ViewPoint

2D GPR Data Acquisition & Processing Application

User Manual

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About This Manual

ViewPoint is a modern and versatile android application used to control data acquisition from ImpulseRadar's PinPointR, CrossOver, PLT and RQT ground penetrating radar systems. A robust user-friendly interface and seamless integration with ImpulseRadar GPR devices make this software suitable to setup, control and perform basic data interpretation on the fly in the field.

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	Software, data acquisition and control
Section 2	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 support@impulseradar.se

1 Software Overview

The PinPointR/CrossOver/PLT/RQT* are set-up and controlled wirelessly via the ImpulseRadar ViewPoint App once installed on a suitable Android Tablet ("Device"). It is perfectly feasible to operate the ViewPoint using an Android Smartphone. However, please note that the small screen size 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 in Appendix A.

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: PinPointR, CrossOver, PLT and RQT, all are controlled by ViewPoint. Information given in this manual holds true for all devices even if only one i.e., PinPointR is mentioned.

Note: The screenshots and following sequences are based on the Samsung Galaxy Tab 'Active Pro' and Samsung 'A52' smart phone.

2 ViewPoint Installation and Connection

You can get ViewPoint software by two methods.

1. It is available on google play store. Just go to google Play Store search-bar and search for 'ViewPoint'. You will find it in the first few results. Just look for icon VP .
2. The latest version can be downloaded from the Resource area of our website (https://impulseradargpr.com/software/).

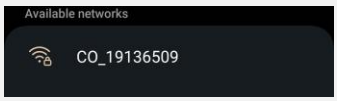
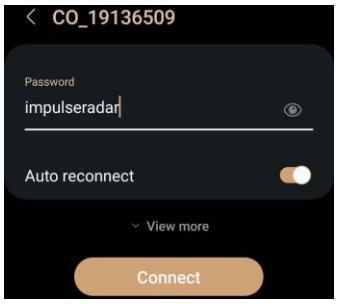
If you got the app via website, then the installation process is as follows:

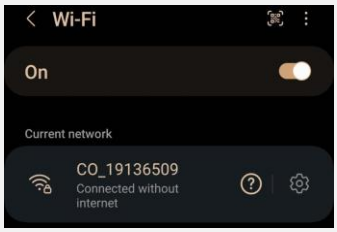
1. Locate the file <**ViewPoint-X.XXX.apk>*** and start it to initiate the installation.
2. The recommended file system for this App is 'ES File Explorer'.
3. When prompted, allow permission for ViewPoint to access photos, media, and files on your Device, so that radargrams can be saved and opened. Also, 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.

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

2.1. Wi-Fi pairing

Follow the process below to connect your Android device to a relevant ImpulseRadar GPR system.

	Switch on the PinPointR/CrossOver system by pressing the ON/OFF button
	On your device, navigate to Settings Ú Wi-Fi Ú and look for the PinPointR system ID, which will appear as 'CO_XXXXXXXX' (where XXXXXXXX is the serial number of the system).
	Select this Wireless Access Point (WAP), and you will be prompted to enter the password, which is 'impulseradar'. Press 'Connect' to complete the process.

	Once connected, a ‘no-internet’ warning may appear, which can be ignored. If the warning dialogue permits, authorize the network and do not show the warning again.
Connected to: PinPointR 400 Mhz Activated 800 Mhz Activated	Now, open ViewPoint app. If connection is successful, you will see the relevant GPR device information and battery status.

Note: In rare cases, if ViewPoint does not recognize the connected GPR unit, a popup window will prompt the user to select the correct unit type (e.g., PinPointR, CrossOver, PLT). This feature helps prevent users from being stuck with an "Unknown Antenna" status.

2.2. 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. Figure 1.

After the first successful connection of an android device to a GPR unit, the Device connection

Figure 1 Example of GPR unit SSID and Wi-Fi network connection

settings will default to ’Auto reconnect’ and it will automatically try to connect to that GPR unit whenever it is within Wi-Fi range. This setting will remain as the default unless the ‘Auto reconnect’ option is disabled, or you tell the Device to ‘Forget’ the GPR unit Wi-Fi SSID, as per the options shown in the Figure 2 below.

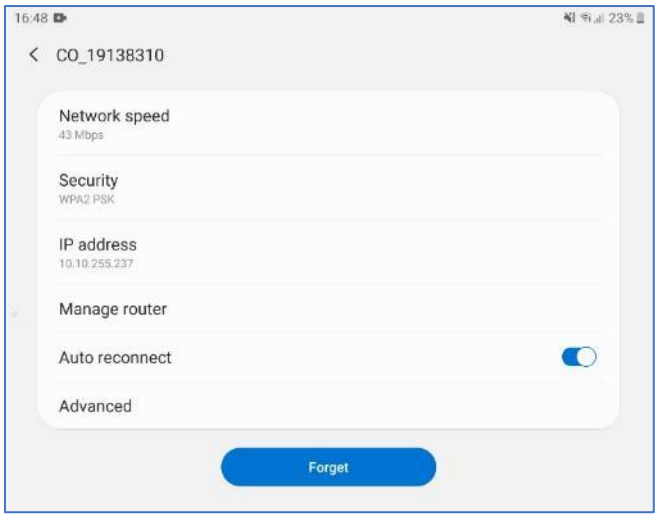


Figure 2 Device connection settings

2.3. 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 reconnect'. Therefore, it is vital that the 'Auto reconnect' 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 3.

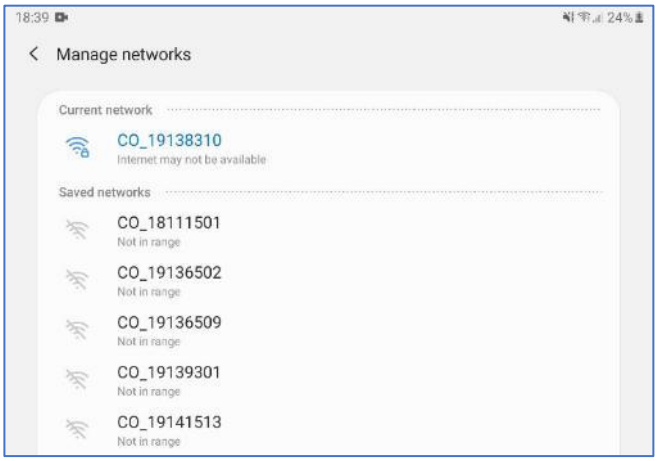


Figure 3 Screenshot of available wi-fi units in the vicinity of the GPR device

2.4. 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 reconnect' setting enabled, then the Device will attempt to connect to that wireless network instead of the GPR unit. Hence the importance of deactivating 'Auto reconnect' 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 automatically reconnect to the GPR unit.

2.5. Multiple Devices

Nowadays, you are likely to have more than one Device in your possession, or within the vicinity of the GPR unit during the measurements. 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 takes care of this generally; however, it is 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.

2.6. 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.

2.7. Key Wi-Fi Actions

1. Allocate a primary Device for each GPR unit.
2. 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.

2.8. Connect  Button

When this button is visible, the App has, for some reason* stopped the attempt to connect to the System associated with the connected Wi-Fi. It means that the App do not send any commands at all to the Wi-Fi, which in turn means that the App and the Android device will not cause any disturbance to the GPR system in the case it already collects data from another Android device.

*It can be of the following reasons:

1. The GPR system has already established a connection to another Android device.
2. The system does not answer.
3. The connected Wi-Fi is not an GPR system.

Click on the connect button, to make a new attempt to connect to GPR system associated with the connected Wi-Fi.

Note: When ViewPoint is installed or upgraded, the antenna factory reset will happen for the first antenna connected after installation (regardless of whether it was connected or not during the installation of ViewPoint).

3 Using ViewPoint

From the home screen of your Device, press the ViewPoint icon [VP] to enter the application's start screen. The start screen, as shown in Figure 4 below, provides access to the various functions of the application.

The left-hand image given in figure XXXX below, shows an example of a connected device with all functions available. This screen includes the system battery status, which can be monitored from within ViewPoint. The right-hand image shows the limited functionality available when ViewPoint is disconnected from the PinPointR system.

A description of ViewPoint start screen options is given in a table on the next page.

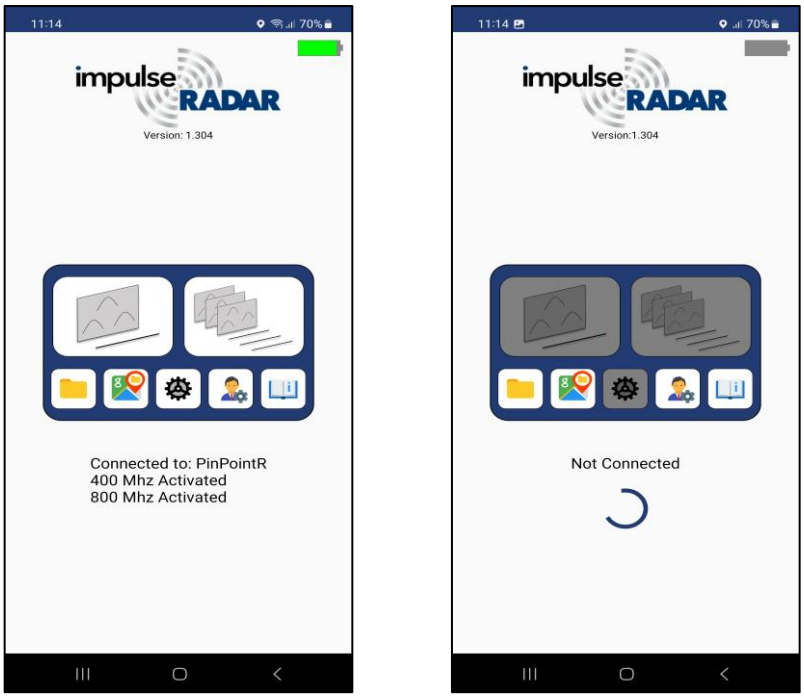
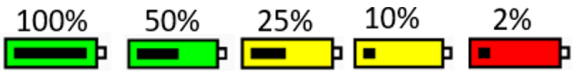


Figure 4 PinPointR start screen when Device connected (L), Device not connected (R)

Note: Generally, ViewPoint version number can be found on the start screen below the ImpulseRadar logo, as shown in the screenshot above. However, this may also appear to the right of the logo, depending on the Device or its screen orientation.

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.

ViewPoint Start Screen - Options		
Menu	Sub-menu	Description
Single Line Project 		Choose to start a new single line project.
		Single line project data acquisition in Non-save mode. Only latest profile is saved in this mode.
		Resume an old single line project.
		Resume latest single line project.
 **Multi Line Project**		Choose to start a new multi-line project.
		Resume an old multi line project.
		Resume latest multi-line project.
 **File Explorer**	File Expolorer. All the project's data can be accessed and shared from here.	
 **Map – Project Overview**	Displays current location & the location of all the other projects. To cache the map view; pan, scroll & zoom the map to the target area. This map view will be displayed together with radar view during data acquisition.	
 **Antenna Settings**	Menu for antenna settings. It is available when ViewPoint is connected to the GPR system (antenna).	
 **User Preferences**	Use it to set numerous project parameters such as Project name, units, marker types etc. Also default factory settings can be restored from here.	
 **About ViewPoint**	Provides application information. You can search for any updates from here.	
 **Battery Status**		
Connected to: PinPointR 400 Mhz Activated 800 Mhz Activated	ViewPoint displays battery status & antenna connection information if it is connected to the GPR system.	

4 Antenna Settings

The settings menu shown in the Figure 5 to the right, contains the parameters needed to control the PinPointR/CrossOver/PLT/RQT GPR systems during data acquisition. Once set, these parameters remain unchanged for all subsequent data acquisition. The settings menu is displayed in a basic version, but an advance mode is also available for additional settings. ViewPoint starts in basic mode, but you can activate the advanced settings by toggling-on 'Show Advanced Settings' from the slide bar.

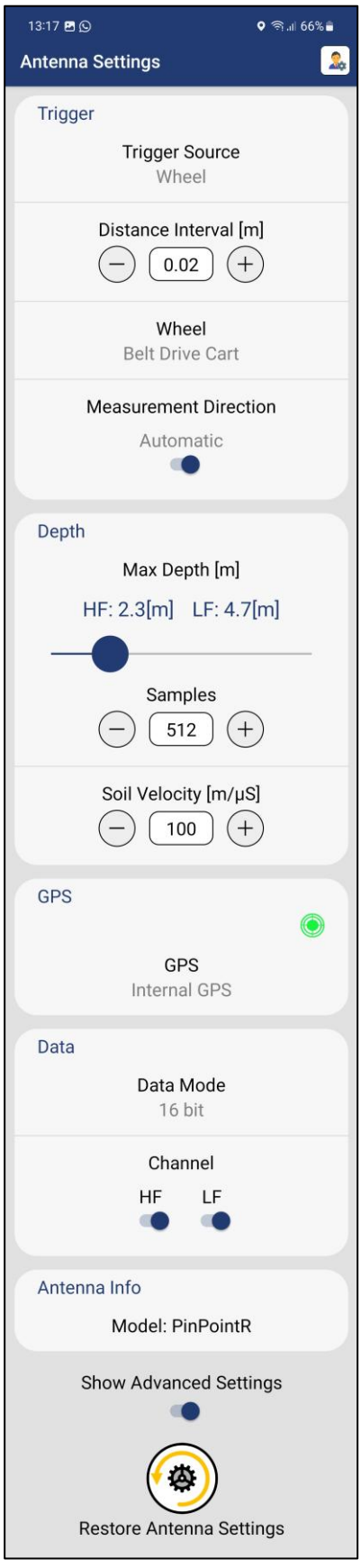


Figure 5 Antenna Settings

Description of GPR antenna settings

Trigger

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 (Amplitude vs. Time).

Distance Interval: Defines the distance between every A-scan when Trig Source is set to wheel or Manual (sometimes also called 'Point Distance').

Time Interval: Defines the time between every A-scan when Trig source is set to time.

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.

Measurement Direction: When this function is enabled, the measurement direction will be set automatically. This means that in all projects types its now also possible to collect data running the GPR system backwards. It is enabled for PinPointR and CrossOver systems as a default but disabled for PLT and RQT systems.

When a measurement is started, the measurement direction for the profile will be set when the wheel has moved 5cm in one direction totally. Data collecting starts directly, but no traces will be drawn on the screen before the measurement direction has been set. So, there will be a drawing delay on the first 5cm of collected data. As soon as the wheels starts to spin, system collects data, but if the direction is changed

before the direction has been set, the data collection will restart from the turning point.

The sensitivity for detecting a direction change is 1cm. This means that you need to move the system at least 1cm in the opposite direction before the App detects that the direction has changed. During data acquisition, current measurement direction is displayed in the status field of the top toolbar by the sign  for 'forward direction' and  'for reverse direction'.

Depth

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.

Soil Velocity: Defines the velocity used to calculate the depth scale.

GPS

It defines whether to use the internal GPS module or an externally connected system. You can see GNSS status and associated information by clicking on GPS status symbol  . It displays the incoming NMEA stream from the GNSS receiver. An un-compatible (non-GGA) NMEA string will be displayed with the message about unsupported format and prompting the user to instruct the GNSS receiver to output correct protocol i.e., NMEA 0183 GGA string.

See later section 'GPS-Symbols and functions' on the meaning of different GPS symbols and further information about GNSS configuration for internal GPS settings.

Following options are available under this section.

Internal GPS: As the name implies, select this option if you wish to use the internal GPS only.

External GPS: If this option is selected, you must adjust for the correct baud-rate for the incoming data which can be obtained from the user manual for the GPS system used. ViewPoint recognizes NMEA 0183 protocol. It recognizes only GGA string.

External GPS + Time Pulse: It is intended for use with an external GPS while gathering precise timestamping 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. ViewPoint also supports Total Station (Pseudo-NMEA).

Total Station (Pseudo NMEA): ViewPoint also supports Total Station (Pseudo-NMEA).

Android Mock GPS: This feature allows the use of GPS systems that require a specific third-party application and/or need to receive their correction data via the internet. For detailed information please see that attached appendix 'RTK-GPS guide for Viewpoint'.

Bluetooth GPS: To receive NMEA 0183 string via Bluetooth, make sure that your GNSS receiver is outputting the NMEA string via a Bluetooth connection. First connect (pair) your GPS acquisition system to your Android device via a Bluetooth. Then press this option and select your paired Bluetooth GPS device in the subsequent popup menu.

Data

Data Mode: Defines how many bits are used while storing the resulting radar data. For PPR4080/CO4080, the default is 16-bits, while for CO1760/CO730, 32-bits are default. ImpulseRadar recommends 16-bit. However, 32-bits can be selected but it is only for specific occasions where 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. It is recommended to use 16-bits and not unnecessary long time-windows to reduce the load on data transmission.

Channel: Depending on the survey priorities, you can enable/disable either High Frequency (HF) or Low Frequency (LF) channels. Data from disabled frequency channel will neither be displayed nor recorded.

Antenna Info

Hardware type and menu through which upgrade of FPGA / firmware may be done. Click on the button FIRMWARE/FGPA UPGRADE tab to locate the file and press START UPGRADE button.

Firmware Upgrade

To upgrade firmware, go to 'Antenna Settings'  -> Toggle ON 'Show Advanced Settings' and press 'Antenna Info' button. Now press 'FIRMWARE/FGPA UPGRADE' button and further press 'Browse File' icon in sub-sequent dialog-box. This will open VP file directory. Go to Folder 'Firmware' and select file 'DUAL_0124-upgrade.elf' and press 'START UPGRADE' button. Wait for the firmware to be upgraded. Upon successful completion, VP will show a dialog-box titled 'Upgrade Complete' and prompt you to restart the GPR unit.

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 their initial state.

5 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. Figure 6.

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 : Information will be stored in the PDF summary report.

Company Name: Information will be stored in the PDF summary 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. Refer to the note give below.

Marker Standard: Select available marker standards (APWA, AS5488, JUPEM, or Custom).

Radargram Colour: Click here to change the radargram display color scale.

Storage: To see available storage space left on the Android Device. You can also clear the whole “ViewPoint Data” folder.

By clicking delete data icon , a confirmation message will display. Pressing ‘Yes’ will permanently delete all the data in data folder.

Restore User Preferences: Set the user preferences to factory default

Figure 6 User Preferences

Note: The app must connect to internet so that the Google Maps API KEY can be initiated. This just need to be done one time. If this is not done, the map functionality will not work at all. Also, the Map View will be disabled when using Total Station (Pseudo NMEA) as the positioning system.

Note: If the Android device has mobile data access, ViewPoint will use it to load Google Maps. This allows users to connect to the GPR unit via Wi-Fi and collect data while maintaining live Google Maps access. However, during the initial installation of ViewPoint, Google Maps must be initialized once over Wi-Fi. The map's status is displayed on the Mian application screen.

Note, Language: ViewPoint defaults to English if the Android device's default language is neither Chinese nor French. The PDF field report and help window always remain in English, regardless of the selected language.

6 Projects

From the start screen, you may select either a 'Single-Line Project' or 'Multi-Line Project.' See Figure 7. As the names imply, this gives the option of collecting radar profiles either as 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 'Reference Line' or 'GPS' project.

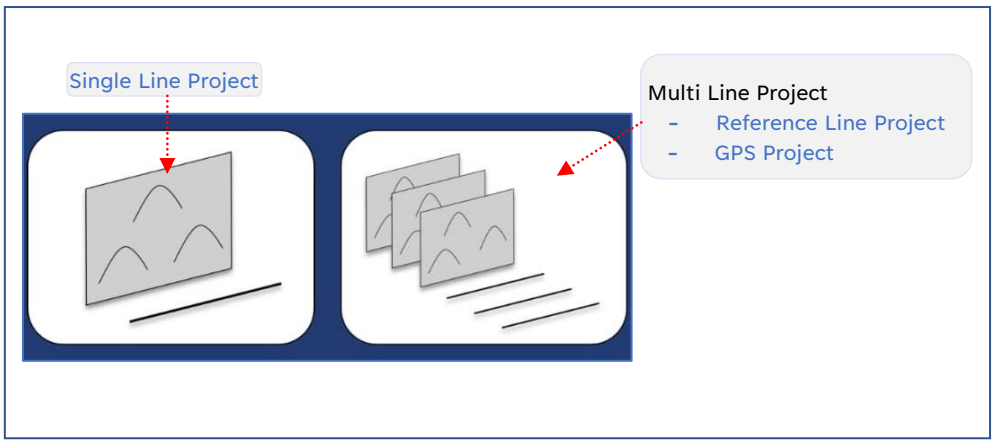


Figure 7 Available project modes in ViewPoint

Regardless of the project type, you must select a project folder to which the data will be saved as shown in the Figure 8 below. Four options are available for a single line project.

Figure 8 Create new, acquire in non-save mode, resume an old project, or resume latest project

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

After a survey, it is possible to zip a project directly in App 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 appears. 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 preferences and confirm. The zip file will appear under the parent folder of the relevant data folder.

Please refer to section **Data storage and export** for more information about data transfer directly from the app.

Note: Non-Save Mode - When running in this mode, only the latest profile is saved. When pushing the play button, the previous profile will be deleted. The profile in this mode is saved in the folder 'ViewPoint Data/Non-Save Mode'. A PDF or KMZ will not be created in this mode. Screenshots will be saved as usual in the 'ViewPoint Data/Non-Save Mode/Export' folder.

Note: Folders, files, and individual profiles can be deleted from the file explorer in the App. Just do a long press and an options menu will pop up. When deleting a profile, all files for that specific profile will be deleted (*.iprh, *.iprb, *.mrk, *.cor, *.gps, *.time, *.tsp).

6.1. Running a single line project and functionality

Figure 9 below illustrates and describes the functions within the header toolbar for controlling data acquisition.

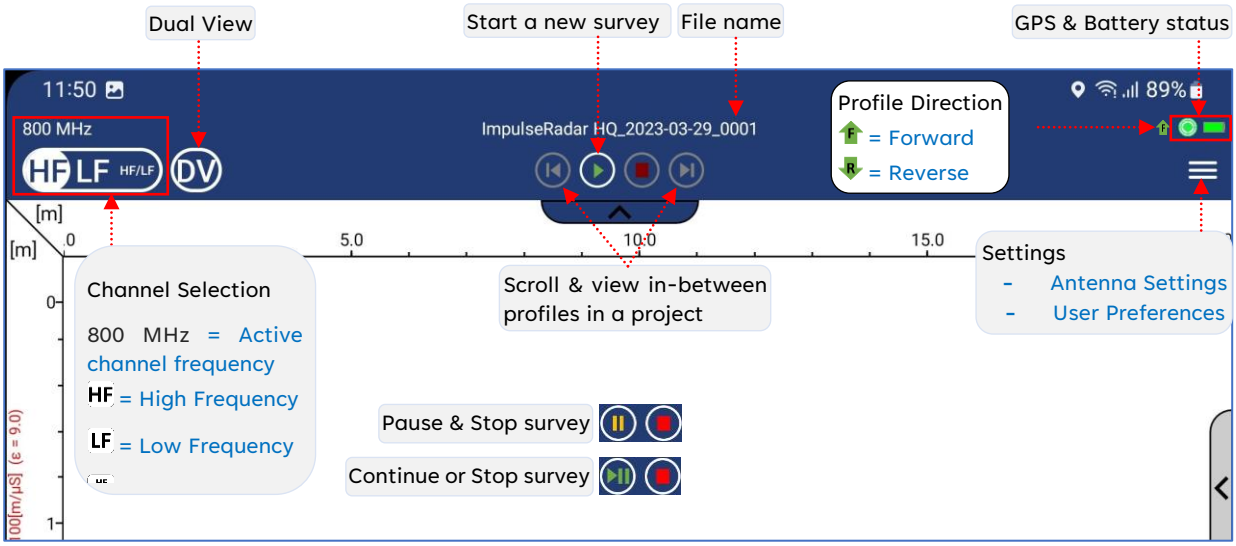


Figure 9 Header toolbar controls

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. DV 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. Furthermore, the back-up cursor (red line) covers both profiles making it even easier to see how closely reflectors align.

When 'Dual View' DV is enabled, the previous profile is displayed above the current profile. Just click on the 'DV' button to activate Dual View. This mode is available when only one channel (HF or LF) is selected. In this mode, the horizontal scroll is locked to the current profile. Per default, the previous profile is drawn on the screen in the reversed measurement direction of the profile. Double tap on the profile number of the previous profile to flip the profile. If there is an 'R' after the profile number of the previous profile, it means that the profile is 'Reversed' [007 vs. 007 (R)].

Figure 10 describes additional functionality available in the footer toolbar 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 [I] and crosshair lock [🔒] are available.

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 → Map [Ú].

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. Here the position of the Android Device will automatically be in focus. This will make it easier to cache map tiles for offline use. 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 exceeded 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.

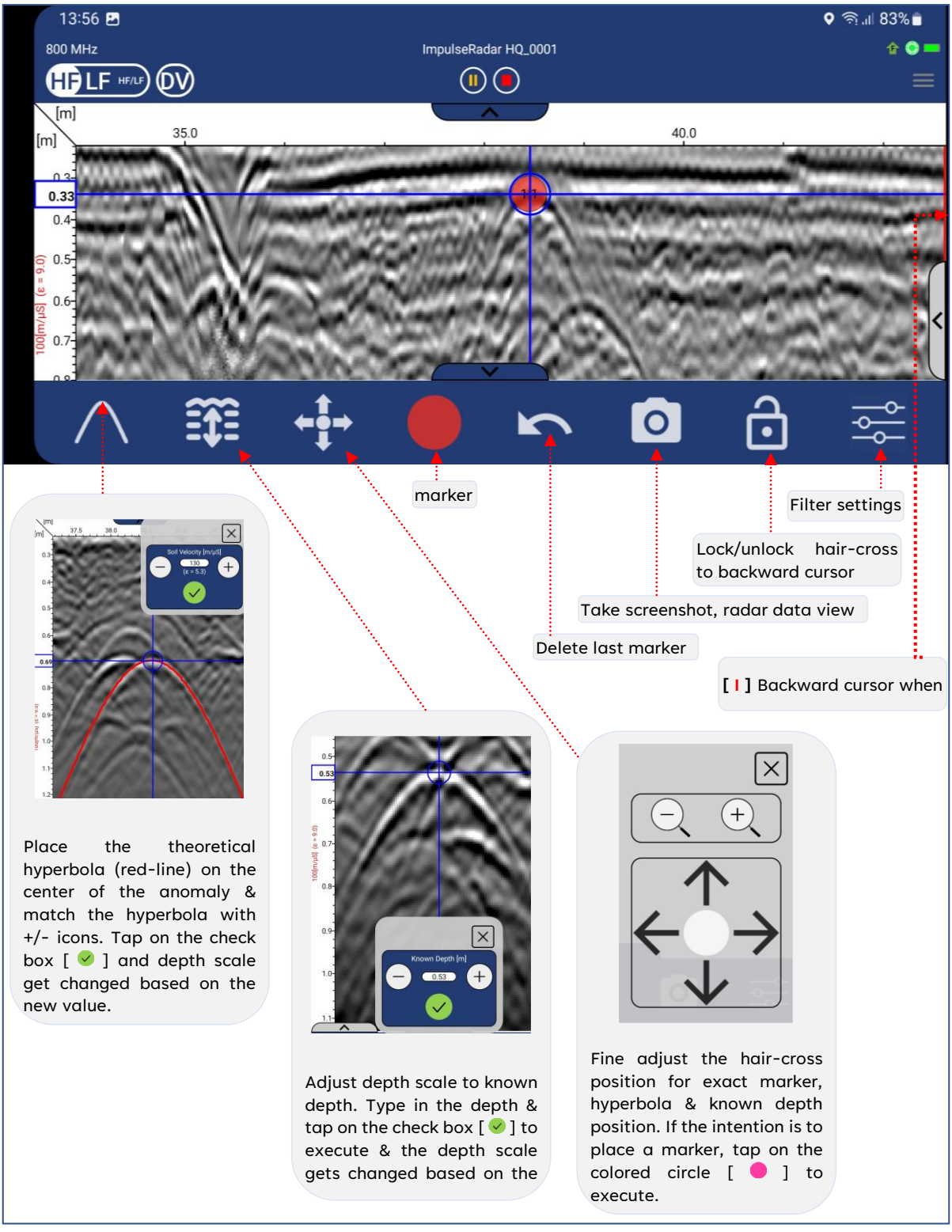


Figure 10 Footer toolbar controls

7 GPS Symbols and Functions

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. During data acquisition GPS symbol will change colour and style according to GPS status, as defined in the table below. By pressing the GPS symbol given in the status field of the top toolbar, you can see a static view of the current satellites and coordinates.

GPS Mode	Explanation
	No GPS signal
	Internal or external receiver, minimum 4 satellites
	External receiver in RTK Float mode
	External receiver in RTK Fix mode
	External receiver minimum 4 satellites plus time sync from internal GPS
	External GPS in RTK float mode plus time sync from internal GPS
	External GPS in RTK fix mode plus time sync from internal GPS
	External GPS but no signal, only time sync from internal GPS

When connecting an external RTK-GPS, the internal GPS can be utilised to log the GPS time for each GPR trace collected. In doing so, the positioning 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.

7.1.1 Precision Marker Mode

When using an external GPS (that has signal) and the trig source is ‘wheel’ and the ‘cursor lock’  is activated, then the ‘Precision Marker Mode’ will be activated. A symbol  is displayed in the status field of the top toolbar, that indicates if this mode is activated or not. When this mode is activated, the coordinates will be loaded from the current GPS fix when you set a marker in the radargram. The app will wait a maximum of one second to receive a new fix, if no fix is received, a normal marker will be set instead. You can see if a marker is ‘Precision marker’ or not by clicking on it to display the info window. In the *.mrk file, the

rightmost field indicates if the mark is a “Precision Mark” or not. The rightmost field will be ‘Y’ if yes and ‘N’ if not.

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

7.1.2 GNSS Configuration for the Internal GPS

Here you can select a different GNSS configuration than the default (i.e., GPS + GLONASS + QZSS) for the internal GPS. For this to work, firmware version on ImuplseRadar GPR must be 49000124 or higher.

In its default settings, ViewPoint automatically scans the best SBAS service area at your location and sets the internal GPS accordingly. However, if you are in a region where several SBAS service areas are within reach, a conflict might arise that prevents you from receiving the SBAS corrections. If that is the case, manually setting the SBAS service area to your region is also possible.

As shown in Figure 11, first go to the ‘Antenna Settings’ and press ‘GNSS Configuration’ button to display the further options as shown in figure below. In ‘SBAS service areas’ section you can select the option that you deem appropriate for your region (EGNOS: Europe, WAAS: North America, MSAS: Japan, GAGAN: India, SDCM: Russia) and press submit.

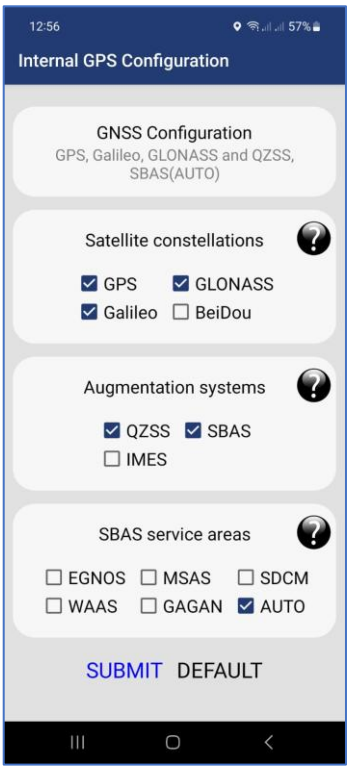


Figure 11 SBAS service area settings

Note: All combination of satellite constellations and augmentation systems are not possible. For more information on what is possible press the question mark buttons to display the list of allowed combinations. Pressing ‘Default’ will reset to factory settings of internal GPS configuration.

8 Data Viewing and Adjustment

The screen and system functionality differ depending on the project type. It is possible to use the marker and velocity analysing functionality for single line projects as well as for reference

line and GPS projects. They are available even when both channels are viewed on the screen or during dual view. 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 . Figure 12.

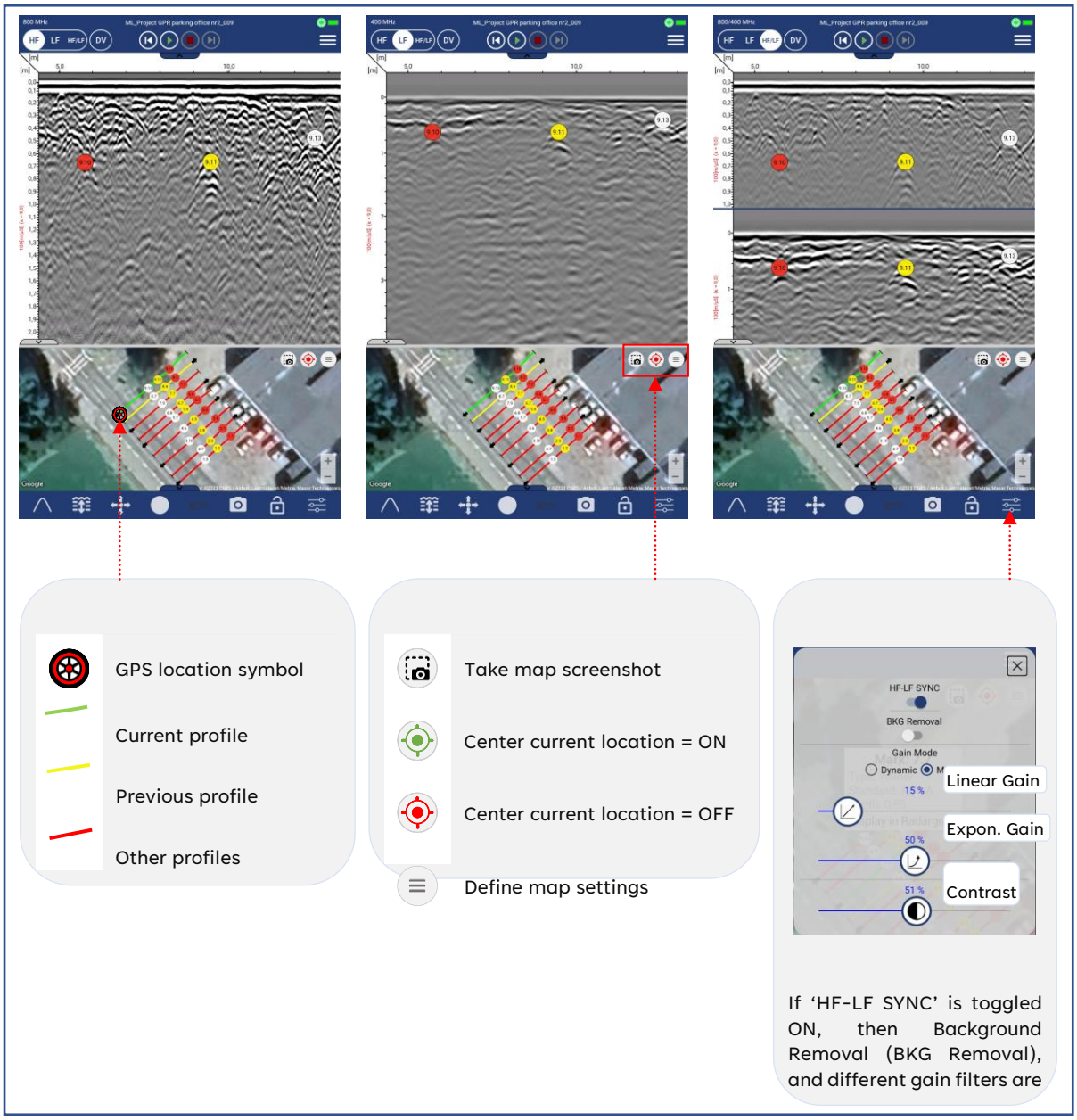


Figure 12 Screen views during data acquisition (Left=HF, Middle=LF & Right=HF/LF)

8.1. Toggling Channel View

During data acquisition independent of project type, by pressing on HF LF HF/LF, the screen view can be set to show either only high-frequency channel, low-frequency channel or both together, as shown in the figure above. Tap on HF, LF or HF/LF in the upper left corner of the screen to change to wanted view.

You can also hide header/footer toolbars or map view that you do not use for the moment by clicking on show/hide functionality  .

8.2. Filter Options

The filter window will pop up when the filter-icon given in the lower-right of footer toolbar is pressed. Figure 12.

Enable 'HF-LF SYNC' HF-LF SYNC if you want to apply filters simultaneously on high and low frequency channels. Disabling this allows you to choose the high/low frequency channel you want to apply your filters on.

You can switch-on/off background filter by pressing BKG Removal. It works in real time and updates itself when new traces are collected. The mask size BKG (the number of previous traces that should be included when the average trace is calculated) can be adjusted.

Both dynamic and manual gain options are available. When dynamic gain is on, an individual gain curve is calculated and applied to every single trace. In this mode, the user only needs to adjust the contrast to the desired level. This gain curve is specially preferred to use on soil with high conductivity or when the material/soil varies a lot along the profile. Manual gain comes with adjustable options for linear and exponential gains and the contrast.

The gain and contrast of the radargram can be adjusted in any frequency mode. To change gain and contrast, hold your finger on the icon for e.g. 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 given on top-right of the filter window will shut the 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 location.

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.

Note: When the trigger source is wheel, the mask size is set in meters or feet and then translated into number of traces. When the trigger source is time, the mask size is set in number of traces.

8.3. Time Zero Adjustment

Time-zero position is factory adjusted but its adjustment can be changed. Long press the vertical scale to activate adjustment mode. When the background colour changes to 'green',

now it is possible to do the adjustments by dragging the vertical scale to the desired position. Tap outside the scale to confirm the new zero level. 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.

It is possible to adjust the time-zero position by same amount for both channels when data is viewed in double-channel view HF/LF. Long press the individual vertical scale bars on HF and the LF channels. When background colour changes to 'green' for both scales, just drag one of the vertical scales. The other scale will automatically drag the same amount.

8.4. Data Zoom

Radar data can be zoomed in or out from up to 5X, using standard Android screen gestures. To zoom in, pinch and expand two fingers: pinch and close two fingers to zoom back out. 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.

8.5. Continuing Measurement on a Saved Profile

Select "Resume Old Project" from the project menu. Then, use the back-and forward button to open the profile that you want to continue. A confirmation message along with saved parameters will be displayed. Do a long press on the play button to continue the measurement on that profile. During measurement, only new data will be displayed on the screen. When the measurement has stopped, the complete profile will be displayed on the screen.

In the case you are resuming an old project, an 'extra report' will be created when you finish the project.

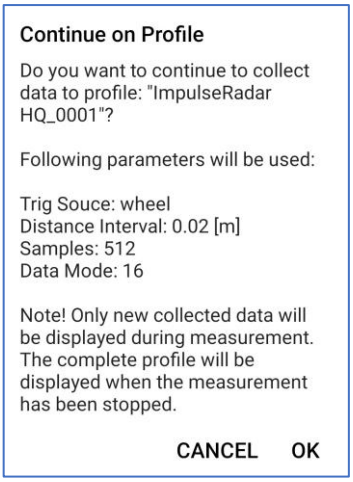


Figure 13 Continuing to measure on a saved profile in an old project

9 Markers

9.1. Marker Selection

Under user preferences  choose your preferred marker standard from the available options 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.

The marker icon is located centrally in the footer toolbar (Figure 14). It is shown as a solid dot  , but can be toggled to quick marker 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 (). Regardless of the selection, a marker palette offers colour choices according to the pre-defined marker standard in User Settings such as American Public Works Association (APWA) standard shown in Figure 15.

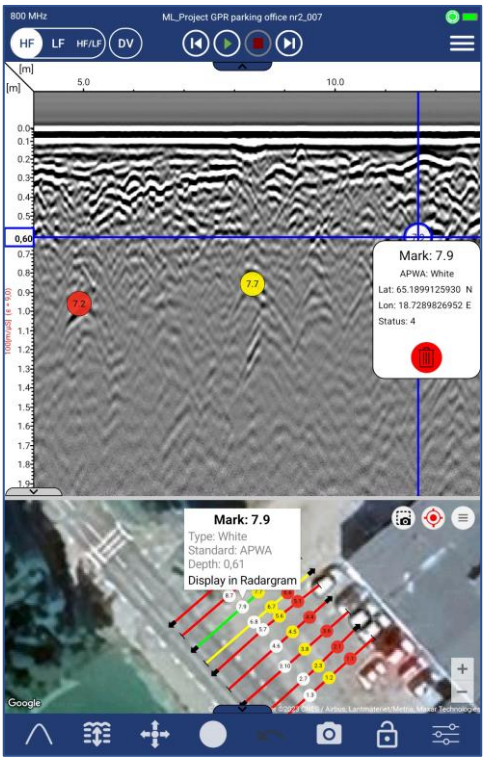


Figure 14 Marker functionality

9.2. Marker Assignment

When the quick marker mode is active  , every tap on the radar data will result in the assignment of a marker. Press  to delete last marker. Normally, the arrow icon  is used to fine-tune the position of a marker in respect of a target in the radargram. Double click the radargram to enable/disable crosshair. User can touch the screen to move the crosshairs to the desired location, then use the arrow icon to fine-tune the final position. You can also drag adjust the positioning of crosshair by dragging it around with your finger. 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. Markers are referenced with numbers according to the radar profile and their sequence for a given marker type. Tap a marker in the radar data or map view to see a pop-up containing marker details. Current profile track colour is 'green', previous in 'yellow' while other tracks are shown in 'red'.

Figure 15 APWA Marker colour palette

Upon clicking on a marker in the map, as shown in above figure in this section, you will see a 'marker info window' with the text 'Display in Radargram'. If you click on that text, the corresponding profile will be opened, and the marker will be displayed in the radargram.

Note: A marker can be deleted by tapping it and then press the trash icon in the marker info window. 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 the KMZ file.

10 Generate PDF summary 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 16. If either of these files already exist for the current project, the old data will be overwritten. Both the files contain information about marker positions, their altitudes, and depths. Generated pdf file also shows GPS signal quality levels.

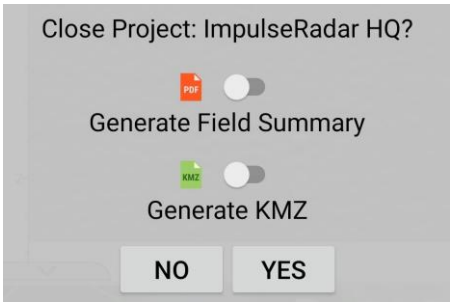


Figure 16 Generate PDF Summary & KMZ file

11 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.

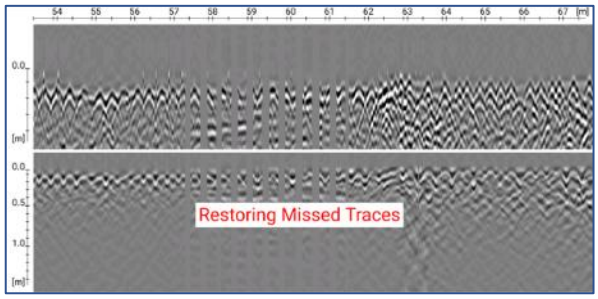


Figure 17 Data recovery when the acquisition is stopped

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 the Figure 17.

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.

12 Multi-line Project

Two types of multi-line projects are available.

1. Reference Line Project (RL)
2. GPS Project

From the project start screen, press multi-line project icon  to get to the start screen (Figure 18). Here, you will be prompted to enter a project name and the distance between each profile. Once registered, press 'Start the Project' button  to continue.

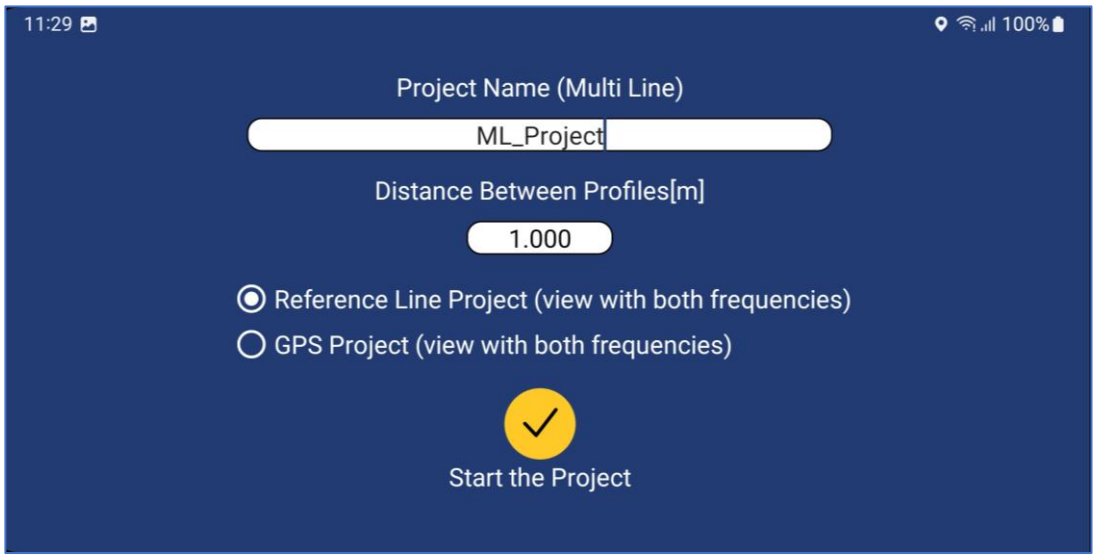


Figure 18 Multi Line Project start screen

12.1. Reference Line (RL) Project

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 (Figure 19). 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

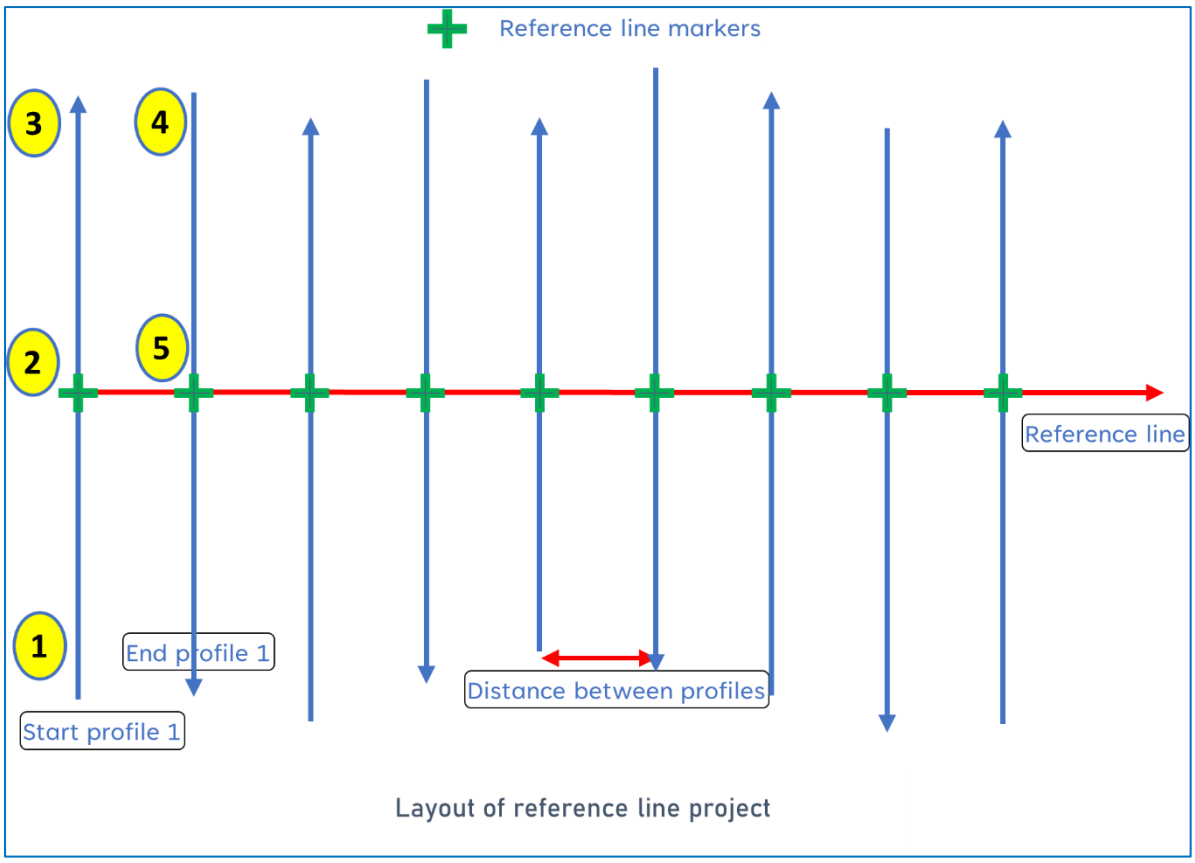


Figure 19 Schematics of reference line project acquistion

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 the sketch below.

Reference Line Project - Data Acquisition

Before starting the 'Reference Line' project, first make sure that 'Measurement Direction' is set to 'Automatic' in the 'Antenna Settings' menu. ⚙ Enabling this feature will let the 'Device' automatically sense its direction of movement (forward vs. backward).

Once the project has started, the data collection screen will appear with directional control buttons, as explained in the Figure 20 and text below.

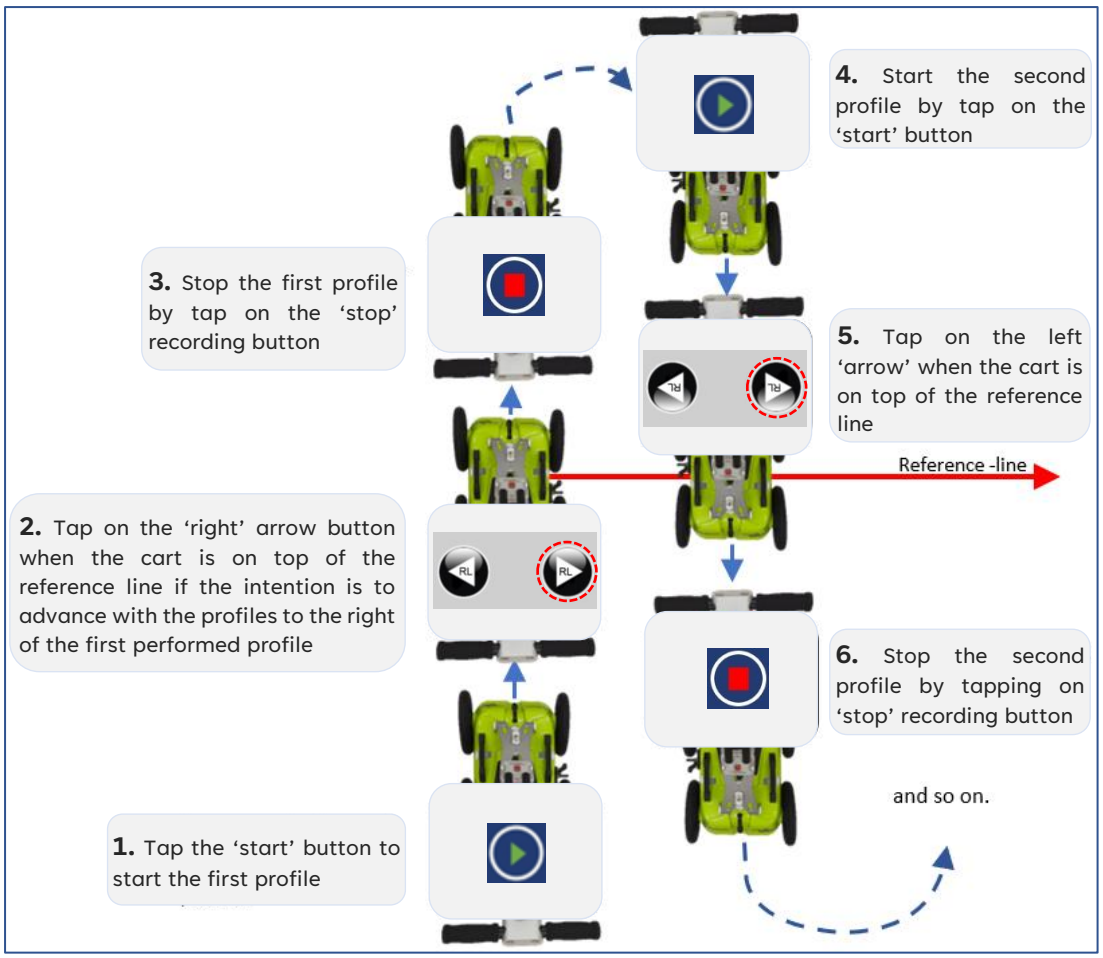


Figure 20 Controls during the reference-line project

Referring to the above figure, press the start button to start the profile. 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 pushcart 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. Again, press the forward button to start the measurement when the pushcart 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 in the standard Android way.

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

12.1.1 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 (Real-Time Kinematic) is required. That said, it is possible to run a GPS-project using the GPR's device internal GPS, but this will lack the precision necessary for accurate interpretation.

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, the CrossPoint will correctly load maps and data.

13 Viewing Files

ViewPoint is not intended for data analysis; however, saved files may be viewed to assist in making on-site decisions, 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, simply tap on the desired profile within the Map View. A dialogue box will open, press that and the selected profile will open. The marker editor allows previously saved markers to be deleted, or new ones can be added post data acquisition. To ensure any changes are updated in PDF or KMZ file, make sure 'Generate Field Summary' and 'Generate KMZ' options are activated when exiting the project.

14 Data Storage and Export

For Android 11 or later users all the project data is stored at the location given below.

- 'Internal Storage/Android/data/se.impulseradar.viewpoint/files/ViewPoint Data'

For users who run Android 6-10, the ViewPoint Data folder will still be found in:

- 'Internal Storage/ViewPoint Data'

It's also possible to send files directly from the ViewPoint file browser. However, only single files with extension *.pdf, *.kmz or *.zip can be sent. So, if you want to send a whole project, you need to zip the project folder as shown in the figure below.

First do a long press on the folder that you want to zip, and then click on the zip option in the pop-up menu. Zipped items will appear in the same directory. Again, do a long press on the zipped file that you want to send, and then click on the send option in the pop-up menu. Then select the target App, e.g., Outlook or Google Drive from the 'Send Menu'. Figure 21.

If you want to send a file to a USB-drive you need to have an external file manager Installed, like “File Manager” from Xiamoi or “X-plore File Manager” from Lonely Cat Games. If that is the case, a “Copy to…” option will be displayed in the “Send Menu” as shown in the figure below.

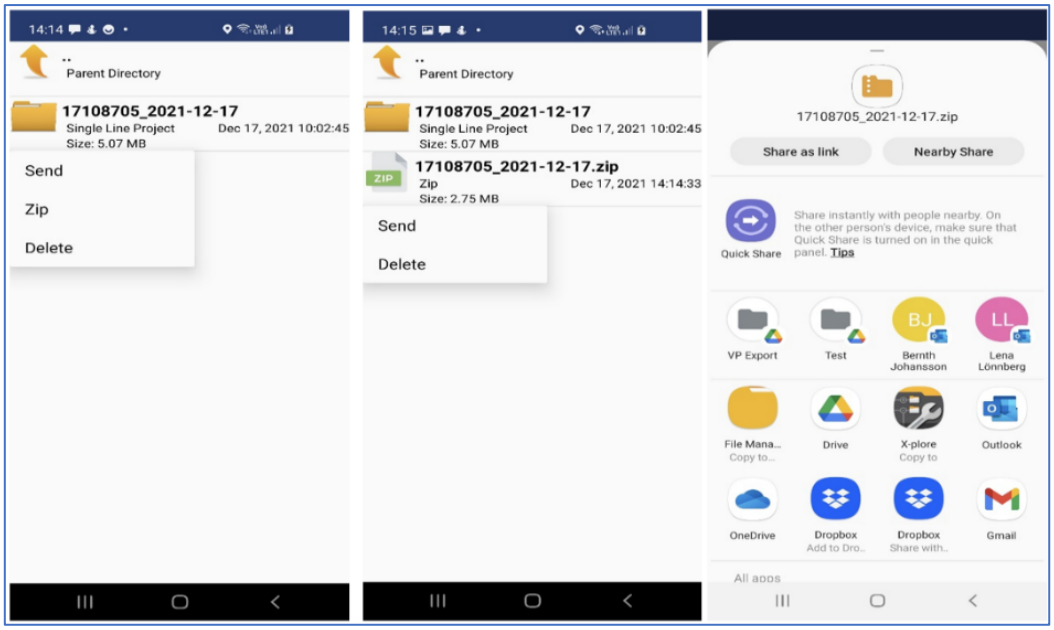


Figure 21 Zipping and data export over the internet

The path to the Viewpoint Data folder is displayed in the User Preferences Menu of ViewPoint as shown in Figure 22.

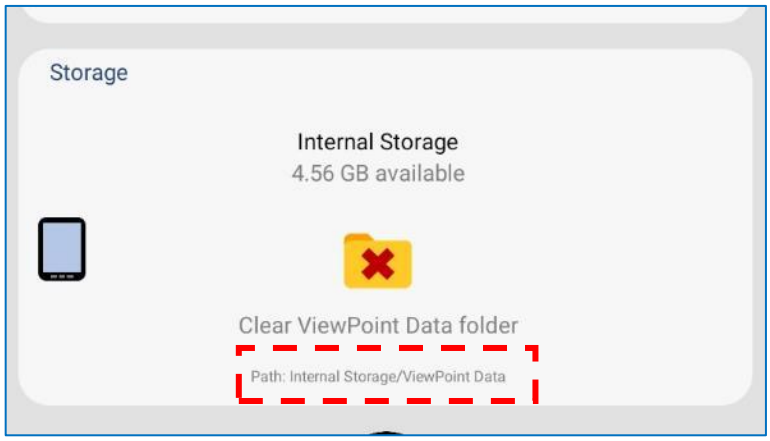


Figure 22 Path to the ViewPoint data folder

Note: The “ViewPoint Data” folder will be cleared if the user uninstalls Viewpoint on an Android 11 device. The “ViewPoint Data” folder will not be cleared when updating the ViewPoint. However, when a new version of ViewPoint is installed or after an update of ViewPoint, the cache is automatically cleared.

ImpulseRadar’s general recommendation is to always backup your data before you uninstall/update ViewPoint!

15 Note on Survey Speed and Settings

The GPR systems 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 from the 'Antenna Settings', 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/CrossOver or any ImpulseRadar GPR, like all GPR systems, will lose lateral resolution with depth. This decreases the demand on the 'Distance Interval', so no need to collect data any denser than necessary, concerning the targets you want to resolve. Thus, increasing the 'Distance Interval' also takes the load off the Wi-Fi datalink. The minimum point interval which can be set is 1 cm.

16 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/CrossOver-4080

GPR UNIT	
Technology	ImpulseRadar real-time sampling
Antenna type	PinPointR/CrossOver 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 bits
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) and Total Station (pseudo NMEA)
Power supply	12 V Li-Ion rechargeable battery, or external 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 (Pushcart only) [1], 20 kg (Pushcart, 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] Pushcart, skid plate and Tablet holder, [2] Pushcart, skid plate, GPR unit, Tablet holder and Android Device

17 Appendix B – File Formats

17.1. Files Stored in the Project Directory

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

ImpulseRadar File Types & Descriptions			
File Type	**Description**	**Naming Convention**	**Explanation**
***. iprh**	Profile header file	<project name>_XXXX_0/1.iprh	where XXXX is the profile number and '0' = Ch-1 or '1' = Ch-2.
***. iprb**	Profile binary data file	<project name>_XXXX_0/1.iprb	where XXXX is the profile number and '0' = Ch-1 or '1' = Ch-2.
***.tsp**	Positions from Total Station (Pseudo NEMA)	<project name>_XXXX.tsp	where XXXX is the profile number.
***.mrk**	Marker file	<project name>_XXXX_0/1.mrk	where XXXX is the profile number and '0' = Ch-1 or '1' = Ch-2.
***.cor**	Positions from GPS	<project name>_XXXX.cor	where XXXX is the profile number.
***. mlproj**	Multi Line - Reference line project	<project name>_XXX.mlproj	Contains information about name, type, and separation of all profiles in the project.
***. time**	Internal GPS for timing purposes	<project name>_XXXX.time	Used to deduct precise time information for synchronization with external GPS data.
***.txt**	Log file	<project name>_LOG.txt	Temperature, wifi and missed traces log file

* Naming convention for single line projects is **<project name>*_XXXX*.*file_type** while for reference line, it is **<project name>*_XXX*.*file_type** where xxx is the profile number.

17.1.1 Files/Information Stored in the System

Profile Header File (. iprh)*

Example of the File Header	Explanations
HEADER VERSION: 20	Version number
DATA VERSION: 16	16b data format
DATE: 2022-12-09	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 Pre-	Pre-processing information
OPERATOR COMMENT: 'Android SDK: 28	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
ANTENNA NAME:	Antenna name
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 = 1, Reverse = -1
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
START TEMPERATURE:	Device temperature at start of the profile
STOP TEMPERATURE:	Device temperature at the end of profile

Profile Data File (. iprb)*

This is a binary data file. ViewPoint 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 Total Station - Pseudo NMEA (.tsp)*

When using this option as position system, a .tsp file will be created instead of a .cor file. The .tsp file contains rows with the following column names:

Trace	X	Y	Z	Time	Status

Marker File (.mrk)*

Each marker is represented by a <tab> separated row in the .mrk file.

Each row has the following fields:

Trace <tab> Sample <tab> Marker Standard <tab> RGB colour code <tab> Marker Type <tab> User Comment <tab> Latitude <tab> North/South <tab> Longitude <tab> East/West <tab> Altitude <tab> Altitude Unit <tab> GPS Status <tab> Precision Marker Flag <CRLF>

Positions from GPS (.cor)*

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 exact positions 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, Inertial Measurement System)

7 = Manual input mode

8 = Simulation mode

Multi Line Project Header (. mlproj)*

Multi Line - Reference Line Project

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

Multi Line – GPS Project

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