



PinPointR

PinpointR User manual

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About this manual

ImpulseRadar PinpointR system uses an antenna that is a 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 antennas and accessories
- Section 2 – Software data acquisition and control
- Section 3 – Appendices additional notes and technical information

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

Hardware

Overview

The PinpointR system and its dual-channel antenna's electronic design is based on a modern real-time sampling (RTS) technology platform, offering state-of-the-art data acquisition capabilities. The PinpointR antenna incorporates two separate GPR-channels, operating at high speed as well as an in-built GPS.

<u>Antenna</u>	<u>Abbreviation</u>	<u>Centre Frequency</u>
• PinpointR	PPR4080	400 MHz and 800 MHz

The PinpointR system includes a push-cart and the PinPointR antenna with a range of accessories shown in **Figure 1** below.



Figure 1 System overview

Data collection is managed over an Ethernet WiFi link and a suitable Android device/PC running the Impulseradar App (IPR-App). With the IPR-App, 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, data-sets may be directly imported into the CrossPoint Windows software for processing and evaluation.

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

Antenna

The PinpointR antenna has a field-rugged design equipped with both a low and high frequency channel, making it possible to detect shallow and deep utilities. Power supply via a removeable and

rechargeable li-ion battery easy to exchange on the top of the antenna. The connectors and On/off button, as shown below in **Figure 2**.

The PinpointR antenna also includes and a high-quality differential GPS receiver (Ublox/Tallysman). There is no external connection to these components, although markings on the housing showing their approximate internal location.



Figure 2 PinpointR antenna with battery attached

Connector panel

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

- **Silver** – On/Off button. Press the button once for approx. 2s to switch the antenna on. When on, the button glows blue. A subsequent press will switch the antenna off.
- **Blue** – External GPS. Allows the connection of an external GPS antenna to provide higher precision positioning. Communication is based on RS232 and the NMEA 0183, V2, protocol.
- **Black** – Measuring wheel. Note, this connector is placed further back on the lower frequencies.

All cable-connectors are high-quality Yamaishi-type. Cable-connectors are inserted/removed by holding the connector sleeve then gently pushing or pulling straight without turning. The connectors are keyed so that it's not possible to damage the unit by attaching a cable to the wrong connector.

Battery

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

Note: *ImpulseRadar Li-ion batteries are approved according to UN38.3 and can, therefore, be safely carried/shipped by air.*

The battery fits securely to the top of the antenna. 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, Refer to the images in **Figure 3** below.

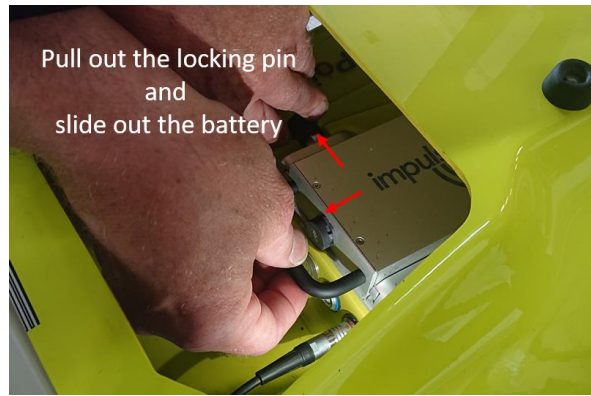


Figure 3 Mounting the battery

Cart

The PinPointR Cart has a foldable handle assembly, as shown below in **Figure 4**. The push-cart allows the antenna to be maneuvered easily over a range of surfaces.



Figure 4 PinpointR Cart (foldable)

The Cart incorporates a brake on the rear-right wheel, easily engaged by your foot.

When not in use, the handle mechanism can be folded by removing the M5 retaining screw, as shown in **Figure 4** above. This reduces the overall physical size to facilitate transportation and/or storage.

The antenna is mounted into a tray that is connected to the cart-hood by adjustable support straps. This allows the antenna to be positioned on, or very close, to the ground surface. This arrangement, as shown in **Figure 5** below, allows the antenna to ‘float’ freely vertically and follow the contour of the ground, or move over bumps and other small obstacles.



Figure 5 Antenna fitting and height adjustments

Antenna fitting procedure, as referenced in **Figure 5** above:

1. Remove the two rear straps from the snap connectors
2. Lift the cart-hood and slide the antenna into the support tray
3. Connect the antenna to the tray with M5 Screws on both sides
4. Close the cart-hood and refit the rear straps into the snap connectors
5. Connect the odometer cable (black connector)
6. Adjust the front and rear straps to obtain the desired height
7. When needed, the battery may be fitted/removed through the opening in the cart-hood

Note: when removing the antenna, remember to disconnect the odometer cable prior to lifting the cart-hood.

Odometer encoder

To measure distance, the push-cart incorporates an odometer encoder that links to the antenna via the odometer cable and connector. The encoder itself is connected to the right-rear wheel by means of a rubber O-ring. If needed, this O-ring can easily be removed and replaced by first removing the wheel by unscrewing the M6 retaining screw (as shown in **Figure 6** below).

Note: when refitting the wheel, use blue Loctite or equivalent to help secure the M6 retaining screw.



Figure 6 Odometer encoder and wheel assembly

GPS mounts

An optional GPS mounting accessory is available for the push-cart, as shown below in **Figure 7**.



Figure 7 GPS-mounts on the Cart

Software

Overview

The PinpointR is set-up and controlled wirelessly via the IPR App once installed on a suitable Android device. Refer to **Appendix A** for a list of specification requirements. Note that an adapter may be needed.

Android devices that meet or exceed 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 offer a quick and simple means of collecting radar profiles.

Since Android devices are not as standardized as PC's, there may be slight variations in the way software is installed and operated between different devices. The following section will detail various screenshots and menus as taken from a recommended device. However, this may be slightly different from your personal device.

IPR App 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 the IPR App is not yet 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 the IPR App.

The IPR App software is supplied on a USB thumb drive and can either be installed directly from this device or by copying it to the internal memory of your Android device. Whichever method you chose, the installation process is as follows:

1. Locate the file <IPR-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 the PinpointR App to access photos, media, and files on your device, so that radargrams can be saved and opened. Also, allow permission for the PinpointR App to access your device location. This permission allows the app to manage Wi-fi and Bluetooth communication, which is necessary for the app to be able to connect properly to the PinpointR antenna. The App will keep asking for the permissions until all the permissions asked for are granted. If you deny the permission and the same time checks "never ask again", you will be directed to the Android Settings App and then the App will exit because the app will not work properly without the permissions.

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

Using the IPR App

From the home screen of your Android device, press the IPR App icon to enter the application's start screen. The start screen, as shown below in **Figure 8**, provides access to the various functions of the IPR App.

From **Figure 8**, the left image shows an example of when the antenna is properly connected, with all functions available. This includes the antenna battery status, which can be monitored from within the App as shown. The right image shows the limited functionality when there is no antenna connection.

Note: the version number of the App is shown below the Impulseradar logo of the start screen and this may be requested in the event you need support services.

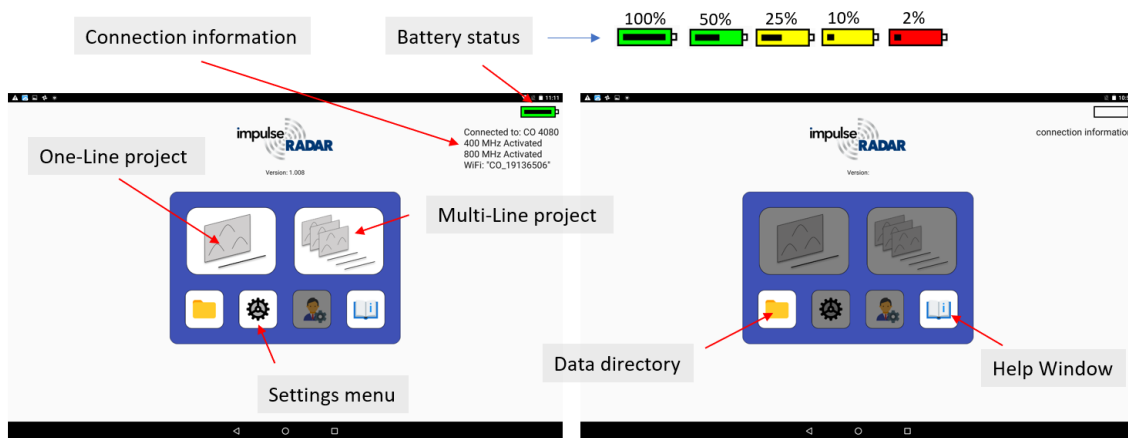


Figure 8 PinpointR start screen. Right: not connected device.

Switching between different antennas

The IPR App will detect if you are connecting to an antenna that not is the same as the previous Antenna that you were connected to, and then prompt you and restart the app.

Settings

The settings menu, as shown in Error! Reference source not found., below, contains the parameters needed for controlling the PinpointR system during data acquisition. Once set, these parameters remain unchanged for all subsequent data acquisition.

A detailed description of each parameter follows:

- **Trig Source** – defines how data collection is controlled. Typically, this will be the Cart wheel selected from the wheel option menu, Time or Manual triggering can also be used. In Manual mode, the user must tap the trig button on the screen for every A-scan¹.
- **Measurement Units** – defines whether metric or Imperial values are used. When set to Imperial, the units will be in feet (ft.) and 10ths of ft.
- **Distance Interval** – defines the distance between every A-scan¹, when Trig Source is set to Wheel, or Manual (sometimes also called point distance).
- **Time Interval** – defines the Time between every A-scan¹ 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 is calculated based on the Soil Velocity.
- **Data Mode** – defines how many bits are used while storing the resulting radar data. PinpointR antennas, below 600 MHz, can provide more than 16-bits, so 32b can be selected. The precise number of useful bits depends on the point distance, survey speed, and antenna frequency. A lower antenna frequency combined with slower speed and larger point distance provides a higher number of useful bits. The limit today is approx. 19-20 useful bits. Note that using 32 bits during surveys requiring high speed only increase 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 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 antenna for distance measurement. Standard wheel options include Cart and Single, but you may create additional wheels and/or adjust wheel calibration settings as described in the ‘wheels’ section below.
- **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 initial state.
- **Firmware upgrade** - Menu trough which upgrade of firmware may be done, see later paragraph.

¹ An A-scan is an envelope, or trace, formed by connecting all the samples collected at one specific point along the survey line.

In **Figure 9** below the general functions on the start screen and data collection screen is shown.

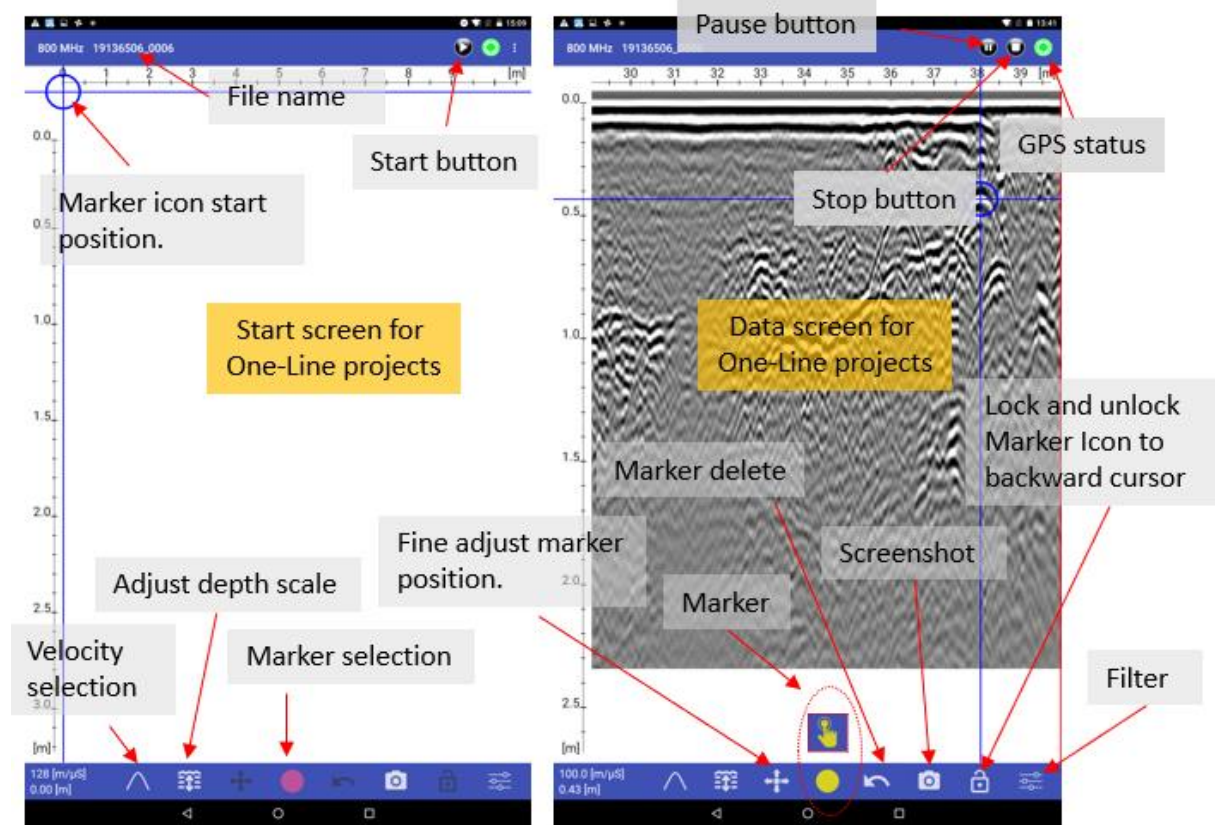


Figure 9, Menu bar during data collection

GPS-symbols and function

By pressing the GPS-symbol a, static view on the present satellites and coordinates can be viewed, see **Figure 10**, below.

The GPS symbol will change with the solutions at hand, symbols we use to show this are given in **Figure 10**.

Note that, for the GPS-coordinates to be saved on file, the GPS-symbol need to be shown, prior to starting the data collection.

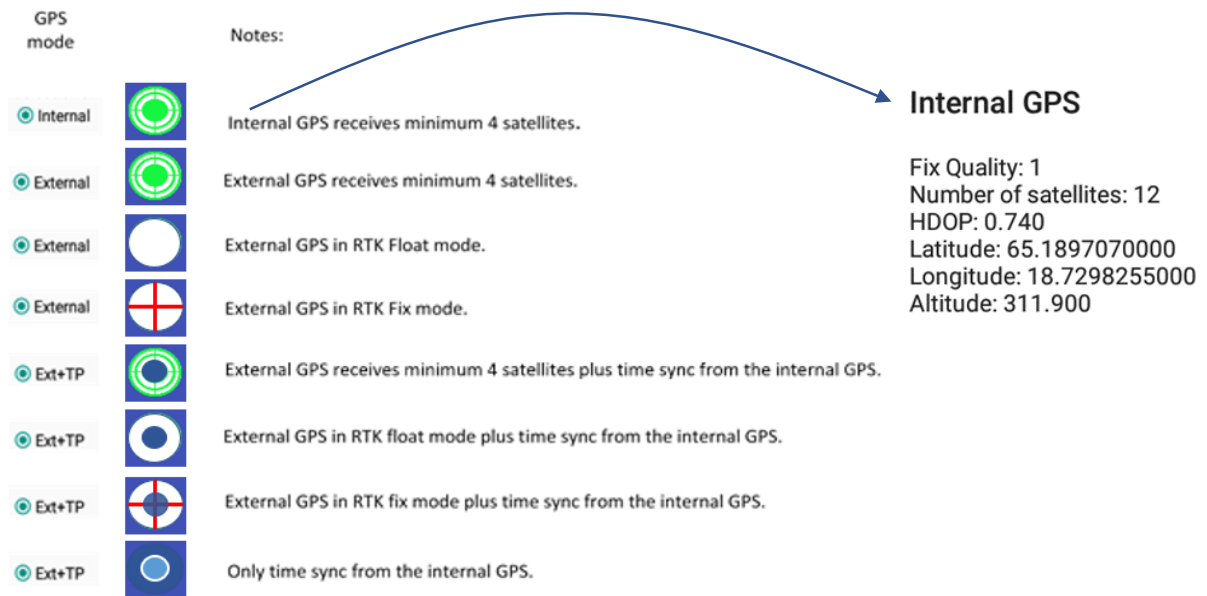


Figure 10, GPS-symbols and their meaning and GPS information showed when the symbol is pressed

Note that when an RTK-GPS is used, hooked up to the system, the positing file generated is adjusted for the time lag in the RTK, so no further data manipulation is needed. The timing-file is provided for the rare occasion when the RTK is run separated from the system, for example; in a multi-sensor setup.

Wheels

The 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 project type. It is only possible to use the marker and velocity analysing functionality for One-Line 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 in **Figure 11** below. A 'double-tap' of the device screen will toggle between these views. For One-Line projects 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 analysing icons are not available on the lower most part of the screen.

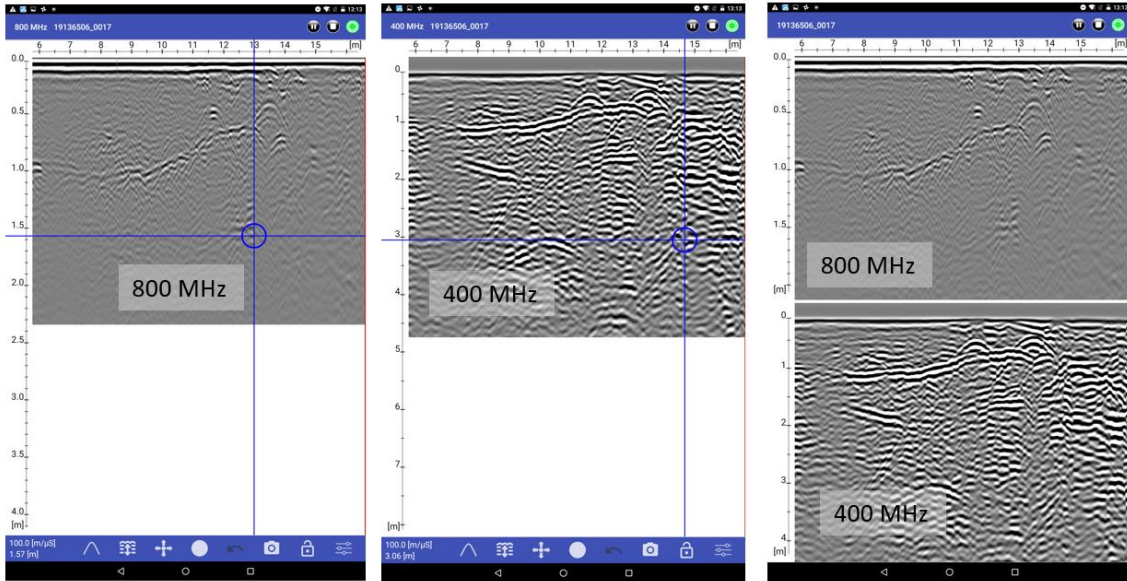


Figure 11 Screen views during data acquisition,

In the single-channel view, the gain and contrast of the radargram image can be adjusted from the scrollbars in the filter-window. The filter window will pop up when the filter-icon is pressed (marked with red in **Figure 14**). The filter window will close if you press the close button or somewhere outside the filter-window. The contrast scrollbar for contrast is marked in green, and the scrollbar for gain is marked in blue in **Figure 14**.

The app remembers which channel you last viewed (HF, LF or both), and which contrast and gain settings you last used. And next time a new project or survey is started it will apply those settings. If you restart the app those specific settings will be reset.

Note: the images shown in **Figure 11** are screenshots from a Panasonic Toughpad FZ-A2 device. Icon sizes will change depending on the size of the Android device.

Whilst also in the single-channel view, the time-zero position can be adjusted, by dragging the scale up and down. Once set, the time-zero position is saved and will be used for subsequent profiles. Therefore, it makes sense to do this early on in a survey; this will also save time in managing data imported into the CrossPoint interpretation and visualization software.

Before starting data collection, or after stopping a line, you have access to the settings through the menu button, which is in the upper right-hand corner of the screen, as shown in **Figure 11** below.



Figure 15 Access setting menu

Zooming is done, as on other Android-devices, with two-finger gestures, increasing or decreasing the distance between the fingers.

If the radargram does not fit on the screen, scrolling may be done with a 3-finger gesture, dragging the fingers up and down on the screen, will scroll the radargram.

Other buttons provide functionality for controlling the collection of data, including Start, Halt/Resume and Stop. Pressing the Halt button temporarily pauses the data collection, whilst pressing the same button again, allows data collection to be resumed.

Restoring missed traces

During data acquisition and the transfer of radar data from the antenna to the Android device, some of the radar traces may be missed. This is typically due to a weak or interrupted Ethernet link. For example, when working in areas with high levels of RF disturbance, or when the data acquisition device is moved too far from the antenna.

However, since all radar data is saved to the antenna's internal microSD card, any missed traces can easily be restored at the end of each profile when the stop button is pressed. Should this occur, a message will be displayed on-screen, as shown in **Figure 16** below.

Note: If you put the App in sleep-mode (minimize the App) during data acquisition (e.g. if you answer a phone call), the ongoing survey will stop and the data will be saved, but the missed traces may not be restored!

Note: it is essential that the data acquisition unit and the antenna are near to each other during this process. Otherwise, the restoration process could take considerably longer.

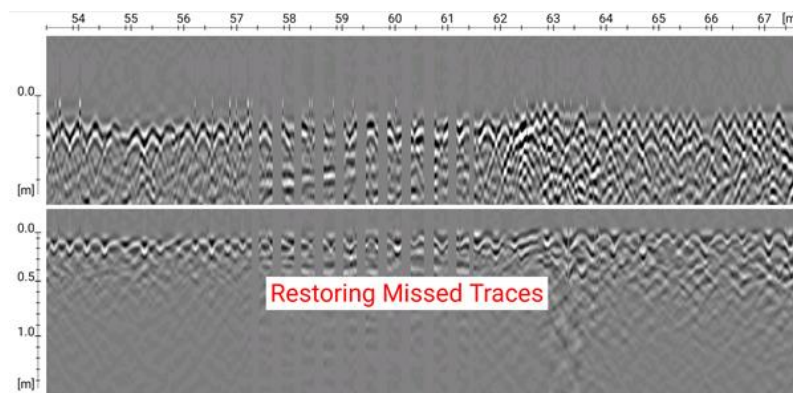


Figure 16 Data recovery when the acquisition is stopped

Projects

From the start screen, you may select either a 'One-Line Project' or 'Multi-Line Project'. As the names imply, this gives the option of collecting projects with either single or multi-line profiles. Regardless of project type, a *.cor file (GPS coordinates) will be saved alongside the GPR data if the internal GPS can lock onto suitable satellites.

One-line project

One-line projects include marker set function and velocity analyzing by the hyperbola fitting method. The function buttons are placed under the radar data screen when data is showed with either the low or high frequency, see **Figure 14**. Within the software the operator can change in-between the AS5488 and APWA standard for markers but also create customized marker types with text and colour symbols. Note that the selection of marker standard or custom must be done before a single project is started. Once a One-Line project is started the markers are locked to the previous used one.


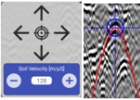




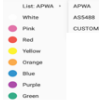







<p>1 Velocity adjustments: Tap on the screen where you want to place the theoretical hyperbola.</p>		<p>2 Tap on the hyperbola icon to activate. Fine adjust the position with the arrow keys and match the red theoretical hyperbola with the minus or plus symbol. Tap the centre hair cross to execute the new velocity setting.</p>		<p>3 The new soil velocity value will be adjusted and viewed in the left lower corner on the screen. Tips! Tap on the camera  symbol and a *.png file will be created in the radar data directory.</p>
<p>1 Adjust depth scale: Tap on the screen where you have your anomaly symbol to adjust the velocity value to match the depth to a known target.</p>		<p>2 Fine adjust the position with the arrow keys. Adjust the depth with the minus or plus symbols. Tap to set correct depth on the hair cross.</p>		<p>3 The new depth together with the soil velocity value will be adjusted and viewed in the left lower corner on the screen.</p>
<p>1 Select standards and type of markers: Tap and hold for 1-2 sec on the present symbol.</p>		<p>2. Select available industry standards or custom markers. Tap on the wanted colour to change marker.</p>		
<p>1 Marker set: Tap on the screen as close you can to your target.</p>		<p>2 Activate the arrow icon, use the arrows to adjust the position for selected marker type.</p>		<p>3 Tap on the marker symbol (yellow dot) and a numbered marker gets created with the selected colour.</p>
<p>1 Quick Marker set: Tap the marker symbol and select the finger/mark icon.</p>		<p>2 Tap on top of a reflector and a numbered marker will be generated. Note! As long quick marker is activated it is not possible to toggle in-between the channels without producing unwanted markers.</p>		<p>3 The last produced marker can be deleted, just tap on the arrow icon.</p>
<p>1 Lock and unlock marker icon to backward cursor: Tap the icon to change in-between.</p>		<p>2 In marker lock position a marker can be set by using the arrow icon, move the Marker icon up and down with the arrow keys. Set the marker by tap in the centre.</p>		
<p>1 Gain and contrast setting: Tap the icon and use the bars for adjusting.</p>		<p>2</p> 		

Figure 16 description of the marker and velocity analyzing functions

Multi-line project

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

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

Reference Line (RL)

The RL project associates and orientates GPR profiles to a straight-line reference. This can be any type of physical line that can be referred to during and after data collection. Examples include boundary,

curb or fence lines, or simply 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 then 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 in Figure 12, below.

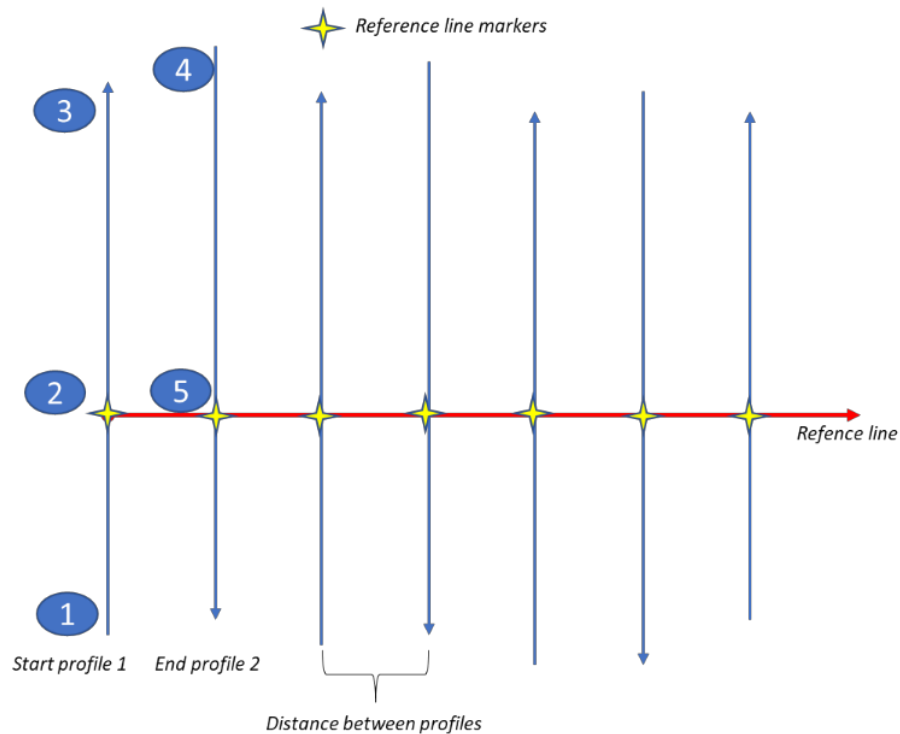


Figure 12, Layout of a reference-line project

From the project start screen (**Figure 13** below), you will be prompted to enter a project name and the distance between each profile. Once entered, press the ‘Start the Project’ button to continue.

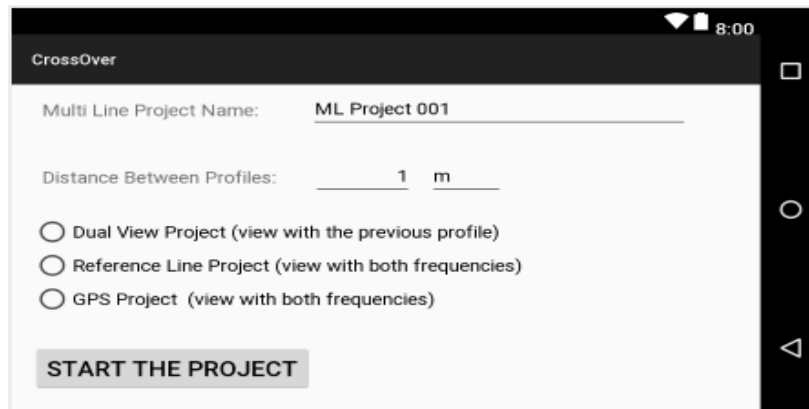


Figure 13 Multi-Line Project start screen

Once the project has started, the data collection screen will appear with directional control buttons, as shown in **Figure 14** 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 'one line project' mode.

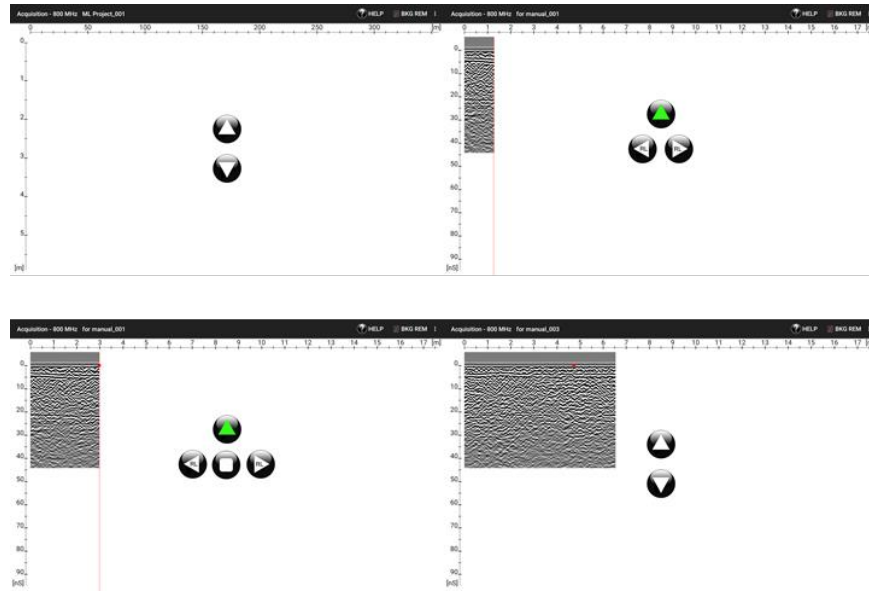


Figure 14 Screen views and controls during reference-line projects

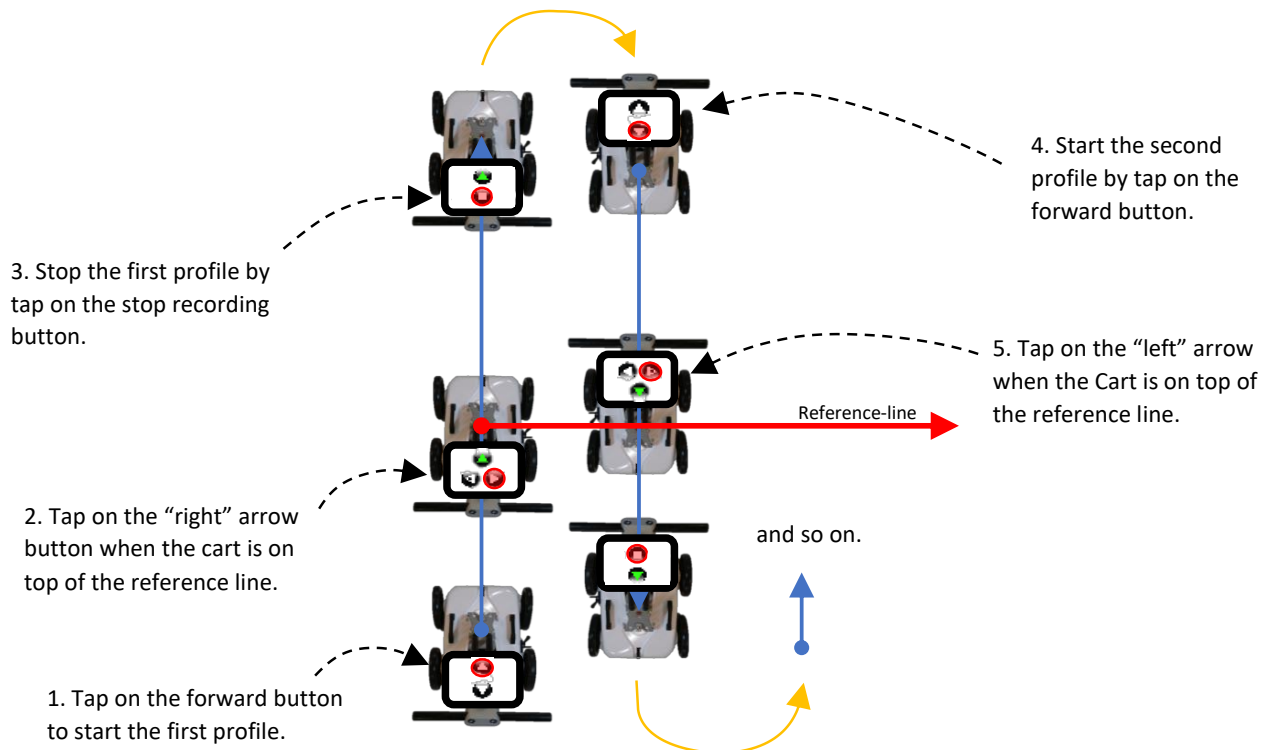


Figure 20 Controls during reference-line projects, forward survey, and profiles to the right of the first profile

Select the direction of the collection (forward/backward) and press the appropriate button to start the profile. Note that the example in **Figure 20** illustrates a forward move of the cart for all profiles in the Reference Line project, requires a 180° turn at the end of each profile. The selected button will be highlighted in green to indicate the selected 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 in relation 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' arrow button. The right button is selected because the next profile will be to the right of the first one. Make sure that the 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**). Important to keep the distance in-between the profiles as decided in figure17. Press the forward button to start the measurement when the 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 sweep from the bottom of the screen on the standard Android way, tap on the arrow pointing to the left and answer yes that this Reference line project will be finished.



Figure 21, Close an RL-project

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 from random debris like a stone or piece of broken rock. 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 viewed 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 22**, below.

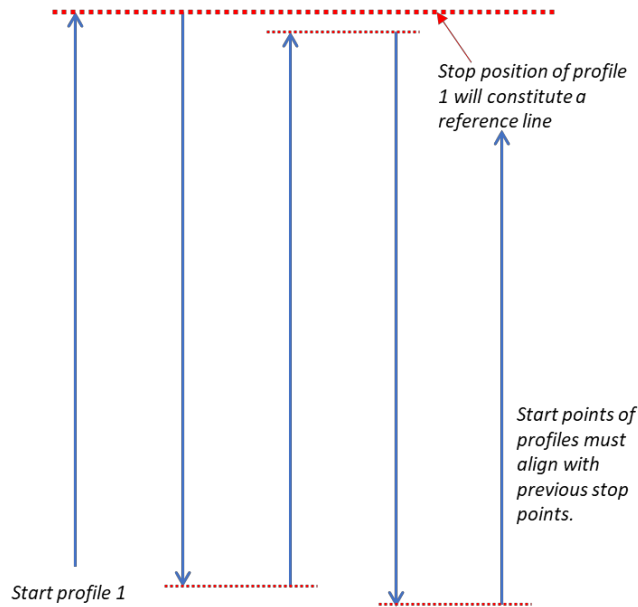


Figure 22 Layout of Dual View-project

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 23** below.

It is possible to import a DV-project into Crosspoint®. Doing so, 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 this is thought of prior to the survey, a DV-project may be used for post-processing/interpretation just as an RL-project.

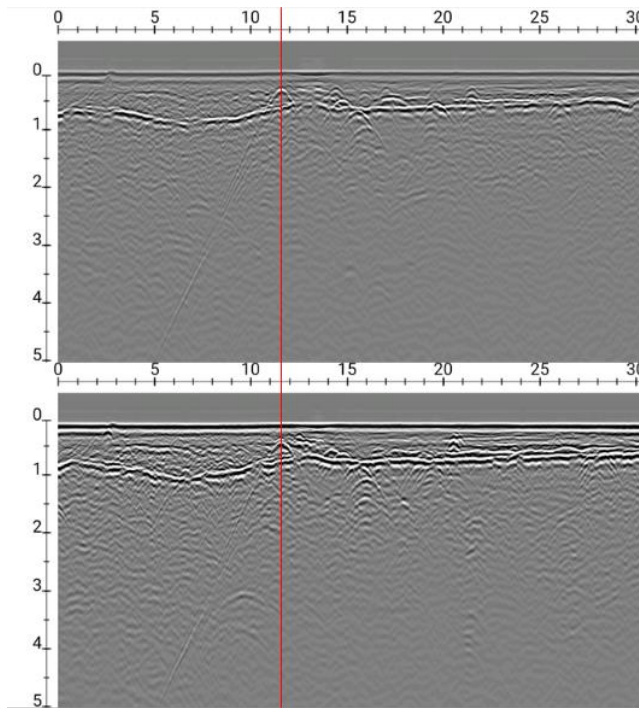


Figure 153 Dual-View project showing two parallel profiles with a back-up cursor

GPS-projects

As the name suggests, this project type requires GPS for positioning. However, to be of any use for accurate mapping a survey-grade RTK-GPS is required. That said, it is possible to run a GPS-project using the PinPointR antenna's internal GPS, but this will lack the precision required for accurate interpretation.

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

Viewing files

The IPR App 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 profiles, which is controlled using one finger-swipe horizontally.

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 Ethernet-link.

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

Choosing unnecessary long time-windows (number of samples) also increase the data transfers, so choosing a fitting time-window is a recommendation.

Finally, all GPR-systems loose lateral-resolution at depth. This decreases the demand on the distance interval, point spacing, no need to collect denser data than necessary, with respect to what you want to resolve. So, increasing the point distance also takes the load off the data-link. We have set the minimum point distance to 1[cm], so short distance interval is only suitable for concrete scanning with the 800MHz.

Note on Wi-Fi communication disturbances

If Bluetooth is enabled in your measuring device (phone or tablet), it will cause disturbances of the Wi-Fi communication between your device and the antenna. Therefore, the IPR App will prompt you and then automatically disable Bluetooth if it is enabled.

When the IPR App is connected to the antenna, the app will block your device from connecting to other local Wi-fi networks, to prevent your device from automatically switch to another Wi-fi during an ongoing survey.

Note: If you have several devices nearby that are connected or has been connected to the IPR antenna it is very important to disable the Wi-fi in all those devices (except your measuring device). Our recommendation is to turn those devices in flight mode! If you don't do this, the communication between your measuring device and the antenna may be disturbed and cause many missed traces.

Appendix A, Specifications

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

ANTENNA	
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	Pending (FCC & CE)
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 (Cart only) ¹ , 20 kg (Cart, Antenna & display) ²
USER INTERFACE	
Display	720 x 1280 pixel or better
Operating system	Android™ (>ver. 5 Lollipop) or later
Memory	2.7 GB SDRAM or better
Processor	Intel Atom x5-Z8550, Quad-core 2.3 GHz Krait 400 or better
Recommendation	<i>Panasonic Toughpad FZ-A2 (or equivalent)</i>

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 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 16-bit or 32-bit data format (see the field "DATA VERSION" in 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	10:12:19:60165.18991723150	N	18.72870853800	E	317.289	M	4
2	2017-03-15	10:12:19:79665.18991695317	N	18.72870772433	E	317.527	M	4
5	2017-03-15	10:12:20:00065.18991630983	N	18.72870888283	E	317.528	M	4
8	2017-03-15	10:12:20:20365.18991530700	N	18.72871088067	E	317.525	M	4
12	2017-03-15	10:12:20:39865.18991406333	N	18.72871390350	E	317.562	M	4
17	2017-03-15	10:12:20:60165.18991227283	N	18.72871711767	E	317.588	M	4
23	2017-03-15	10:12:20:79665.18991046267	N	18.72872101300	E	317.557	M	4
33	2017-03-15	10:12:21:00065.18990848683	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 antenna -- 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 poor 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 simply 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.

Appendix D, Regulatory notices

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 V1.2.1
- US FCC, Part 15.F
- Canada IC RSS-220 limits

The CrossOver-antennas 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

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.

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 licence-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.

USA Warranty service and repairs:

Authorized Distributor:



Tracer
Electronics LLC

impulse **RADAR**

**SALES
TRAINING
REPAIR & CALIBRATION**

6981 Eastgate Blvd., Lebanon, TN 37090 / T (615) 285-3952
sales@tracerelectronicsllc.com / www.tracerelectronicsllc.com

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)

PinpointR: 2ALZQ-CO4080