CrossOver®-User manual

V1.1, January 2018

Content

About this manual

ImpulseRadar CrossOver® antennas are state-of-the-art, self-contained Ultra-Wide Band (UWB) Ground Penetrating Radar (GPR) systems. The dual frequencies and mechanical design combined with the various accessories, such as push-carts and forest-kits, makes each antenna suitable for several different applications.

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

This manual is structured as follows:

- Section 1 – Antennas and accessories
- Section 2 – Data Acquisition
- 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

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 Vl.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

This unit contains a WiFi module (XR2WIZFI630A) and to satisfy RF exposure compliance, it should always be kept at 20cm or larger distance from any person, when powered on.

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.

Overview

ImpulseRadar CrossOver® antennas are self-contained Ultra-Wide Band (UWB) Ground Penetrating Radar (GPR) systems. The electronic design is based on a modern real-time sampling (RTS) technology platform, offering state-of-the-art data acquisition capabilities. Each CrossOver antenna incorporates two separate GPR-channels, operating at high speed as well as an in-built differential GPS. The following antennas are available at the time of writing:

- CrossOver-730, with centre frequencies of 70 and 300MHz, abbreviated CO730
- CrossOver-1760, -"- 170 and 600MHz -"- CO1760
- CrossOver-4080, -"- 400 and 800MHz -"- CO4080

For the two antennas with higher frequencies we provide push carts as well as forest kits, for use in rough terrain. For the lowest frequency we only provide the forest-kit.

In Figure 1, below, an CO4080 antenna and most accessories are shown.

Figure 1, System overview

Data collection is managed with the CO-app over a wireless link with a suitable Android device, see Appendices for recommendations. With the CO-app, the operator may collect single line data, albeit with two frequencies, or a few different types of multi-line projects. Whether single line of project-based data has been collected, data-sets may be directly imported into the CrossPoint® Windows software for processing and evaluation.

Please note that, despite that we recommend quite high-performance devices for data acquisitions, we regularly use ordinary Android phones for acquisition. This gives some limitations, such as zoom and direct interpretation, but it is very convenient, in some applications.

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

Section 1-Antennas and accessories

CrossOver antennas

In Figure 1, below, a CO4080 is shown, the other models are similar, except for size, so our description here is valid for all models.

All Crossover antennas have inbuilt differential GPS and WIFI, there's no external connections to these units, although there are markings on the cover showing the approximate locations of these devices.

With reference to Figure 1 the connector panel contains the following, from left to right:

- Yellow- Connector for future options and kill switch. In certain countries GPR used on walls should have a kill-switch. If needed the switch will come with the antenna.
- Red- Power and Ethernet over wire. Batteries is the preferred way of powering the antennas but if the application so demand, a power cable may be ordered, it's not part of any standard kit. The wire-Ethernet is used only for factory upgrades and tests.
- ON/OFF-button. An, approximately 2s push on this button will turn the antenna on. Next push, regardless of duration, will switch it off.
- Blue- External GPS. Although the unit has an inbuilt differential GPS of good quality (Ublox/Tallysman), it sits low and cannot provide the accuracy needed in many applications. So, the usage is twofold, to be able to raise the GPS-antenna high and/or to gain precision positioning. The format should be NMEA 0183, V2, RS232-levels.
- Black- Measuring wheel. Note, this connector is placed further back on the lower frequencies.

All cable-connectors are high-quality Yamagishi-type and are connected by grabbing the sleeve and pull/push straight, no turning. The connectors are keyed so that it's not possible to damage the unit by attaching a cable to the wrong connector.

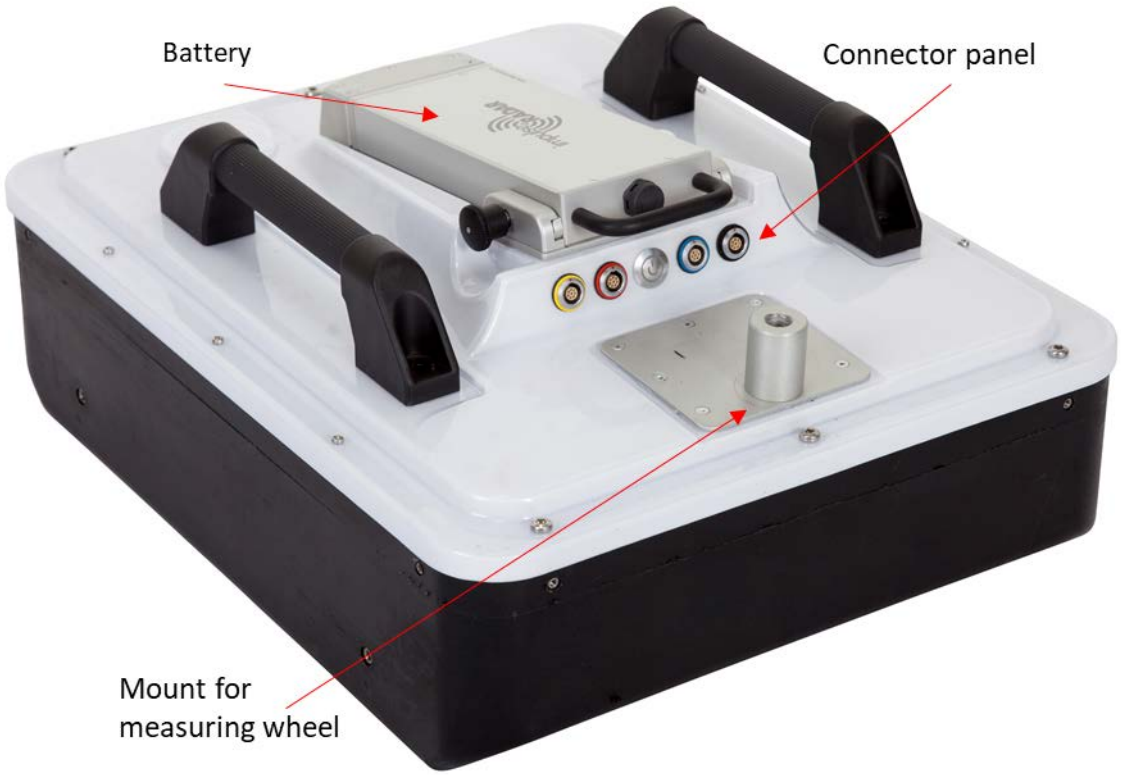

Figure 2, CO4080 Antenna with battery attached

Batteries

Our standard batteries are nominal 8.7Ah(96.57Wh), giving approximately 7 hours operation time on CrossOver antennas. They are approved according to UN38.3 and can thus be carried/shipped by air.

Figure 3, Mounting the battery

Referring to Figure 2, above. The batteries have flanges which fits into tracks on the battery mount. A locking pin holds the battery in place when mounted.

To mount the battery, place it in the mount and slide it gently in place, until you hear the locking pin click.

Removing the battery is most easily done by pulling out the locking pin with your left hand while pulling the battery out with your right, while pressing on the antenna with you thumb.

Cart

To help users to keep the antenna as close to ground as possible, our Carts are designed so that the antennas are floating freely vertically. The antennas can thus be mounted very close to ground and will float upwards over bumps. It has an odometer mounted inside the hood, connected to one of the rear wheels by means of a rubber O-ring. The cart also have a break on the rear-right wheel, easily engaged by your foot.

Antenna height adjustments

Loosening the rear straps

Sliding the antenna in place

Changing battery and attaching the odometer cable

Figure 4, Height adjustments and mounting of the antenna in cart

Referring to Figure 4, above:

- The height of the antenna is adjusted by means of two straps in the rear and one in the front.
- Mounting the antenna is most easily done from the rear, but disconnecting the straps, sliding in the antenna and then reconnecting the straps and attach the odometer cable trough the cart opening in the top. When removing the antenna, remember to disconnect the odometer cable prior to lifting the cart.

For transportation, the Cart may be collapsed by unbolting the one screw (M5) on the front plate, see Figure 5, below.

Figure 6, Folding the Cart

The O-ring connecting the wheel with the odometer may have to be replaced/renewed now and then. In order to do so, the wheel has to be removed. This is done by unscrewing the M6 screw on the wheel axis, see Figure 5.

When reassembly, use blue Loctite or equivalent.

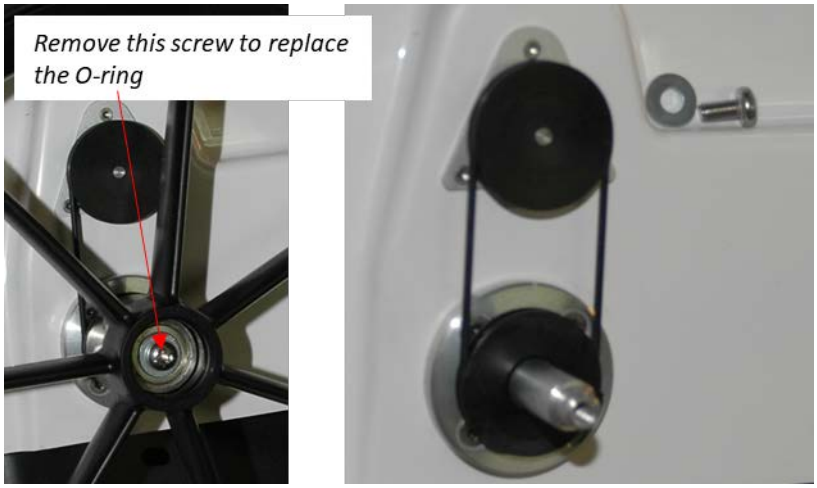

Figure 5, Removing the wheel and replacing the O-ring

GPS-mounts

We provide GPS-mounts for both the Carts and antennas, see Figure 7 below. For the antennas we provide rods with different length to enable reasonable heights of the GPS, the wheel attachment is used as one anchor-point.

Figure 7, GPS-mounts for the Cart and antennas

Measuring wheel

Referring to Figure 3, below. The measuring wheel is made of printed plastics, the odometer and cable are housed inside, protected. Downward pressure is accomplished with rubber straps and the shape is optimised for smooth operation, in all cases. Please note that there's a threaded hole in the mounting part, for keeping the locking bolt when the wheel is not in use (will help our clients keep track of the bolt).

Figure 8, Measuring wheel attached on antenna

These accessories are primarily used in rough terrain, where carts are non-practical, and of course with the CO730-antenan for which no cart is available, see Figure 9, below.

Figure 9, practical use of the waist belt, pulling rods, handle and pad-harness

Section 2 – Data Acquisition

Overview and how to avoid WIFI-troubles

Data collection is managed from a suitable Android-device, over WIFI, for specifications see Appendices. The better acquisition platforms, as the one recommended, usually gives much better WIFI-reach and significant better performance when performing, zoom, data scrolling and data recovery. Having said that, at the factory, we often do data acquisition with our mobiles.

Android devices are somewhat less standardized than PC's. The way to install applications, transfer data to/from the unit and other operations may therefore look somewhat different from device to device. It's therefore not possible for us to show precisely how the user screen will look on all devices, but in general, the differences are small.

The CrossOver-antenna acts as an access point (AP), and provided that the Android device (AD) has been connected before to the antenna, and that the AP has not been disabled (forgotten) in the AD, the two will connect as soon as they can.

Typically, a user has more than one unit to collect data with, a phone as backup and a tablet for real work, for example. This raises an issue: What devices are really talking with each other? If nothing is done to this, it may be that data acquisition is interrupted, by mistake, from a nearby device.

We have resolved this by letting the antennas stop responding on broadcast from other devices, once the data acquisition has started. They are, so to speak, paired, once the data acquisition has begun.

This also means that to connect another AD to the antenna, you must reset the antenna first by switching it off and on again, to change data acquisition unit.

To avoid troubles, we recommend users with multiple systems, to use one data collection unit only with a certain antenna and once the data collection unit is connected to another antenna the previous AP should be disabled.

Installation of the CrossOver-applicaton

Installation from unknown sources must be allowed. This setting may be found at different locations, dependent on the specific device, a few common locations:

Settings -> Personal -> Security -> Unknown sources
Settings -> Security -> Unknown sources
Settings -> Lock screen and security -> Unknown sources

Start "CrossOver-1.155.apk". This may be done from an email, from a USB-stick, or from uSD card, it doesn't matter. You may have to manually uninstall previous versions, in order to install a new.

The first time the application is started you'll have the question (or similar) "Allow CrossOver to access photo, media and files?" You must answer yes to this question, otherwise no data can be saved.

Connecting the antenna with the Android device

Reffering to Figure 10, below:

When the antenna has been turned on, it will appear in the <settings> -> Wi-Fi as “CO_XXXXXXXX” where XXXXXXXX is the serial number of the unit. Tap on this AP and you will be asked for a password.

The password is always “impulseradar”, tap it in and press <Connect>.

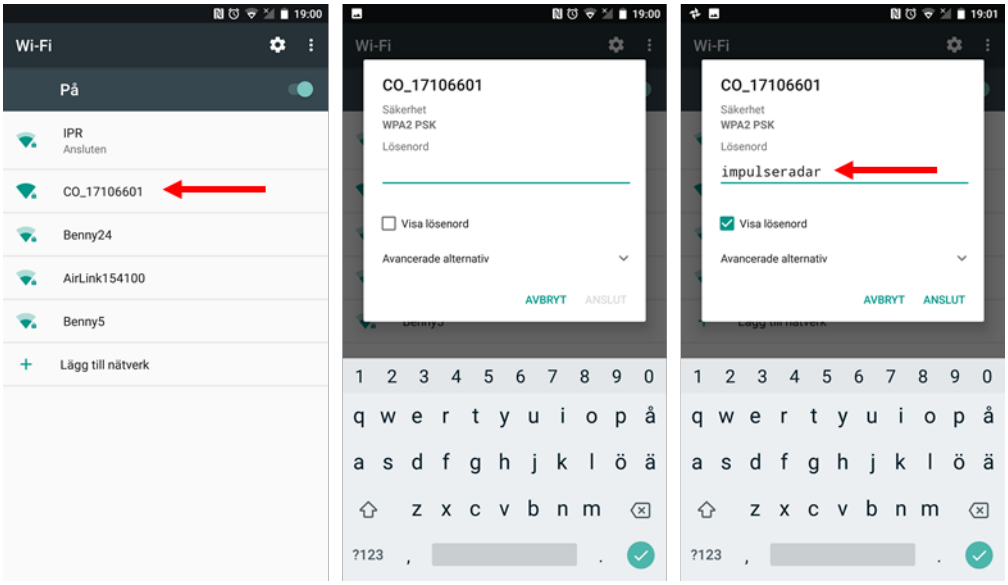

Figure 10, Connecting the CrossOver antenna to the data acquisition unit

The unit will connect, with a warning that there’s no internet, disregard this warning, and better, tap on the warning and tell to use the network anyway and not display the warning again.

Start screen

The start screen may look somewhat different dependent on the device in use, in Figure 11, below we show two phone-screens, left start-screen when antenna is connected and right; without antenna connected.

A battery indicator shows battery-status for the Antenna, not the Android device.

Please note the version number at the bottom, you may be asked this when contacting our support.

In the following paragraphs we go trough the menus, starting with the Settings.

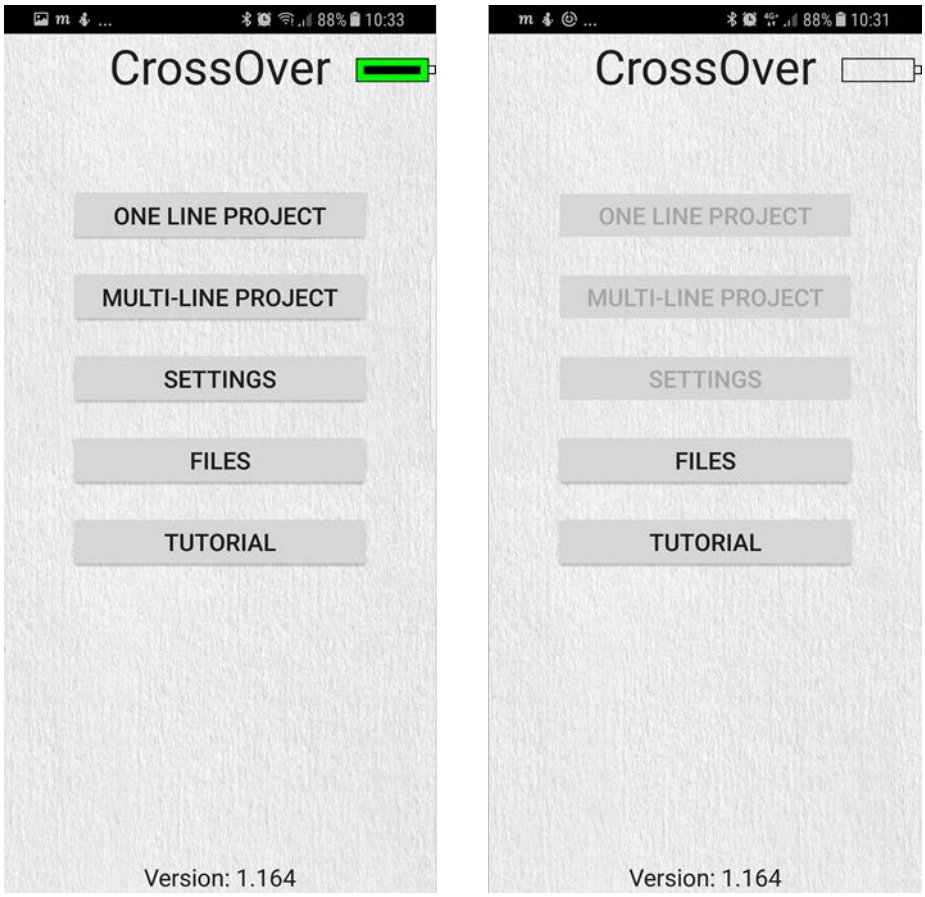

Figure 11, CrossOver start screen. Right: not connected device.

Data acquisition

Settings

In this menu, all parameters needed for controlling the radar system is set. The settings made here is valid for all subsequent data acquisition, regardless of project type. Referring to Figure 12, below, detailed description:

Trig Source: Defines what tells the CrossOver to gather data, most commonly the measuring wheel, but in certain applications, one can use Time or Manual also. In manual mode the user must tap the trig button on the screen for every A-scan.

Measurement Units: Metric or Imperial, when set to Imperial the units will be ft. and 10ths of ft.

Distance Interval: The distance between every A-scan, when Trig Source is set to Wheel, or Manual.

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

Soil Velocity: Defines the depth scale.

Number of Samples: Defines the time window, or maximum penetration depth, the adjacent Max Depth is calculated with the current Soil Velocity.

Data Mode: Defines how many bits are used while storing the resulting radar data. Or systems, below 600MHz, are capable of providing more than 16-bits of useful bits. Precisely how many depends on the point distance, survey speed and atenna frequency, the lower antenna frequency the

slower speed, the larger point distance, the higher number of useful bits. The limit is about19-20 useful bits.

GPS: Internal or External, if External you must set the proper baud-rate, see the manual for that GPS.

Wheels: Selecting the Wheel attached to the CrossOver. We provide two Wheel settings by default; Cart and Single.

If a user manufactures his own wheel, or if he attaches the odometer to a vehicle it is necessary to calibrate the wheel, which is done by either creating or editing a selected wheel, see Figure 12, below. Editing or creating a wheel is done in the same dialogue, just that in the latter case you should give the new wheel an name as well.

Calibration of a wheel is done by entering the calibration distance, hitting the <START CALIBRATION> button and then moving the will the set distance and press the <Stop button>.

If you know the number of tics/m the wheel is producing, you may as well tap in the correct number directly and then leave he dialogue. For our single wheel, correct number of tics is: -382, and for our Cart is it: 306.6.

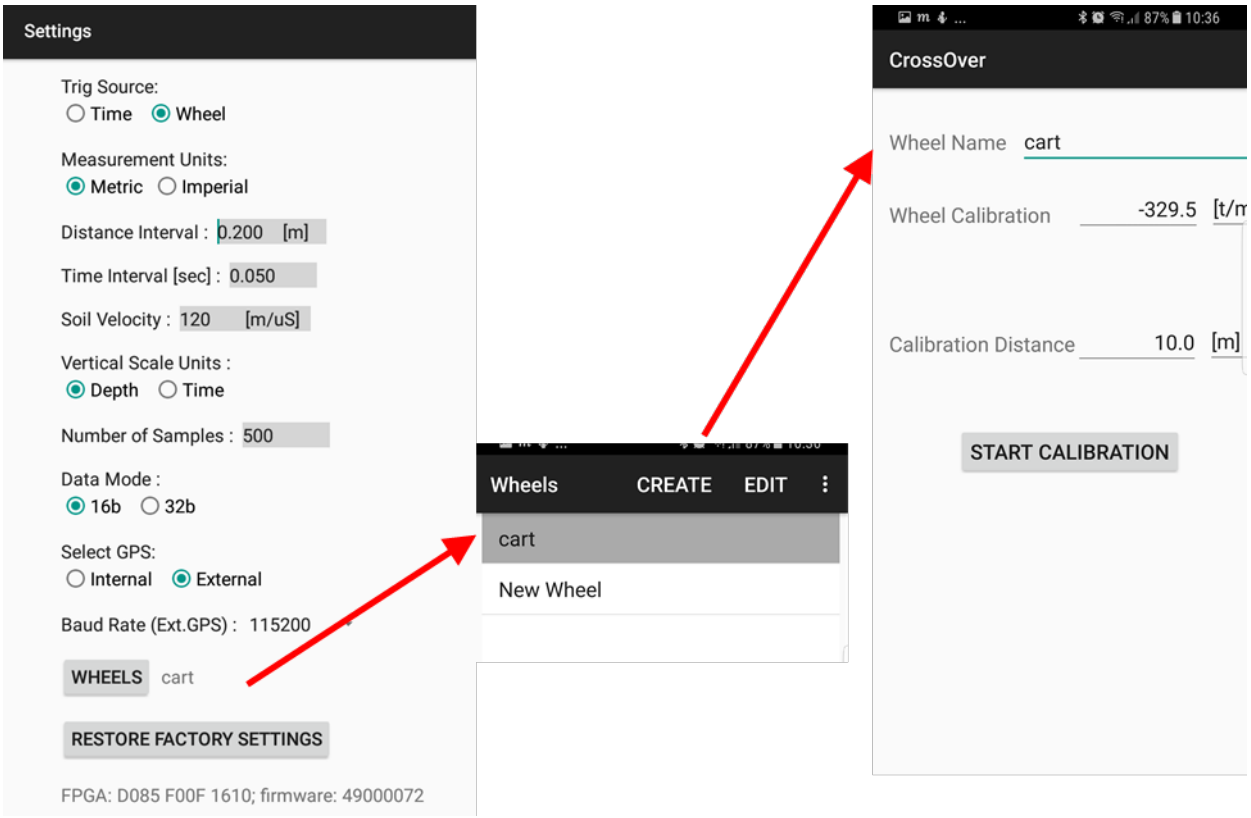

Figure 12, Settings menu and it's two child-menus, wheel selection and calibration

Screen and functions during acquisition

The screen and system functionality are much the same, regardless of what kind of project is being done. A user may choose between three different screens during data collection; they higher-, the lower, or both frequencies.

In the single frequency-view, the gain and contrast of the radar image can be altered by a vertical gesture(with one finger) on the rightmost part of the screen, see Figure 13, below. Also, the time-

zero can only be set on the single-frequency screen. Note that it's wise to set the time-zero correctly since its imported into the CrossPoint interpretation software and saved for subsequent profiles.

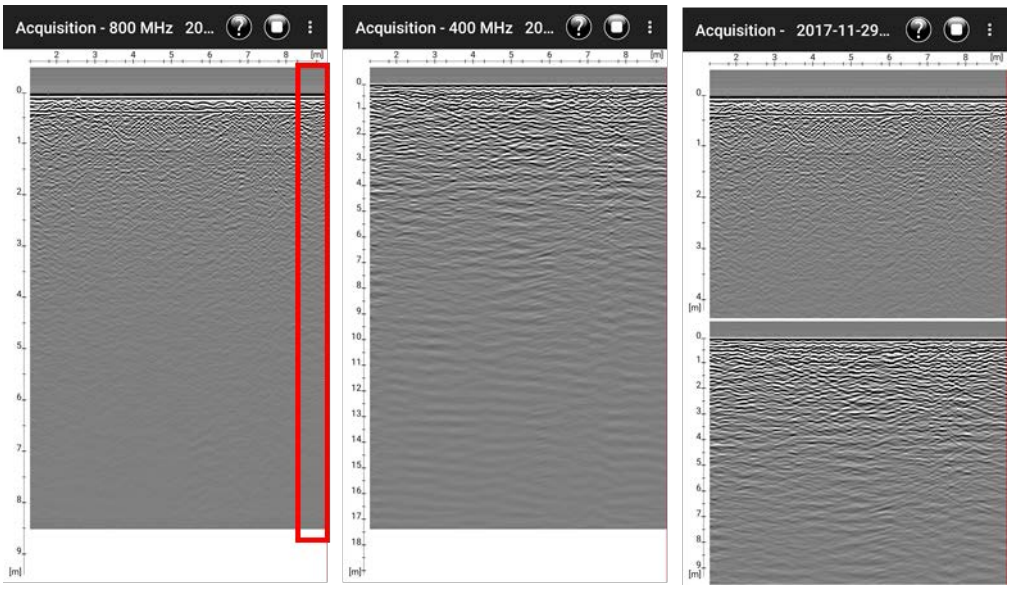

Figure 13, Screen during data collection, the marked red area is where a user sets gain/contrast of the image, by sliding upwards or downwards, note these screenshots are from a mobile.

Appendix B

Appendix C