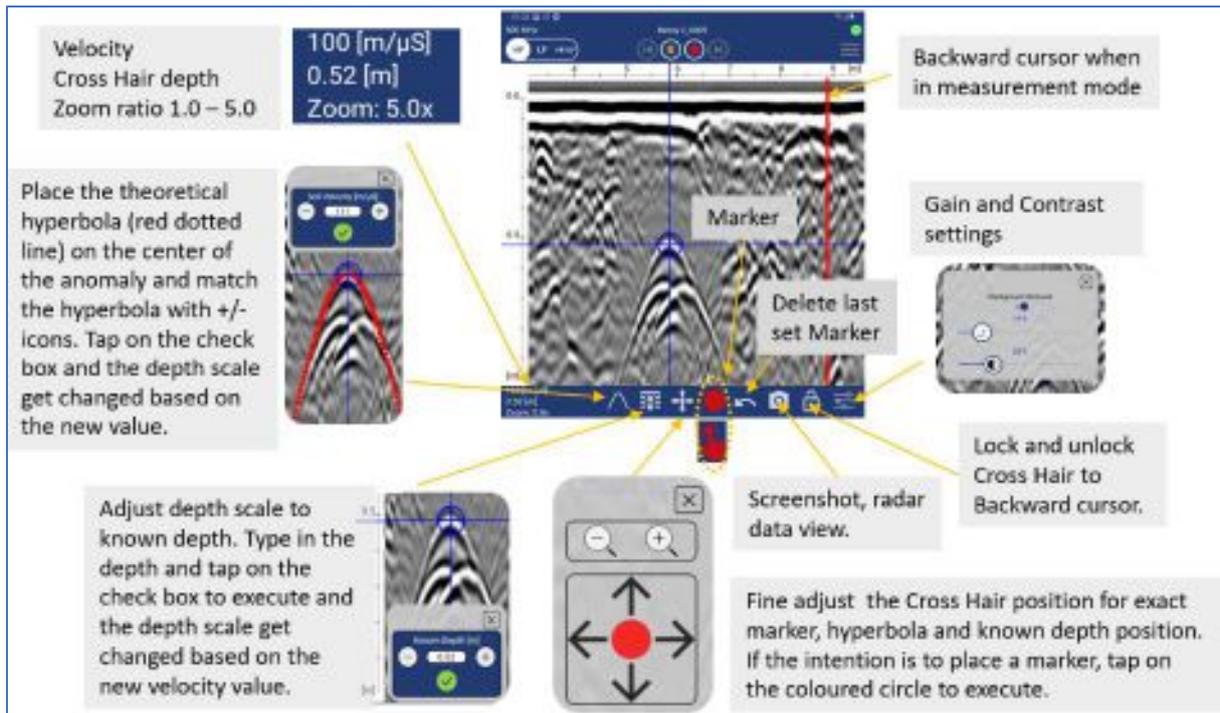
Figure 19 Footer toolbar functions

When using the internal GPS or an external GPS receiver, a background map can be activated and viewed alongside the radargram to show the georeferenced position of profile tracks and assigned markers. The map view is enabled via a checkbox under the user preferences menu. In order for ViewPoint to display a background map in the map view, the Device must first be connected to the internet to load and cache a Google Map of the survey area. From the ViewPoint start screen, press the Google Map icon to enter the Project Overview mode. Here you will see a map of your current location. Pan, scroll and zoom the map until it covers the target survey area. Exit back to the start screen and that map view is now cached; this view will be displayed together with the radargram for the next survey. Repeat this process for each new area to be surveyed. If you forget, or you exceed the boundaries of the cached map, no background map will be displayed in map view, although you will still be able to see profile tracks and marker placements.

GPS-symbols and function

Regardless of project type, a *.cor file (GPS coordinates) will be saved alongside the GPR data if the internal GPS or an external GPS receiver can lock onto a suitable number of satellites. The GPS symbol will change colour and style according to GPS status, as defined below in **Figure 20**. By pressing the GPS-symbol you can see a static view of the current satellites and coordinates.
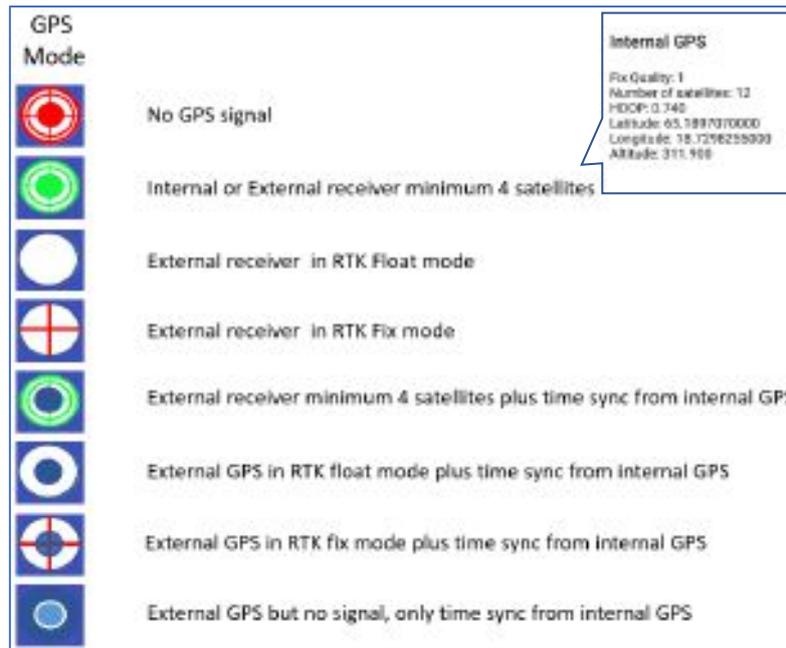
Figure 20 *GPS symbols and their meaning*

When connecting an external RTK-GPS, the internal GPS can be utilized to log the GPS time for each GPR trace collected. In doing so, the positing file generated is adjusted for any time lag from the RTK-GPS, and no manipulation of the positioning data is required. A *.time file is recorded and can be used if the RTK-GPS is run separately from the GPR unit; for example, in a multi-sensor set-up.

Wheels

The push-cart wheel is the default selection for the PinPointR system. Any other use of the system will require a new wheel calibration.

Data viewing and adjustment

The screen and system functionality differ depending on the project type. It is possible to use the marker and velocity analyzing functionality for One-Line projects as well as a Reference line and GPS projects. During data acquisition independent of project type, the screen view can be set to show either the high-frequency channel only, low-frequency channel only, or both high and low-frequency channels together, as shown below in **Figure 21**. Tap on the icon in the upper left corner of the screen to change to wanted view. Note that markers can only be set when one of the two channels are viewed on the screen. When both high and low frequencies are viewed the marker and velocity analyzing icons are not available on the toolbar at the bottom of the screen. Only screenshots and filter adjusting function will work in dual view.
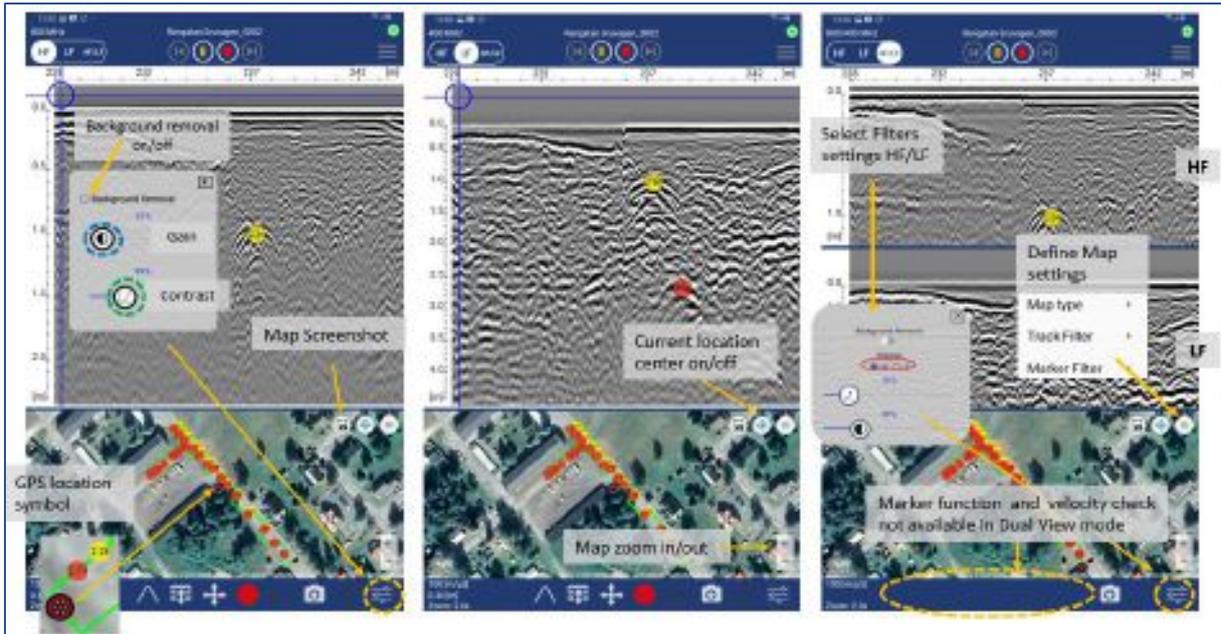
Figure 21 *Screen views during data acquisition*

The filter window will pop up when the filter-icon is pressed (circled in orange in **Figure 21**). The gain and contrast of the radargram can be adjusted in any mode, but when in dual-mode, you must select the channel to adjust. In **Figure 21** above, the contrast scrollbar is circled in green, while the scrollbar for gain is circled in blue. To change gain and contrast, hold your finger on the icon and move the scrollbar to the desired position. It is always better to keep the gain and contrast settings to the lowest value that will allow you to interpret the radargram. Higher gain and contrast levels can make the radargram more challenging to understand. The close button will shut the filter window, as will any screen press outside the filter window. It is also possible to move the position of the filter window on screen – simply press inside the window and drag it to the desired loctation.

ViewPoint remembers which channel you viewed last, as well as contrast and gain settings, and these become the default for any subsequent measurements, until the next time they are changed. If auto-zoom is active, the zoom will automatically adjust to fit the radargram every time a new measurement is started. However, anytime ViewPoint is closed and restarted, then these settings are reset to the standard defaults.

Adjustment of the time-zero position can be made when in single-channel view. Simply press and drag the vertical scale to the desired position. Once set, time-zero is saved and will be used for all subsequent profiles. Therefore, it makes sense to do this early on in any survey; it will also save time in managing any data exported for processing and interpretation in the CrossPoint visualization software.

Before starting data collection, or after stopping a line, you can access the settings and user preferences via the menu button located in the top-right corner of the header toolbar, as shown in **Figure 22**.
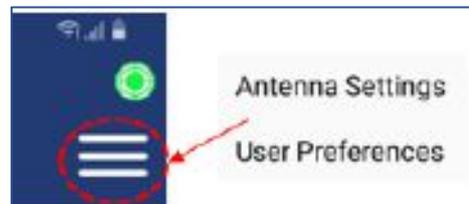
Figure 22 *Access the settings menu*

Radar data can be zoomed in or out from 1.0x to 5.0x, using standard Android screen gestures. To zoom in, pinch and expand two fingers; pinch and close two fingers to zoom back out. The current zoom level can be seen in the bottom-left corner of the footer

toolbar. If the radargram does not fit on the screen when data is zoomed in, scrolling may be done by dragging one finger up and down on the screen.

Other buttons provide functionality for controlling the collection of data, including Start, Pause/ Resume, and Stop. Press the Pause button to halt the data collection without fully stopping the profile. Press the same button again, to resume data collection.

Markers

Under user preferences, chose your preferred marker standard from the presets available, or define a custom code with your text and colour symbols. This selection must be made before the start of a project because once started, the selection is locked.

Marker assignment or editing can only be done when observing data in a single-channel view (LF or HF). The marker icon is located centrally in the footer toolbar. The marker icon is shown as a solid coloured dot, but can be toggled to quick mode in which case the icon changes to show a finger pressing a smaller dot. The colour of the icon matches the marker colour. Toggle between the two modes by pressing the icon, which will change accordingly (![icon]). Regardless of the selection, a marker palette offers colour choices according to the defined marker standard, as shown in **Figure 23**.

When the quick marker mode is active, every tap on the radar data will result in the assignment of a marker. Ordinarily, the arrow icon ![arrow] is used to fine-tune the position of a marker in respect of a target in the radargram. Touch the screen to move the crosshairs to the desired location, then use the

Figure 23 Marker functionality

arrow icon to fine-tune the final position. Tap the coloured ring in the centre of the arrow icon to assign the marker, which will simultaneously appear in the map view (if that option is active). Designated markers are semi-transparent so the radar data can be viewed below. Markers are referenced with numbers according to the radar profile and their sequence for a given marker type. Double-tap a marker in the radar data or map view to see a pop-up containing marker details.

Note: It's not possible to click a marker when "quick marker mode" is active. Markers can be deleted when the Marker info window is open by simply tapping the trash icon. When a marker is assigned, an automatic screenshot of the radar data with the marker assignment is saved for use in the PDF Field Summary report and KMZ file.

Generate PDF Summery and KMZ file

Independent of whether you are in file reading mode or a measurement mode when leaving the current project, you will be prompted to generate a PDF Field Summary report and a KMZ file, as shown in **Figure 24**. If either of these files already exist for the current project, the old data will be overwritten.

Figure 24 Generate PDF Summery and KMZ file

Restoring missed traces

During data acquisition and the transfer of radar data from the GPR unit to the Device, some of the radar traces may be missing. This effect is typically due to a weak or interrupted Wi-Fi signal. For example, in areas of high RF disturbance, or when the Device is moved away from the GPR unit.

However, since all radar data is saved to the GPR unit's internal memory (microSD card), any missing traces can be restored. When a profile is stopped, a checksum is performed to confirm the data in both the GPR unit and Device. If traces are missing, they are quickly restored, at which time you may note the momentary display of a message stating 'restoring missed traces', as shown in **Figure 25**.
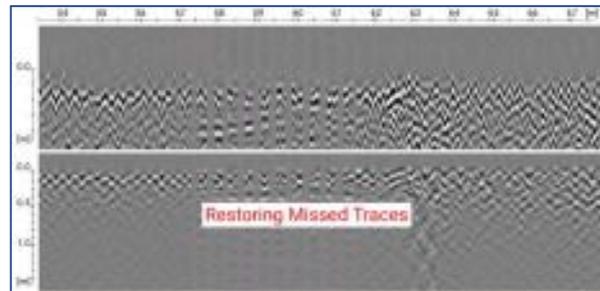
Figure 25 Data recovery when the acquisition is stopped

Note: If ViewPoint enters sleep-mode (minimized) during data acquisition, the ongoing survey will stop, and the data will be saved; however, any missed traces may not be restored. Furthermore, it is essential that the data acquisition unit and the system are near to each other during this process. Otherwise, the restoration process could take considerably longer.

Multi-line project

Three types of multi-line projects are available as follows:

- Reference Line (RL)
- Dual View (DV)
- GPS

From the project start screen, as shown in **Figure 26**, you will be prompted to enter a project name and the distance between each profile. Once registered, press the 'Start the Project' button to continue.

Figure 26 *Multi-line start screen*

Reference Line (RL)

The RL-project associates and orientates GPR profiles to a straight-line reference. This reference line can be any type of physical line visible within the survey area during and after data collection. Examples include boundaries, curb lines, fence lines, or merely a metering-tape laid on the ground. Regardless, one end of the line needs to be defined as the starting point and then equidistant points marked along its length. Profiles are gathered in straight lines, perpendicular to the reference line, and a reference-marker is placed within the GPR data every time the reference line is crossed, as illustrated below in **Figure 27** and **Figure 28**.
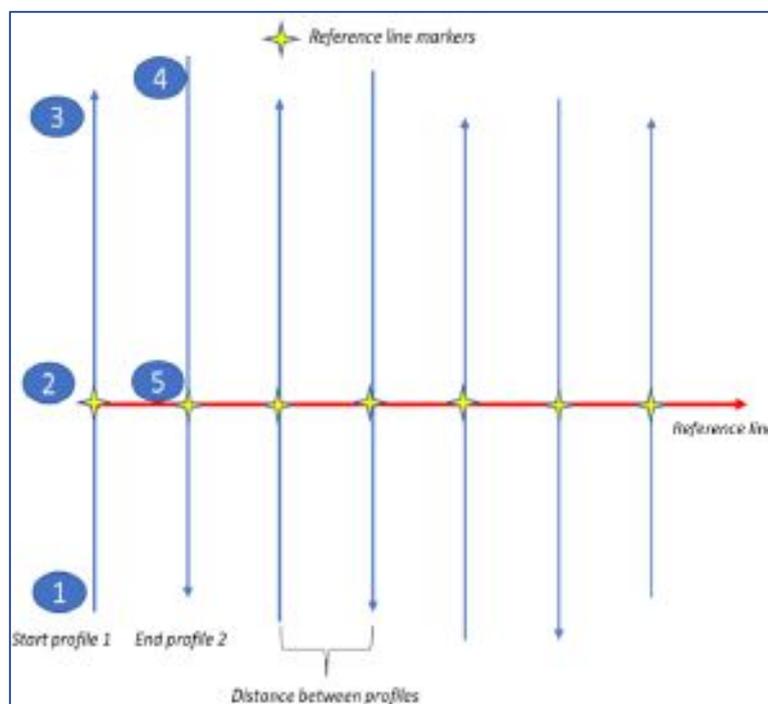

Figure 27 *Layout of a reference-line project*

Once the project has started, the data collection screen will appear with directional control buttons, as shown in **Figure 28** below

Note: during data collection, you can still view either the single-channel (low or high frequency) or dual-channel (low and high frequency) data, just as in the 'single-line project' mode.
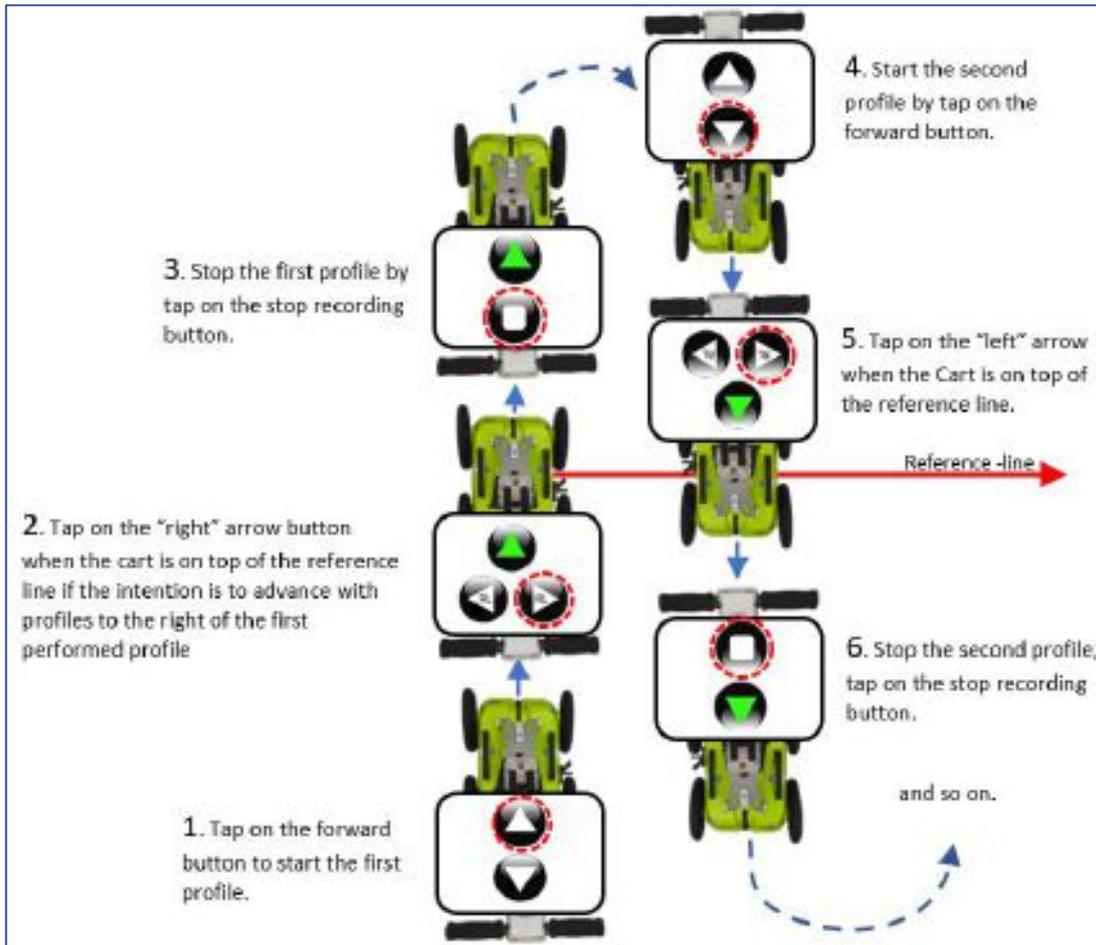
Figure 28 Controls during reference-line projects, forward survey, and profiles to the right of the first profile

Select the direction of the collection (forward/ backwards) and press the appropriate button to start the profile. Note the example in **Figure 28** illustrates a forward motion of the push-cart for all profiles in the Reference Line project and requires a 180° turn at the end of each profile.

Instead of turning the push-cart 180° at the end of each profile, you can also reverse the push-cart - just activate the recording using the reverse arrow on the screen. The selected button will be highlighted in green to indicate the chosen direction, and additional buttons (left/right) will become available. These buttons are used for the placement of the reference marker, by indicating the position of the start point to the direction of travel when crossing the reference-line.

Referring to, the first profile is collected by moving away from position **1.** Upon reaching the reference-line at point **2**, a reference marker is placed in the data by pressing the 'right' or "left" arrow button. If the decision is to move to the "right" with the upcoming profiles, from now on, all profiles in the project must be moved to the "right" of the first profile. Make sure that the push-cart is stopped on top of the Reference line, arrows on the Cart hood must match the Reference line. The profile continues to be collected until reaching point **3**, at which the stop button is pressed.

The system is then moved to the start point of the second profile (point 4). It's essential to maintain the distance in-between the profiles as decided during set-up. Press the forward button to start the measurement when the push-cart is in position for the second profile. Upon reaching point 5, a reference marker is again placed into the data. This time the left marker button is selected because the next profile will be to the left of the present one.

After the last profile has been stopped, just return to the main menu on the standard Android way.

If data is correctly gathered, all profiles will be correctly aligned and orientated with the reference-line and each other when opening the project in the CrossPoint software.

Dual View (DV)

This project type is intended to aid in on-site interpretation, rather than in post-processing. It is particularly useful for identifying features/objects that are relatively linear across a survey area, e.g., foundation walls, tree roots or utility lines.

When collecting and viewing a single GPR profile, it is difficult to judge whether a reflector is a genuine point of interest, or simply a reflection from debris or a random object. Consequently, it is useful to view one or more parallel profiles to assist in their interpretation. This is the basis for the DV-project, which allows the current profile being collected to be displayed alongside the previous one, thereby making it easier to see if reflectors line up in similar positions across them. For this to work, the start position of each profile must be aligned with the stop position of the previous profile, as shown below in **Figure 29**.

Stop position of profile 1 will constitute a reference line

Start points of profiles must align with previous stop points.
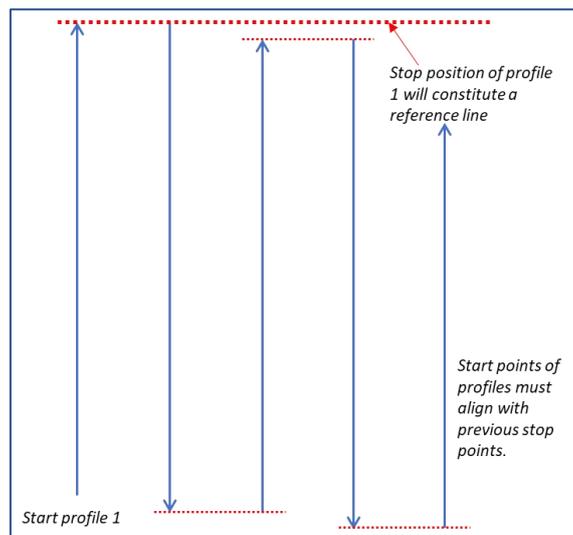
Start profile 1

Figure 29 *Layout of Dual View-project*

When the stop button is pressed at the end of a profile, the radargram is automatically reversed, so that the next profile start point is aligned correctly. As the new profile is collected, it's data can be compared with the previous line. Furthermore, the back-up cursor (red line) covers both profiles making it even easier to see how closely reflectors align, as shown in **Figure 30** below.

It is possible to import a DV-project into Crosspoint. However, there should be equidistant spacing between all profiles and profiles should be parallel as required for an RL-project. On import, the end of profile 1 constitutes an artificial reference line. If considered before a survey, a DV-project may be used for post-processing and interpretation just as an RL-project.
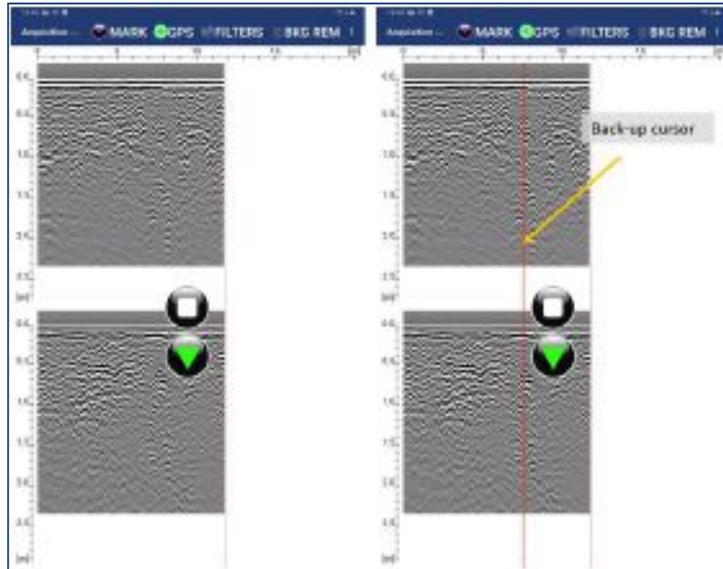
Figure 30 Dual-View project showing two parallel profiles with a back-up cursor

GPS-projects

As the name suggests, this project type requires GPS for positioning. For accurate mapping, to survey or map grade, RTK-GPS is required. That said, it is possible to run a GPS-project using the PinPointR's internal GPS, but this will lack the precision necessary for accurate interpretation. GPS projects using the internal GPS can be used for a field sketch with the Google Mapping capability and accuracy will vary depending upon the location and time of day of the survey.

When using GPS, everything is arranged according to the accuracy of the GPS, so no special survey procedures are required. Start and stop profiles as needed or take a single long profile while zig-zagging across the survey area. However, the former makes for much easier data interpretation when using post-processing software like ImpulseRadar CrossPoint, since several profiles can be viewed simultaneously. Regardless, CrossPoint will correctly load maps and data.

Viewing files

ViewPoint is not intended for data analysis; however, saved files may be viewed to assist in making decisions on-site, including QA/QC of collected data. There is no special view for project-based data, but individual profiles are accessible. When viewing saved files, you may zoom and adjust gain/contrast just as you would during data collection. However, an additional function is provided to scroll along with profiles, which is controlled using one finger-swipe horizontally.

Within a project that includes several profiles, you can use the left and right buttons in the header toolbar to scroll in-between the profiles. Alternatively, if profiles have been collected with GPS, simply tap on the desired profile within the Map View. The marker editor allows previously saved markers to be deleted, or new ones added post data acquisition. To ensure any changes are saved within a previously collected profile, ensure the PDF/ KMZ options are activated when exiting the project.

Note on survey speed and settings

The PinPointR system can produce very large amounts of data. The bottleneck in survey speed is mostly related to the Wi-Fi Ethernet-link.

At high survey speeds and short point intervals, the system will rarely be able to go beyond 16-bits; therefore, the load on the Wi-Fi data link may be reduced by choosing to collect 16-bit data, instead of 32-bit data.

Choosing an unnecessarily long time-window (number of samples) also increases the demand for data transfer, so selecting a suitable time-window for each project is highly recommended.

Finally, the PinPointR, like all GPR systems, will lose lateral-resolution at depth. This decreases the demand on the point interval, so no need to collect data any denser than necessary, concerning the targets you want to resolve. Thus, increasing the point interval also takes the load off the Wi-Fi data-link. By default, the minimum point interval is set to 1 cm.

ImpulseRadar products are under continuous development, and we reserve the right to change specifications at any time and without prior notice. You may verify product specifications at any time by contacting our headquarters at; support@impulseradar.se

PinPointR

GPR UNIT	
Technology	ImpulseRadar real-time sampling
Antenna type	PinPointR dual-channel
Centre frequency	CH-1: 400 MHz / CH-2: 800 MHz
Signal to noise ratio (SNR)	>100 dB
Significant/useful number of bits	>16 bit
Scans/second	>800
Survey speed	> 130 km/h @ 5 cm point interval
Time window	400 ns
Bandwidth	>120%, fractional, -10 dB
Acquisition mode	Wheel, time or manual
Positioning	Wheel encoder, internal DGPS, external GPS (NMEA 0183 protocol)
Power supply	12 V Li-Ion rechargeable battery, or ext. 12 V DC source
Power consumption	1.26 A
Operating time	7 hours
Dimensions	444 x 355 x 194 mm
Weight	6.35 kg (including battery)
Operating temperature	-20° to +50°C
Environmental	IP65
Regulatory certification	CE, FCC, and IC Approved
CART	
Dimensions (folded for transport)	870 x 540 x 370 mm
Dimensions (when in use)	1010 x 540 x 1030 mm
Wheels	4 x Ø315 mm
Weight	12.8 kg (Push-cart only)[1], 20 kg (Push-cart, GPR unit & Device)[2]
USER INTERFACE	
Display	720 x 1280 pixel or better
Operating system	Android™ >ver. 6.0 (Marshmallow) or later
Memory	2.7 GB SDRAM or better
Processor	Intel Atom x5-Z8550, Quad-core 2.3 GHz Krait 400 or better
Recommendation	*Samsung Galaxy Tab Active Pro, or equivalent*

[1] *Push-cart, skid plate and Tablet holder*

[2] *Push-cart, skid plate, GPR unit, Tablet holder and Android Device*

Files stored in the project directory

<project name>   - current project name (project data directory has the same name)

<project name>_Combined   - combined files are saved in the subdirectory

File Type	Description	Naming Convention	Explanation
*.IPRB	Profile Data File	<project name>_XXX_AYY.iprb	Where YY is profile (channel) running number (counting from 1) and XXX is a profile running number (counting from 1) [1]
*.COR	Positions from GPS	<project name>_XXX.cor	where XXX is a profile running number. [1]
*.mlproj	Multi Line Project Data File	<project name>_XXX.mlproj	Where YY is profile (channel) running number (counting from 1) and XXX is a profile running number (counting from 1) [1]

Table 1 *ImpulseRadar file types and descriptions*

[1] *file names are padded with zeros to replace 'X', e.g., <project name>_001_AYY.iprb*

Files/information stored in the system

Profile Header File (text file)

Example of the Header File	Explanations
HEADER VERSION: 20	Version number
DATA VERSION: 16	16b data format
DATE: 2017-06-12	Measurement date
START TIME: 14:48:13	Measurement start time
STOP TIME: 14:48:38	Measurement stop time
ANTENNA: 800 MHz	Antenna frequency
ANTENNA SEPARATION: 0.090	Antenna separation in meters
SAMPLES: 500	Number of samples in a trace
SIGNAL POSITION: 6	Signal position
CLIPPED SAMPLES: 0	Clipped samples (not in use now)
RUNS: 64	Number of runs
MAX STACKS: 512	Maximum number of stacks
AUTOSTACKS: 1	Autostacks (1 = ON)
FREQUENCY: 10240	Sampling Frequency
TIMEWINDOW: 48.828	Time Window in nS
LAST TRACE: 1741	Number of traces in the Profile
TRIG SOURCE: wheel	Trig Source – time or wheel
TIME INTERVAL: 0.010	Trig Interval if the trig source is time (sec)
DISTANCE INTERVAL: 0.009778	Trig interval if the trig source is wheel (m)
USER DISTANCE INTERVAL: 0.010000	Distance interval for interface
STOP POSITION: 17.024	Stop Position in meters
WHEEL NAME: cart	Wheel name (max 20 chars)

WHEEL CALIBRATION: 306.799877930	Wheel calibration (ticks per meter)
ZERO LEVEL: 58	Zero Level
SOIL VELOCITY: 100	Soil Velocity (m/uS)
PREPROCESSING: Unknown Preprocessing	Pre-processing information
OPERATOR COMMENT: Android SDK: 28 (9) Device: **Sony H8324**	Android Version and Device Name
ANTENNA F/W: 49000072	Receiver Firmware Version
ANTENNA H/W: F1702	Not in use now
ANTENNA FPGA: D085	Receiver FPGA Version
ANTENNA SERIAL: CO_117755	Receiver serial number
SOFTWARE VERSION: CO 1.163	Software version
POSITIONING: 0	Positioning: (0-NO; 1-TS; 2-GPS)
CHANNELS: 2	Number of channels used
CHANNEL CONFIGURATION: 1	This channel configuration
CH_X_OFFSET: 0.000	Channel Position relative to ext. positioning
CH_Y_OFFSET: 0.000	Channel Position relative to ext. positioning
MEASUREMENT DIRECTION: -1	Forward or backward
RELATIVE DIRECTION: 90	Direction to RL start (clockwise 360°)
RELATIVE DISTANCE: 1.000	Distance from RL start to cross-section
RELATIVE START: 0.000	Distance from profile start to cross-section

Table 2 *Profile header file information*

Profile Data File

This is a binary file. PinPointR can create data files with a 16-bit or 32-bit data format (see the field "DATA VERSION" in the header file). Samples are stored as signed 16-bit or 32-bit integers. The traces are stored sequentially.

Positions from GPS

This is a text file. The file format is simply a parsed version of the NMEA string written with tab separators as follows:

Trace number <tab> date <tab> time <tab> latitude <tab> "N" <tab> longitude <tab> "E" <tab> height above MSL <tab> "M" <tab> Fix quality (4 – RTK)*

Trace number is counted from 1 (not from 0). Trace number is connected to positions exactly using time from internal GPS.

Example:

1	2017-03-15	10:12:19:601	65.18991723150 N	18.72870853800 E	317.289 M	4
2	2017-03-15	10:12:19:796	65.18991695317 N	18.72870772433 E	317.527 M	4
5	2017-03-15	10:12:20:000	65.18991630983 N	18.72870888283 E	317.528 M	4
8	2017-03-15	10:12:20:203	65.18991530700 N	18.72871088067 E	317.525 M	4
12	2017-03-15	10:12:20:398	65.18991406333 N	18.72871390350 E	317.562 M	4
17	2017-03-15	10:12:20:601	65.18991227283 N	18.72871711767 E	317.588 M	4
23	2017-03-15	10:12:20:796	65.18991046267 N	18.72872101300 E	317.557 M	4
33	2017-03-15	10:12:21:000	65.18990848683 N	18.72872542550 E	317.557 M	4

* Fix quality field:
```
0 = invalid
1 = GPS fix (SPS)
2 = DGPS fix
```

```
3 = PPS fix
4 = Real Time Kinematic
5 = Float RTK
6 = estimated (dead reckoning) (2.3 feature)
7 = Manual input mode
8 = Simulation mode
```

Multi-Line Project Header (.mlproj), text file

Dual-view proj type 1

ML_PROJECT_TYPE: REF_LINE
<profiles>
2ch dual nr2_001_0
2ch dual nr2_001_1
2ch dual nr2_002_0
2ch dual nr2_002_1
2ch dual nr2_003_0
2ch dual nr2_003_1
</profiles>
TYPE: 1
SEPARATION: 0.25

Ref line proj type 2

ML_PROJECT_TYPE: REF_LINE
<profiles>
2ch refline nr2_001_0
2ch refline nr2_001_1
2ch refline nr2_002_0
2ch refline nr2_002_1
</profiles>
TYPE: 2
SEPARATION: 0.25

ML proj GPS 3

ML_PROJECT_TYPE: GPS
<profiles>
1.201 extern gps ml outside_001_0
1.201 extern gps ml outside_001_1
1.201 extern gps ml outside_002_0
1.201 extern gps ml outside_002_1
1.201 extern gps ml outside_003_0
1.201 extern gps ml outside_003_1
</profiles>
TYPE: 3
SEPARATION: 0.25

How RTK Works

RTK involves a stationary base station and one or more mobile GPS receivers, also known as rovers. Provided that the base station has continuous line-of-sight to each rover, it transmits GPS corrections to each in real-time using radio waves. If a sufficient number of satellites are visible, RTK can provide a fixed position within a fraction of an inch. If insufficient satellites are visible, RTK can provide only a float solution, with a precision of a few inches.

Fixed RTK

RTK uses a complicated mathematical formula or algorithm to calculate the exact number of radio wavelengths between the satellites and the base station system -- a process known as ambiguity resolution -- and yield either a fixed or float solution. In a fixed solution, the number of wavelengths is a whole number or integer, and the algorithm is constrained to yield a whole number. A low number of visible satellites, poor satellite constellation geometry, and a week radio link between the base station and the rover may prevent a fixed solution.

Float RTK

In a float solution, the algorithm does not yield an acceptable fixed solution, so the ambiguity is allowed to be a decimal or floating-point number. According to Tripod Data Systems, a float solution typically generates precise coordinates to between 4 and 18 inches over a known distance between two points of just over half a mile. If a float solution is the only solution available, it may be possible to reinitialize an RTK system, or wait, for a more precise fixed solution. However, if poor satellite visibility is to blame, a fixed solution may be unavailable.

Considerations

The precision of RTK data collection depends on the distance between the base station and the rovers, so it's desirable to keep the distance between them to less than 6 miles. RTK systems are available in single and dual-frequency versions; dual-frequency versions are typically faster, more precise and operate over longer distances than single frequency versions, but they are correspondingly more expensive.
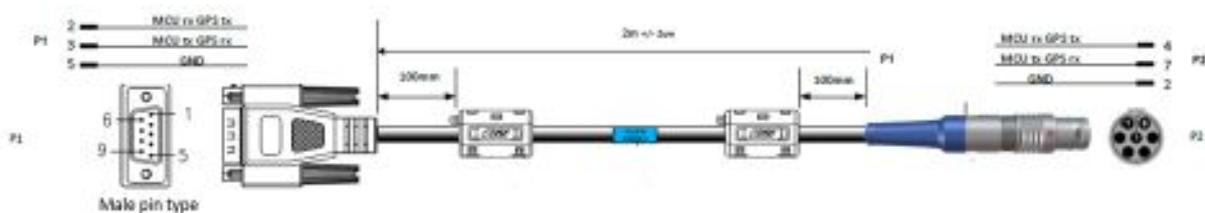

Figure 31 *External GPS diagram and wiring arrangements*

The operation of GPR instruments is governed by various regulatory bodies and legislation depending on geographic location as follows:

- Europe   ETSI EN 302 066-1&2 Vl.2.1
- US   FCC, Part 15.F
- Canada   IC RSS-220 limits

The CrossOver-systems meets the legislation requirements for each of these regulatory bodies.

A common requirement of these regulations is that GPR equipment should only be used by professionals and those who adhere to the following rules of operation:

- UWB-transmitters should always be used near the ground or the material under investigation
- When not in use, the data collection should be stopped, and the unit/s switched off
- The transmitters should not be directed upwards, only towards the investigation body

Additional notes for users in Canada and the US

The operation of this Device is restricted to law enforcement, fire and rescue officials, scientific research institutes, commercial mining companies, and construction companies. Operation by any other party is a violation of 47U.S.C.301 and the operator may be subject to legal penalties.

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 of the Device.

The operation of this Device shall only occur when in contact with or within 1 m of the ground.

RSS 220:

Ce dispositif radar à pénétration du sol ne doit être utilisé qu'en contact avec le sol ou à au plus 1 m du sol.

Ce dispositif radar à pénétration du sol ne doit être utilisé que par des organismes d'application de la loi, des établissements de recherche scientifique, des sociétés minières commerciales, des entreprises de construction, et des organismes d'intervention d'urgence ou de lutte contre les incendies.

RSS GEN :

This Device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

(1) This Device may not cause interference.

(2) This Device must accept any interference, including interference that may cause undesired operation of the Device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage;

2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

GPR Use Coordination (USA)

FCC regulation requires users of GPR equipment to coordinate the use of their GPR equipment as described below:

§15.525 Coordination requirements.

(a) UWB imaging systems require coordination through the FCC before the equipment may be used. The operator shall comply with any constraints on equipment usage resulting from this coordination.

(b) The users of UWB imaging devices shall supply operational areas to the FCC Office of Engineering and Technology, which shall coordinate this information with the Federal Government through the National Telecommunications and Information Administration. The information provided by the UWB operator shall include the name, address and other pertinent contact information of the user, the desired geographical area(s) of operation, and the FCC ID number and other nomenclature of the UWB device. If the imaging device is intended to be used for mobile applications, the geographical area(s) of operation may be the state(s) or county(ies) in which the equipment will be operated. The operator of an imaging system used for fixed operation shall supply a specific geographical location or the address at which the equipment will be operated. This material shall be submitted to Frequency Coordination Branch, OET, Federal Communications Commission, 445 12th Street, SW, Washington, D.C. 20554, Attn: UWB Coordination.

(c) The manufacturers, or their authorized sales agents, must inform purchasers and users of their systems of the requirement to undertake detailed coordination of operational areas with the FCC prior to the equipment being operated.

For your convenience, the information required by the FCC is indicated on the next page, please print and fill in the information and put the letter in the mail. FCC will respond with confirmation of coordination.

Date: _____

To:
Frequency Coordination Branch., OET
Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554
ATTN: UWB Coordination
Fax: 202-418-1944

RE: FCC GROUND PENETRATING RADAR COORDINATION NOTICE

COMPANY NAME:

_____
_____
_____

PRIMARY ADDRESS:

_____
_____
_____
_____

CONTACT INFORMATION [CONTACT NAME AND PHONE NUMBER]:

_____
_____
_____

AREA OF OPERATION [COUNTIES, STATES OR LARGER AREAS]:

_____
_____
_____
_____

FCC ID (tic the box)

CrossOver 4080: 2ALZQ-CO4080 ☐