Sensors & Software

CONQUEST® 100
User's Guide

2015-00049-05

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Component Serial Numbers (refer to packing list or the sticker on the component)

Comp:	Serial #	Comp:	Serial #
Comp:	Serial #	Comp:	Serial #
Comp:	Serial #	Comp:	Serial #
Comp:	Serial #	Comp:	Serial #
Comp:	Serial #	Comp:	Serial #
Vendor Name:		Date Received:	

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1999-00236-04

Important Safety Information

Use the DVL-500 only as specified in these operating instructions or the protection provided by the unit may be impaired.

The battery charger/AC adapter must only be connected to a power outlet which provides a protective earth (ground).

Connect the AC power cord only to designated power sources as marked on the battery charger/AC adapter.

The battery charger/AC adapter is rated for indoors use only.

Do not replace detachable MAINS supply cords for the battery charger/AC adapter by inadequately RATED cords.

Use only Sensors & Software Inc. battery charger/AC adapter - part number 100-55-0024, TDK-Lambda DT80PW180C.

Use only Sensors & Software Inc. battery - part number 100-55-0025, RRC Power Solutions Inc. RRC2020.

Do not position the DVL-500 so that it is difficult to disconnect the battery charger/AC adapter.

The exterior of this product should be cleaned using a damp cloth.

Safety Symbols

Consult this documentation in all cases where this safety symbol appears. This symbol is used to inform you of any potential HAZARD or actions that require your attention.

Table of Contents

1 Overview

Conquest 100 is an integrated ground penetrating radar (GPR) system specifically designed to meet the needs of the concrete inspection industry. The system consists of the Display Unit, Sensor Head, cable, survey grids, battery and battery charger/AC adapter. Optional items include a resizable handle for the Sensor Head, harness, Bluetooth remote, extra battery and a desktop battery charger.

The PCD (Power Cable Detector) feature uses an additional sensor built into the Conquest Sensor Head to detect and image current-carrying cables inside or beneath the concrete. The PCD data are collected at the same time as the GPR data so there is no additional effort required by the operator.

Conquest 100 is also available in an Enhanced configuration. The chart below summarizes the differences between the two configurations:

Criteria	Conquest 100	Conquest 100 Enhanced
How is data saved?	Screenshots (.JPG)	Screenshots (.JPG) and .GPZ files
How much data can be saved?	1 Project with: • 20 grids • 200 lines • 1000 screenshots	20 Projects each with: • 20 grids • 200 lines • 1000 screenshots
File organization	Lines and Grids	Projects containing Lines, Grids & Screenshots
PC-based data display	Any .JPG viewing software	Data can be opened in EKKO_Project

This manual references embedded software version V2 R3. This number can be found from the swipe down menu (Section 4.1).

Online training videos for the Conquest 100 can be found on Sensors & Software's website at:

https://www.sensoft.ca/training-events/training/conquest-100/ (Note: you will need to setup a login & password to access this)

2 Principles of Operation

The Conquest system uses ground penetrating radar (GPR) technology to image concrete and other similar materials (soil, rock, asphalt, etc.). GPR systems emit a high frequency radio wave pulse and detect the echoes that return from objects within the material. The concept is shown in Figure 2-1.

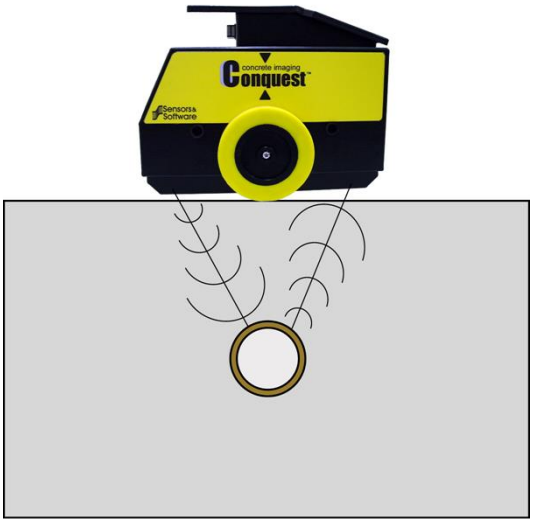


Figure 2-1:The Conquest Sensor Head transmits GPR signals into concrete and collects the signals that reflect from rebar, conduits and other targets embedded inside.

2.1 Line Scans Crossing Targets Perpendicularly

Conquest detects rebar and conduits which are generally rod-like in shape. The sensor should cross perpendicular to the long axis of the feature, i.e. it should cross the feature at 90° (Figure 2-2). When the sensor crosses a target, the result is the typical “hyperbolic” or inverted “V” response. The point (apex) of the hyperbola gives the position and depth of the feature, as shown in Figure 2-3.

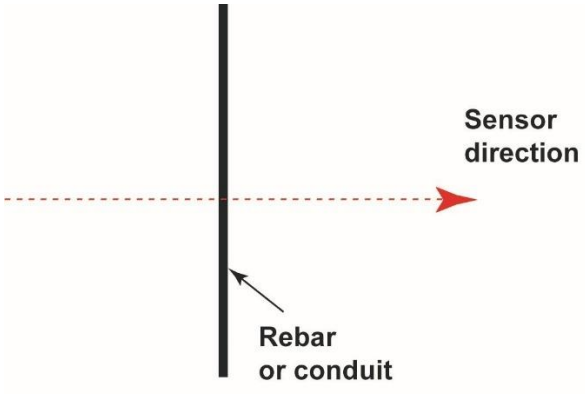


Figure 2-2: The red arrow represents the path of the sensor, crossing the rebar or conduit at 90°.

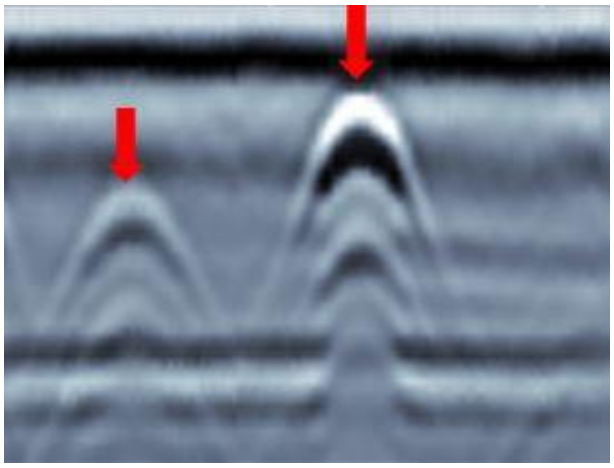


Figure 2-3: Crossing a rebar perpendicularly produces hyperbolas in the GPR Line image. The location of a target corresponds to the top or apex of the hyperbola, as shown by the red arrows

2.2 Line Scans Running Parallel to Targets

Moving parallel to (or directly on top of) the subsurface feature (Figure 2-4) results in a constant flat line in the data image (Figure 2-5). Other features such as layers and the bottom of concrete will also appear as flat responses.

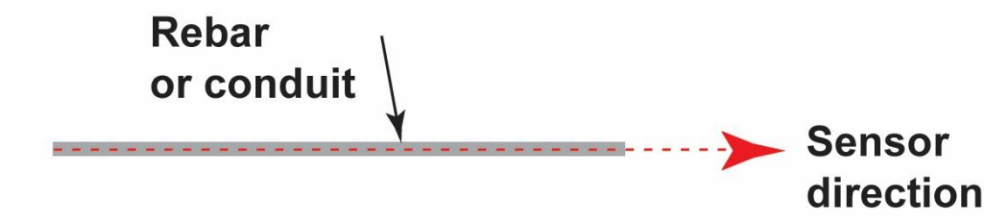


Figure 2-4: The red arrow represents the path of the sensor, running on top of a rebar or conduit.

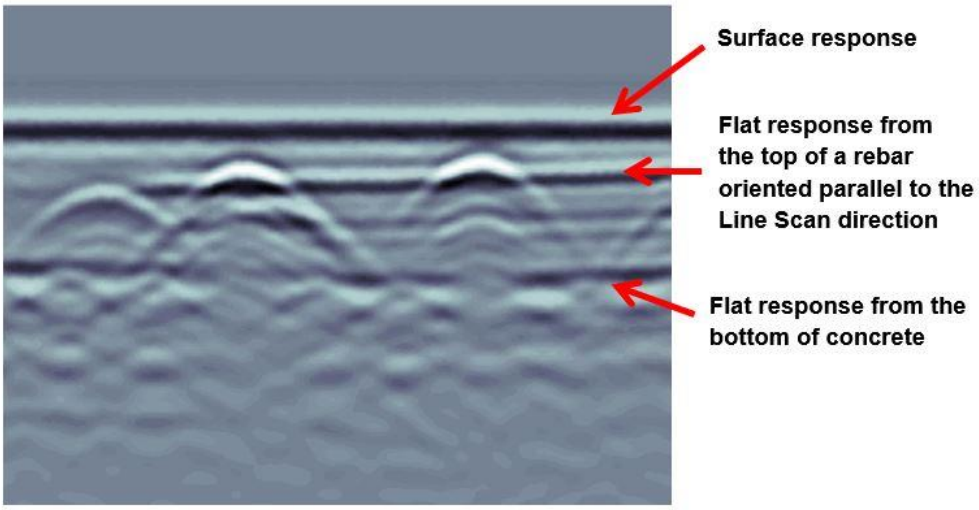


Figure 2-5: The image shows a flat response from the top of a rebar running in the same direction as the Line Scan. The flat response from the bottom of concrete is also indicated. The data image also contains 3 hyperbolas produced by crossing rebar perpendicularly

2.3 Concrete Cal

The “Concrete Cal” parameter is a measure of the velocity with which the radar signals travel through the concrete. The Concrete Cal is determined automatically based on the shape and positioning of hyperbolas. An accurate Concrete Cal is required for reliable depth estimates and depth slice images.

The user must set the Concrete Cal at each site for accurate depth measurements (Section 6.8.6). This can be determined once some GPR Lines have been acquired. Crossing the target perpendicularly is important to ensure an accurate Concrete Cal value.

The Concrete Cal number typically varies from 85 to 130 depending on moisture content, percentage of air entrapment, addition of fly ash or other admixtures and the aggregate size.

2.4 Grid Scan Collection

A Conquest **Grid Scan** consists of collecting a series of parallel lines in both directions on a grid (Figure 2-6). The lines labeled 1 to 7 are called “Numeric” lines, and lines labeled A to G are called “Alpha” lines. The origin (0, 0) of the grid is located in the lower left corner; the intersection of lines A and 1.

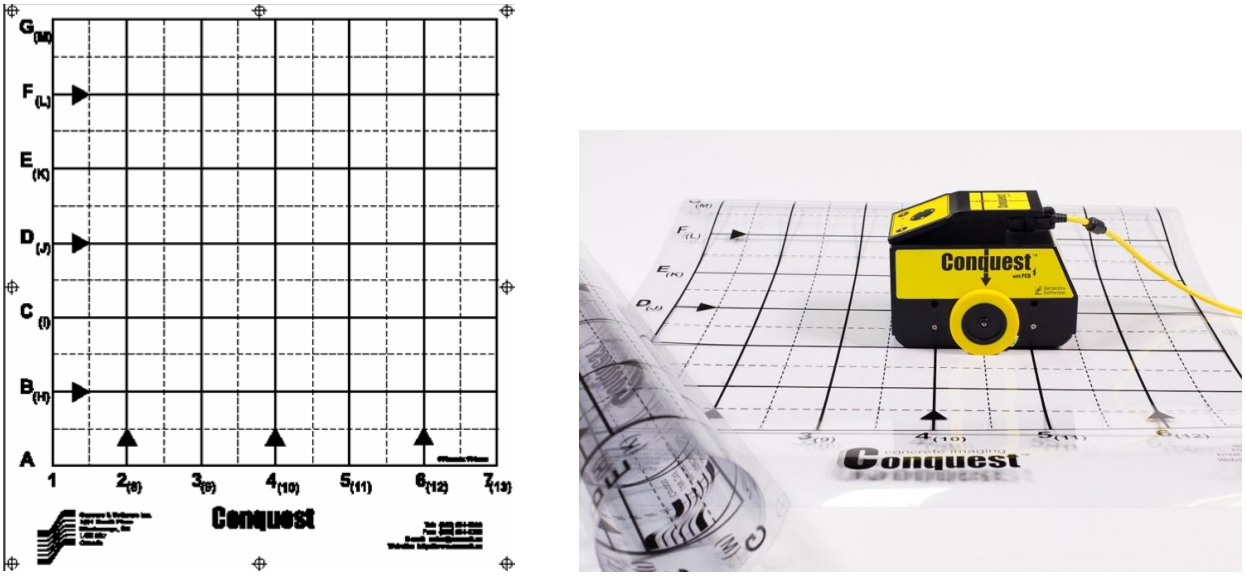


Figure 2-6: Grid Scans are based on collecting multiple line scans in two directions on a grid.

Once a grid is collected, the data can be processed to create a series of depth slices. Conquest displays 1 inch (25mm) thick depth slice images moving through the data volume from top to bottom (Figure 2-7).

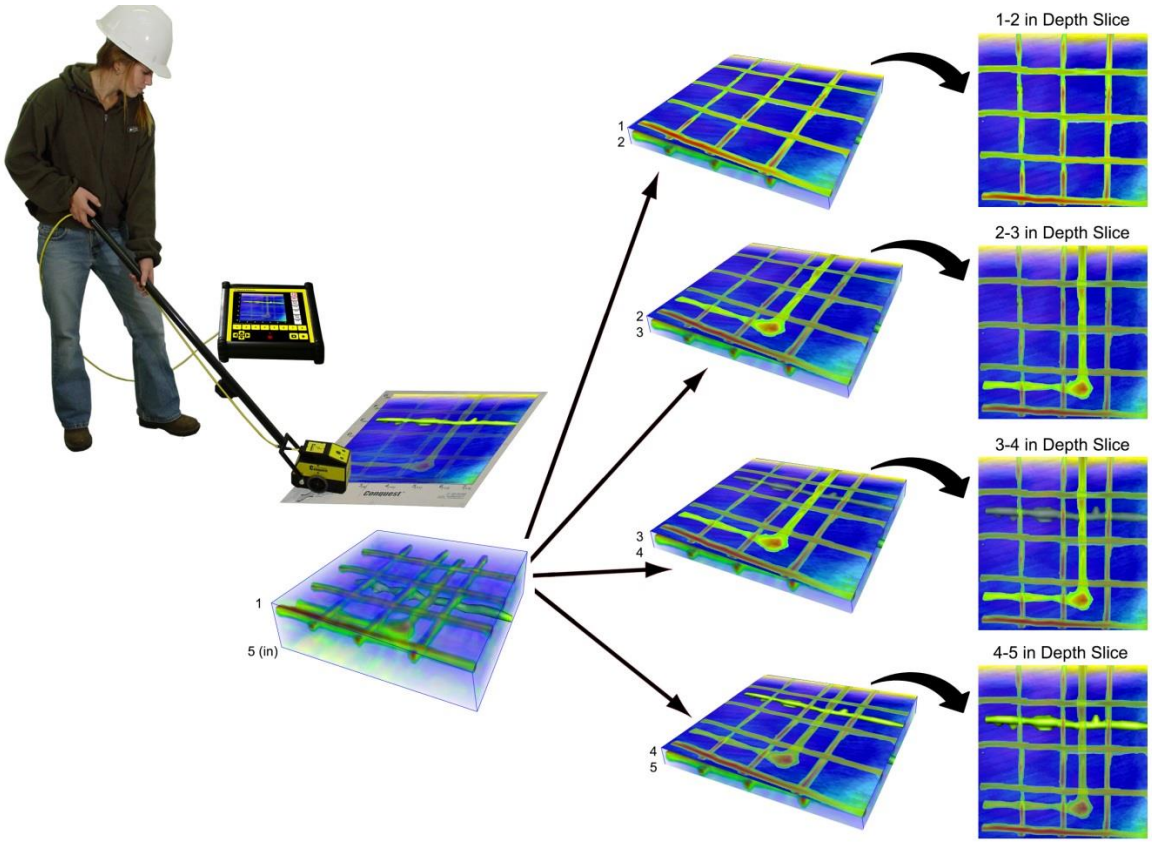


Figure 2-7: The concept of grid scanning with Conquest. Collecting a grid of data results in a data cube or 3D volume that is visualized as a series of 25mm (1 inch) thick depth slices.

2.5 Limitations

Before using the Conquest system, keep in mind that Conquest will not solve every problem that you will face.

2.5.1 New Concrete

Conquest will not work effectively on very new concrete. When concrete is very fresh, it is extremely conductive and absorbs the signals that the Conquest system emits and does not allow penetration to substantial depths. Depending on the concrete mix and local conditions, curing can take several weeks. As a result, the use of Conquest in the early stages of concrete construction has to be considered experimental until the concrete is adequately cured.

2.5.2 Concrete with Metal

In some situations, concrete may be covered by metal or contain a very fine screen mesh. This can happen in a plastered wall or in a terrazzo floor. In these cases, the metal screen acts like a perfect mirror for the radio signals emitted by the Conquest sensor. All the signals are reflected back and nothing will penetrate into the subsurface. At such sites, Conquest will not be effective for subsurface imaging.

Some slab-on-grade concrete floors contain fine steel fibers for crack control. The results of Conquest surveys on these floors vary with the amount and distribution of the metal. Basically, the more metal fibers, the poorer the penetration and overall results.

2.5.3 Penetration Depth

GPR uses radio waves to image the subsurface. These waves are strongly absorbed by the material being scanned. The electrical conductivity of the material dictates how deep signals will penetrate. Concrete can be highly variable depending on the original mix and state of wetting. Figure 2-8 shows how the depth of penetration can vary with concrete type.

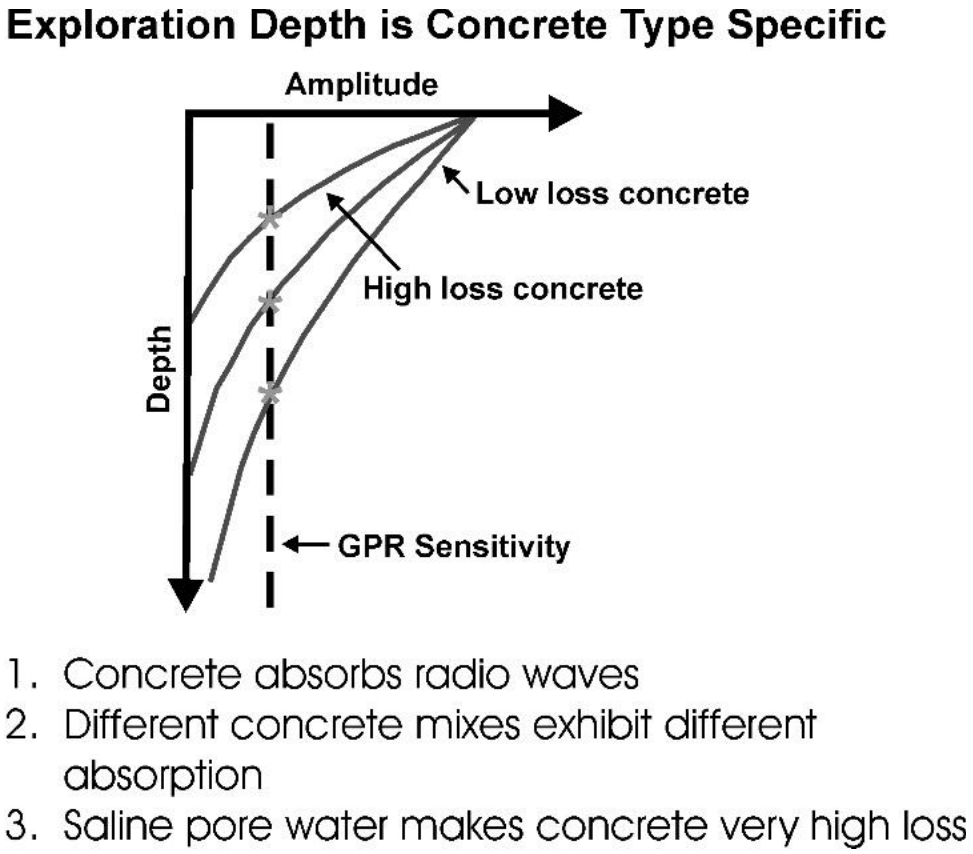


Figure 2-8: Concrete absorbs GPR signals and generally limits penetration to about 24" (0.6 m).

There is a finite limit on the concrete thickness that can be measured with GPR. Experience indicates that approximately 24" (0.6 m) of concrete is the limit of exploration under good conditions. In most practical scenarios, the presence of rebar or wire mesh, as well as the constituents of concrete (aggregate, admixtures, and air entrainment) will often result in penetration that is slightly lower than 24".

2.6 Power Cable Detection (PCD) Principles

Conquest 100 uses two technologies when imaging concrete for embedded objects: GPR and a device for detecting current-carrying wires (Figure 2-9) called the Power Cable Detector (PCD).

The PCD sensor maps the location of current-carrying cables by detecting the magnetic field created by AC current flowing (Figure 2-9) at 60 Hz (North America, parts of South America, Philippines) or 50 Hz (Europe, Asia, Australia). Ensure this setting matches the standard for the country you are in.

Like the GPR itself, PCD responses show up best when crossing the target perpendicularly (Figure 2-10). When collecting a Line Scan (Figure 2-11) or a Grid Scan (Figure 2-12), both GPR and PCD data are collected and displayed simultaneously.

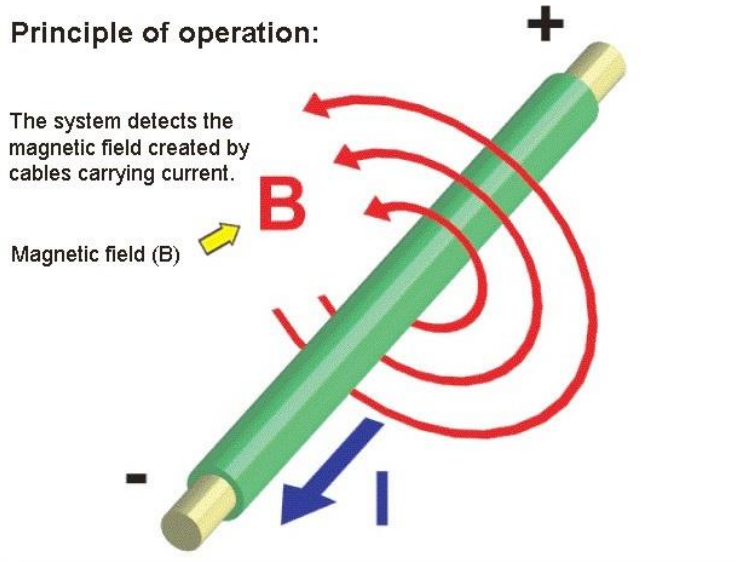


Figure 2-9: Depiction of the magnetic field created by AC current flowing in a wire.

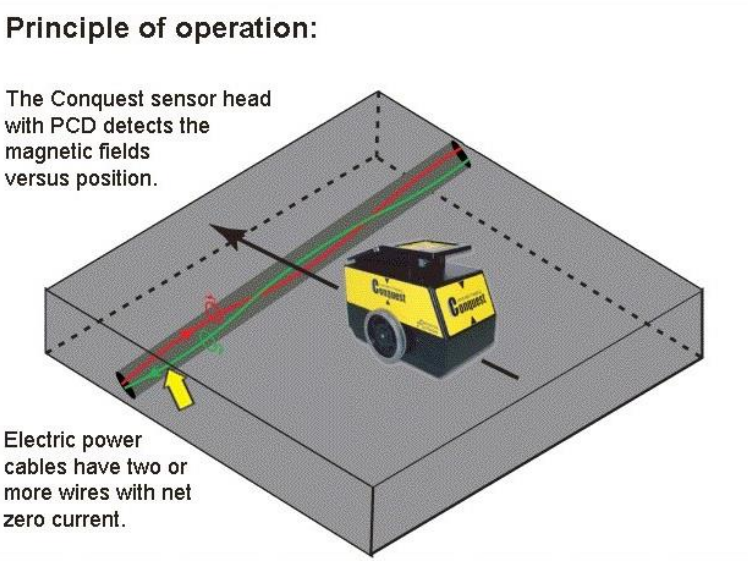


Figure 2-10: Conquest detects the current-carrying cable best when crossing it perpendicularly.

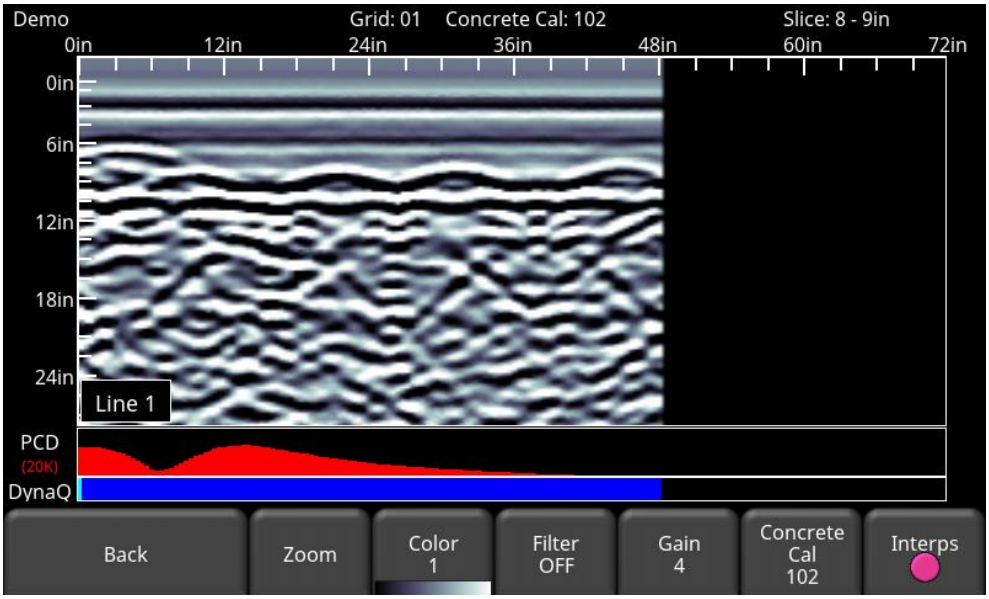


Figure 2-11: In Line Scan mode, the PCD profile appears under the GPR Line image. The PCD profile also appears after collecting each line in a Grid Scan.

With Grid Scan data, the PCD responses from all the grid lines are combined together to generate a map image of the magnetic field strength at the surface caused by flowing current (Figure 2-12). This image determines the position and location of the target but, unlike GPR depth slices, there is only one PCD image and it is not possible to measure how deep a target is based only on its PCD response.

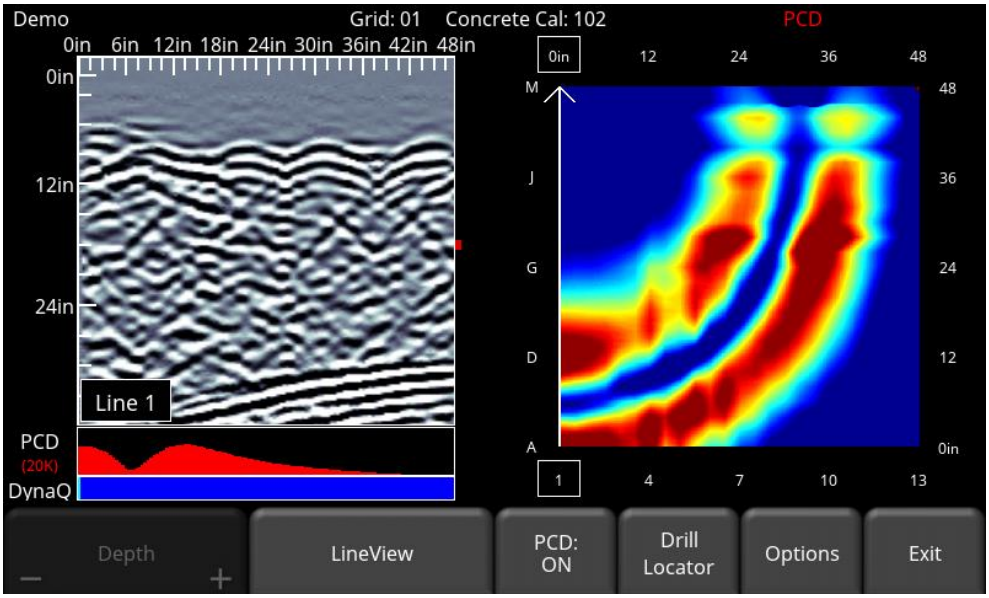


Figure 2-12: After Grid Scan data have been processed into depth slice images, the PCD image can also be displayed.

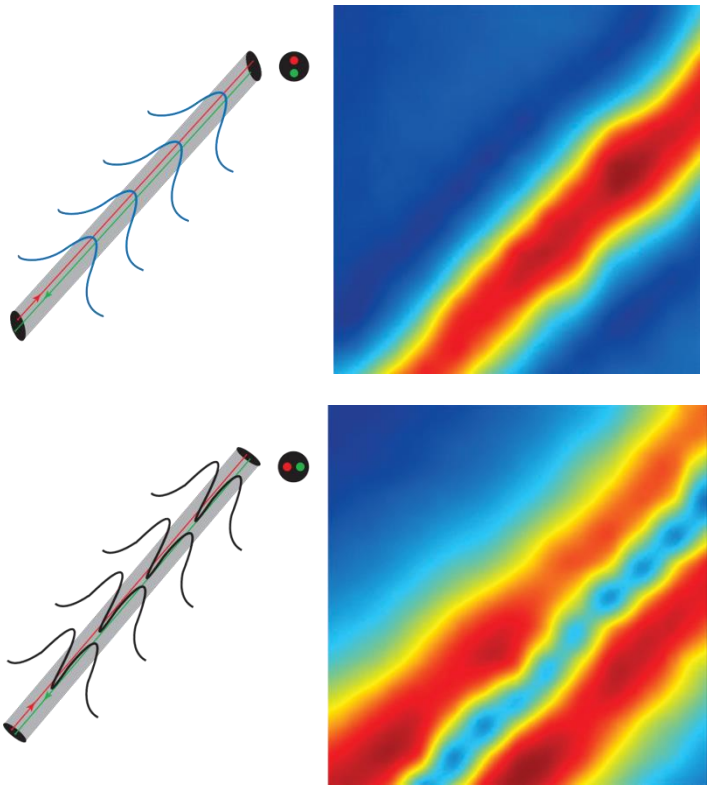
2.6.1 PCD Responses

The magnetic field generated by current flowing in wires can be simple or highly contorted depending on how the wires are oriented. Examples of simple and twisted wires are shown in Figure 2-13. The strength of the PCD response is affected by:

1. **Amount of current in the wire**: Typically a wire needs a minimum of 2 Amps of current to be detectable. If the amount of current in the wire is very small, the PCD response may be very weak or not detectable.

2. **Depth of the wire:** If the wire is deep, the PCD response may be very weak or not detectable.

3. **Orientation of the wires:** Whether the wires are twisted, or if they have constant separation, will affect the PCD response.



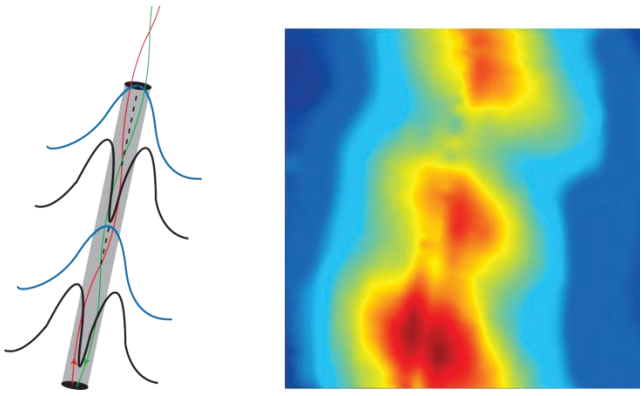


Figure 2-13: The shape of the magnetic field generated can be simple or complex depending on whether the wires are straight, vertically or horizontally oriented, their spacing and the degree of twist.

These factors mean that a deep wire with little current will not be detectable.

PCD can only detect 50 or 60 Hz AC current; it cannot detect wires carrying DC current, like telephone, alarm and communication wires.

PCD responses in the GPR data don't necessarily come from the ground. Overhead wires or nearby transformers can appear in the PCD response if the current is high enough.

2.7 Construction Practice

Before starting any work, you should obtain information about any construction practice that can help in your interpretation of the Conquest results. Remember that construction plans and drawings are just that: design plans! In construction, the implementation can deviate from the plan. Do not be surprised when your Conquest results show some differences from your expectations. This is a common occurrence.

2.8 Further GPR knowledge

While this manual explains operation of your Conquest 100 system, knowing GPR theory and principles will help in making your scanning successful. Sensors & Software's website (www.sensoft.ca) contains a wealth of information, case studies and support.

Click here to visit the FAQ (Frequently Asked Questions) page on our website to learn more topics, such as:

1. Basic GPR Theory
2. How deep can GPR see?
3. What creates GPR Reflections
4. How do I select a GPR frequency?
5. How can velocity be extracted from hyperbolas?

3 Assembling Conquest

3.1 Basic Assembly

Follow the steps below to assemble the Conquest 100 unit:

3.1.1 Open the shipping case

The components are shown in Figure 3-1.

Figure 3-1: Conquest 100 components in the carrying case.

3.1.2 Unpack the Components

Remove all the system components and ensure all items are present (Figure 3-2).

Figure 3-2: Conquest 100 Base system components

3.1.3 Connect Cable to Display Unit

Connect the male end of the standard yellow sensor cable to the port on the back of the Display Unit (Figure 3-3). Ensure that the connection “clicks” into place so it cannot be disconnected without squeezing the clips on either side of the connector.

Figure 3-3: Sensor cable connection to the Display Unit

3.1.4 Connect Cable to the Sensor Head

Connect the other (female) end of the yellow sensor cable to the Sensor Head in a similar manner. Note that the receptacle is under the handle grip (Figure 3-4).

Figure 3-4: Sensor cable connection to the Sensor Head

Insert Battery into Display Unit

Conquest 100 uses a Lithium-Ion battery with an external “Battery Level” button to indicate the current level of battery charge.

Note: When using the battery for the first time, be aware that the battery is shipped from the factory at about 50% capacity in a “transport” state for increased safety. The battery and battery level button will not work until the battery has been initialized by either:

a) Inserting the battery into the Display Unit and then plugging the Battery Charger/AC Adapter into an AC source and connecting it to the Display Unit, or
b) Connecting the battery to the optional desktop charger.

The battery can be used immediately after initializing it but with a capacity of 50%, it won’t last as long. It is best to fully charge the battery before use.

Figure 3-5: Battery with Battery Level Indicator

Any long term storage of the battery (weeks not days) should be done with the battery at approximately 50-75% capacity.

See Section 13.2 for more information about the battery.

Insert the battery into the battery compartment on the right side of the Display Unit. Loosen (do NOT remove) the 2 thumbscrews until the door can swing open and insert the battery. The battery compartment is keyed with rounded corners so the battery can only go in the right way. Insert the battery such that the battery tab remains out (this is so you can easily remove the battery), as shown in Figure 3-6. Close the battery compartment door and tighten the thumb screws.

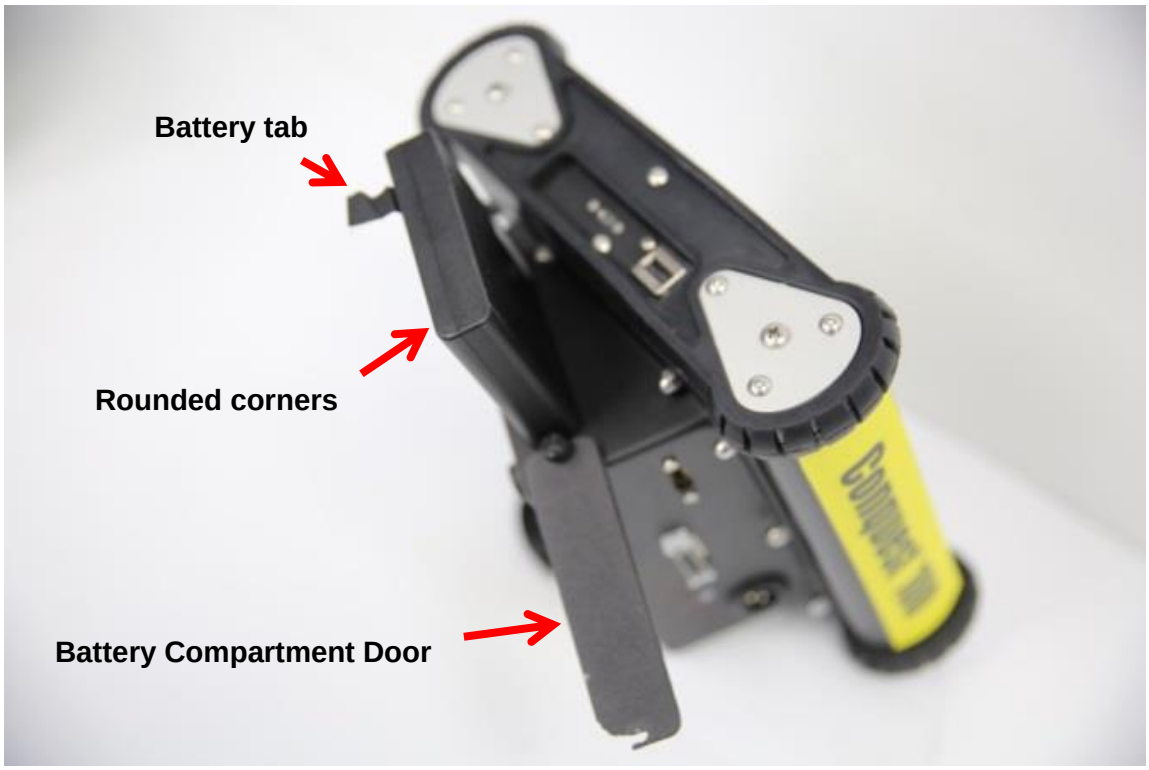


Figure 3-6: Inserting the battery into the Display Unit. The compartment has rounded corners on one side to match the shape of the battery.

3.1.5 Charging the Battery

See Section 0 about using the battery the first time.

To charge the battery, insert it into the Display Unit and connect the Battery Charger/AC Adapter to the 3-pin connector on the back of the Display Unit (Figure 3-7). The light on the back of the Display Unit indicates if the battery is charging (orange) or charged (green).

The battery can also be plugged into the optional desktop charger.

The Conquest 100 system can be used while the battery is being charged (for details, see Section 13.2).

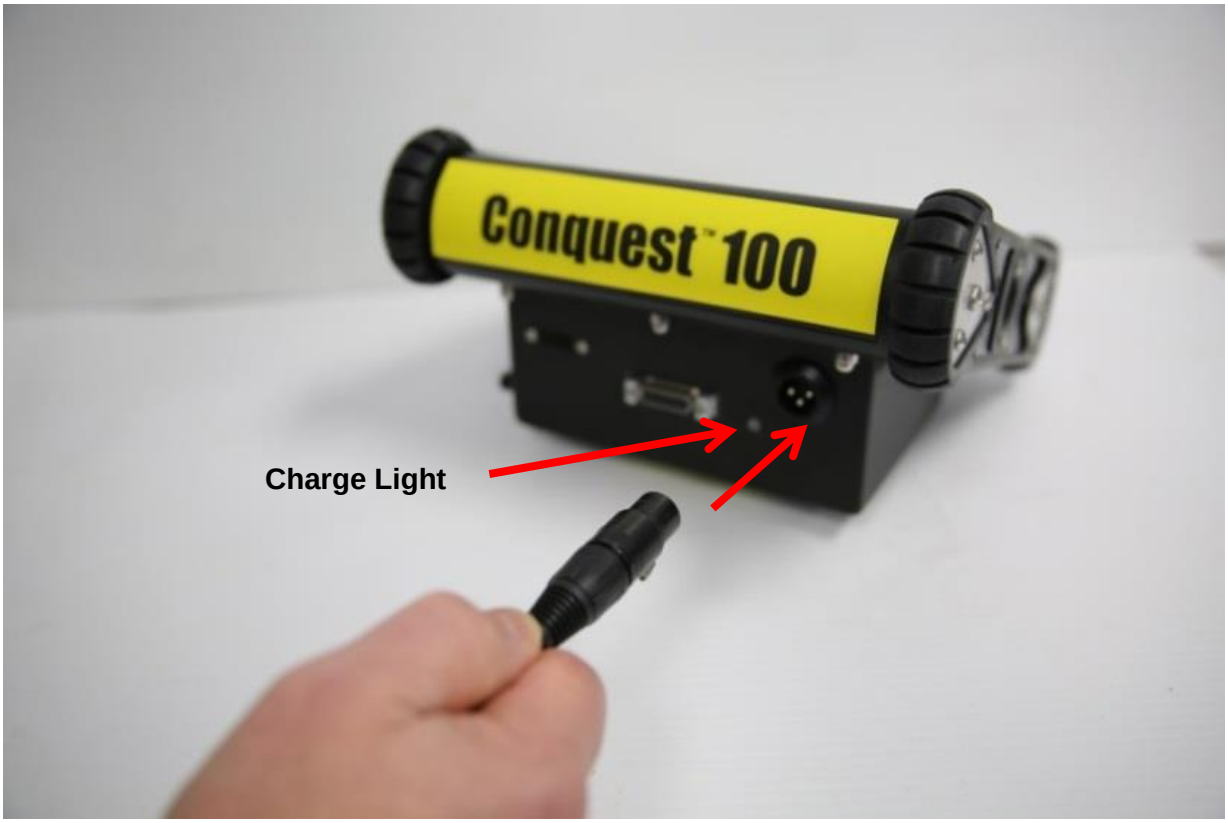


Figure 3-7: Connecting the Battery Charger / AC Adapter to the Display Unit. The light beside the connector is colored orange when charging and green when fully charged.

3.2 Optional Accessories

There are some optional accessories to make surveying easier and more comfortable.

Figure 3-8: Available optional items include a resizable handle & harness

3.2.1 Resizable Collapsible Handle

The optional handle allows the operator to stand up during data collection on floors.

The long handle consists of 3 threaded pieces (Figure 3-9) screwed together by hand. A shorter handle can be made by leaving out the middle piece.

Figure 3-9: The optional resizable handle to the Sensor Head allows data collection to be performed from a standing position.

To connect the handle to the Sensor Head, slightly retract the 2 spring-loaded knobs on the end of the handle forks, align with the two holes at the back of the Sensor Head and release them to lock into position (Figure 3-10). Ensure that the cable remains below the handle to avoid stressing it.

Figure 3-10: The 2 spring-loaded knobs on the forks of the handle are typically inserted into the holes at the back of the Sensor Head.

There is an additional set of handle mounting holes at the front of the Sensor Head which are used under unique circumstances such as scanning a vertical surface, or in confined spaces when pulling the Sensor Head towards the user may be preferable to pushing it (Figure 3-11).

Figure 3-11: The handle can also be attached to the Sensor Head using the holes in the front. This mounting position can make it easier to scan walls or complete surveys in situations where pulling the Sensor Head is preferable to pushing it.

Secure the cable to the handle using the Velcro straps. Ensure there is enough slack in the cable that, as the handle moves up and down, it does not strain the cable or the connector.

3.2.2 Carry Harness

For convenience during data collection, the Display Unit can be carried using the optional harness shown in Figure 3-12.

Figure 3-12: The Display Unit can be attached to the optional harness for operating the system.

The clips on the harness connect to the rings in the four corners of the Display Unit. The longer straps go over the shoulders and the short straps go under the arms. Adjust the length of the straps for comfort.

3.2.3 Deluxe Harness

The Deluxe Harness allows the operator to easily mount the Display Unit at a comfortable, fixed viewing angle for ease of operation. The harness resembles a vest which is pulled over the body (Figure 3-13).

Figure 3-13: Deluxe harness

3.2.4 Conquest Transducer Cable (1.75m)

A shorter cable (1.75m) may be more convenient when using the Conquest 100 system with the handle and harness.

3.2.5 Battery Pack

An extra battery (Figure 3-14) would be useful for long days, where AC power is not available.

Figure 3-14: Conquest 100 Battery Pack

3.2.6 Desk Charging Station

The optional Desk Charging Station provides a method of charging the battery without having to insert it into the Display Unit and connect the Battery Charger/AC Adapter (Figure 3-15).

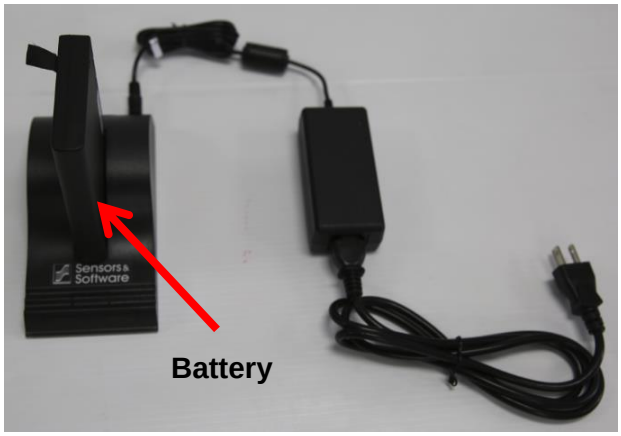


Figure 3-15: The optional Battery Desk Charger.

3.2.7 Bluetooth Trigger

A Bluetooth trigger can be used to start and stop the system (Figure 3-16). This is especially useful when standing up and using the handle (but without the harness). Bluetooth operation is described in Section 5.1.8.

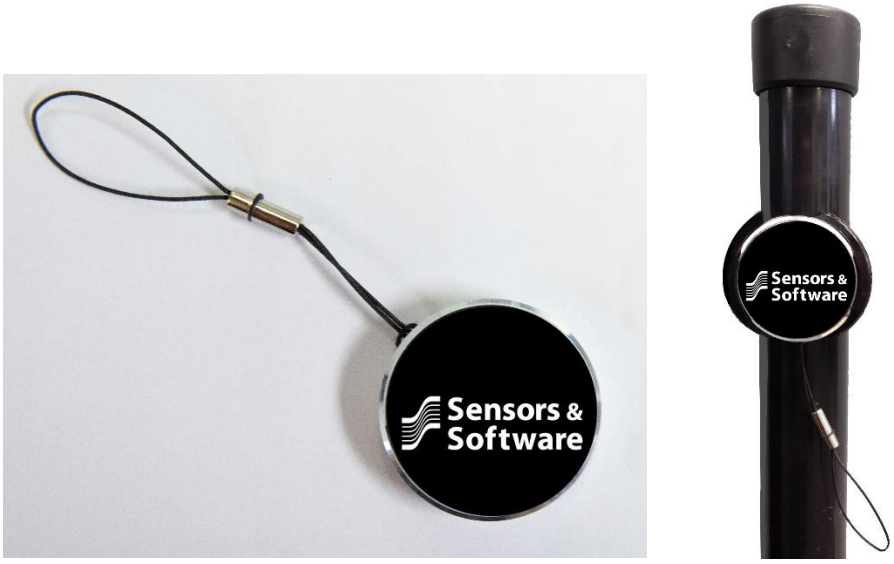


Figure 3-16: Bluetooth Trigger (L) and attached to the handle (R)

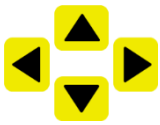
3.3 Display Unit

Data collection is controlled by the Display Unit. The Display Unit has embedded software to set survey parameters and collect, display and store data.

The Display Unit offers touchscreen operation, as well as a water-resistant membrane keypad with a number of buttons that can be pressed to perform various tasks. All standard operations can be done using the keypad while some specialized functions can only be done with the touchscreen.

3.3.1 Keypad Buttons

Use the following table as a guide to working with the keypad on the Display Unit:

Item	Description
Menu Buttons 	The yellow buttons labelled 1 to 8 correspond to menu choices that appear on the screen.
4-way directional keypad 	Controls Up/Down/Left/Right operations in certain menus.
Camera 	Saves a screenshot of line data, grid data or processed depth slices.
Asterisk / Special Function 	Used for adding Flags during data acquisition.

3.3.2 Power Button and Lights

Under the 8 yellow buttons is a red power button used to turn the system on and off. The light above the button changes colors as the system boots up and also indicates battery power level during operation (Section 3.5.1).

Figure 3-17: The Display Unit

3.3.3 USB port

The Display Unit saves data to internal memory. Data can be transferred to a PC for post processing and report writing.

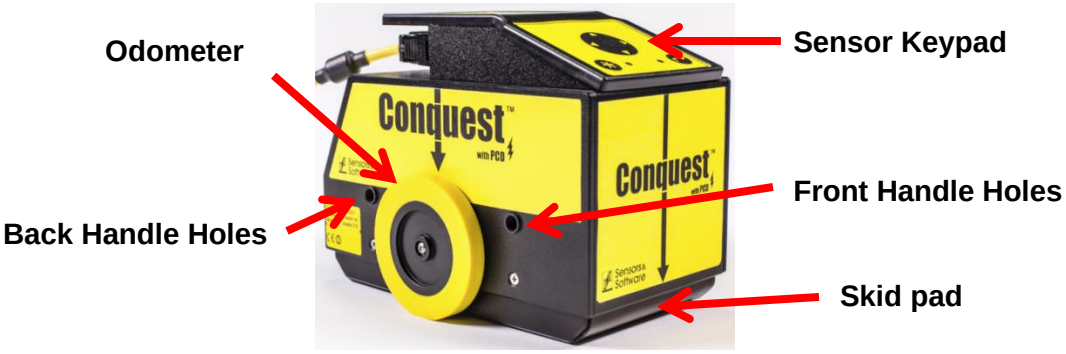
Figure 3-18: The Display Unit has a USB port for data export.

To transfer data from the Display Unit to a PC, insert a USB 2.0-compatible drive (memory stick) into the USB port on the right side of the Display Unit (Figure 3-18). Once the USB drive is recognized, the user is prompted to confirm they would like to copy the data.

The USB port is also used to update the Display Unit software (Section 13.5). When a USB drive with a new embedded software installation is inserted, the user is prompted to confirm they would like to update the software.

3.4 Sensor Head

3.4.1 Features



- **Housing:** Contains the GPR transmitter, receiver and PCD electronics.
- **Odometer:** integrated, spring-loaded, 2-wheeled odometer for triggering data collection.
- **Skid pad:** a replaceable wear-pad to protect the bottom of the Sensor Head from abrasion.
- **Handle Holes:** two sets of holes (front and back) for attaching the handle.
- **Sensor Keypad:** for remote control of data collection (Figure 3-20).
- **Speaker:** for the Conquest operator to hear audio “beeps” indicating the start and end of the line.
- **Alignment Arrows:** The Sensor Head has a red dot with lines and arrows drawn to the front, back and sides in the center of the unit. Positions on Conquest Line and Grid Scans are always based on the center of the Sensor Head, so the dot and arrows are important for lining up the Sensor Head properly at the start of a line (Figure 3-16).

Figure 3-19: The Sensor Head has a red dot in the center with 4 arrows drawn across the top and down the sides in each direction. These arrows help to properly align the Sensor Head for data collection.

3.4.2 Sensor Keypad

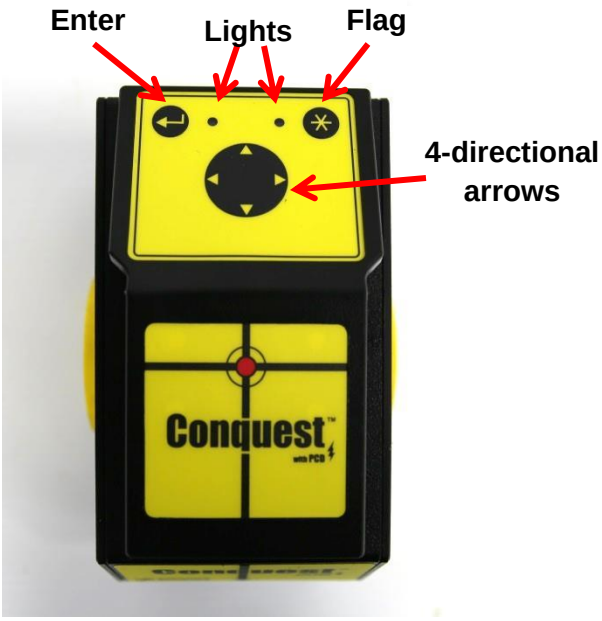


Figure 3-20: The Sensor Head keypad.

Enter Button: Pressing the **Enter** button will start data collection in Line Scan and Grid Scan modes. Pressing Enter again will stop data collection. In Grid Scan mode, data collection will stop automatically when you reach the end of the line, but you can end a line prematurely by pressing Enter.

Left Light: The light beside the Enter button is solid green after the Sensor Head is powered on. A flashing green light after the system has fully booted up indicates a problem with the system.

Right Light: The light beside the Star (*) is off but turns solid red during data collection.

Star (*) Button: Pressing the **Star** (*) button will put a flag in the data during Line Scan collection.

Arrows: The 4-way directional arrows are used anytime the screen requires this type of movement, for example, changing the selected line in Grid Mode.

3.5 Powering Conquest

3.5.1 Powering Up

After the system is completely assembled, power it up by pressing the red power button on the front of the Display Unit.

When the system is powered by battery, the light on the front of the Display Unit will illuminate green as the system boots up. Once it boots up, the color of the light will depend on the current battery charge:

- 100% to 20% = green
- 20% to 10% = orange
- 10% to 0% = red

When the system is powered by the AC Adapter, the light on the front of the Display Unit will illuminate red at first and then orange as the system boots up and remain orange until the system is powered down.

As the Sensor Head is initialized, it will beep and the lights on the Sensor Head keypad will flash several times. When the main menu appears on the Display Unit, the system is powered up and ready to collect data.

There are certain conditions when the user will be forced to do a Sensor Calibration on bootup. These are:

- A different Sensor Head is connected to the Display Unit
- After an embedded software update
- User resets to factory defaults (Section 5.1.12)

The procedure for the Sensor Calibration is described in Section 5.2.7.

The Sensor head **MUST** be connected to the Display Unit for the Sensor Calibration. Do **NOT** connect the Sensor Head after system power up has begun. Power down the system **BEFORE** connecting the Sensor Head cable; otherwise damage to the Sensor Head could result.

3.5.2 Powering Down

The system can be powered down at any time by pressing the red button on the front of the Display Unit. The user is prompted to confirm they would like to power down the system.

4 Main Screen

The first time you turn on Conquest 100, you will need to configure the system (Figure 4-1). A series of screen prompts will allow you to setup the language, units, date & time, and some other options. A reboot is required once this is complete. This will have to be done anytime the embedded software is updated (13.6).

Figure 4-1: Initial configuration screen

Every subsequent time the system boots up, you will see the main screen (Figure 4-2). If you have purchased (or upgraded to) the Conquest 100 Enhanced, you will see the screen in Figure 4-3.

Figure 4-2: Conquest 100 main menu

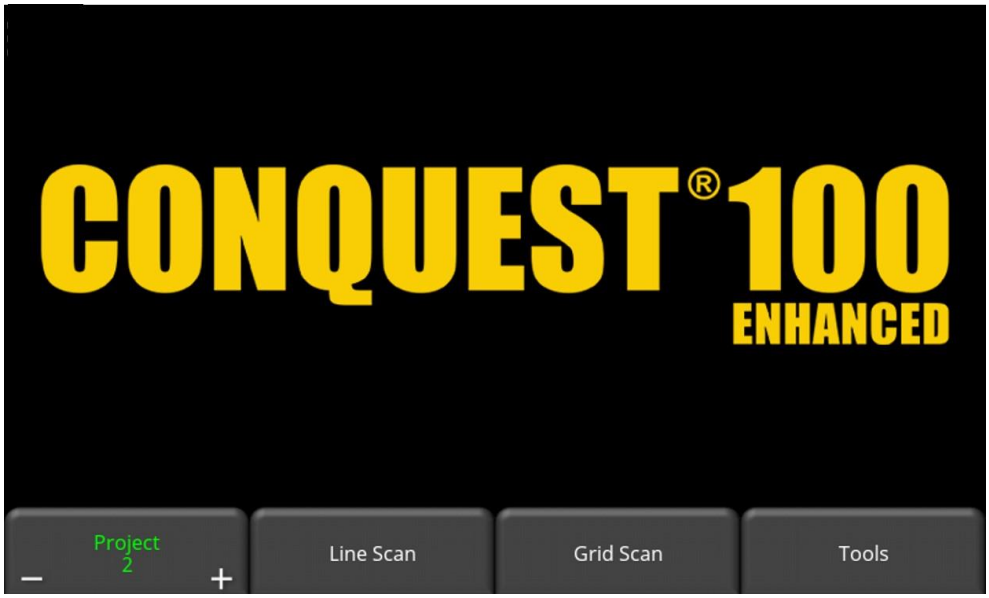


Figure 4-3: Conquest 100 Enhanced main menu

The differences between the two configurations are described in Section 1. Everything remains the same in the on-board software, except for the Enhanced system where the main screen will allow you to organize data into Projects. Within each Project, you can have a number of lines and/or grids.

With the Enhanced system, select the Project number to work in. Projects that contain data are in red color, whereas those with no data are in green. As you change Projects, the main screen

will also display the number of lines and grids collected in each Project. These will appear under the Line Scan and Grid Scan buttons respectively.

4.1 Swipe Down menu

When the Display Unit is powered on, you can “swipe” your finger from the top of the screen towards the bottom, to bring up a drop-down menu with the following items:

Date and Time: The current date and time (12-hour clock) are displayed. The time needs to be changed for your local time zone.

Battery: The battery icon displays the amount of power remaining in the battery. If the Display Unit is connected to the battery charger, there will be a flash shown on the battery symbol.

Wi-Fi Network: Indicates if the system is connected to a wireless network and, if so, the name of the network.

Volume: The Volume + and - buttons are used to increase and decrease the sound.

Brightness: The Brightness + and - buttons are used to increase and decrease the screen brightness. Increasing the Brightness setting may improve the visibility of the screen in bright sunlight. Note, however, that increasing the screen brightness also increases power consumption, reducing battery life.

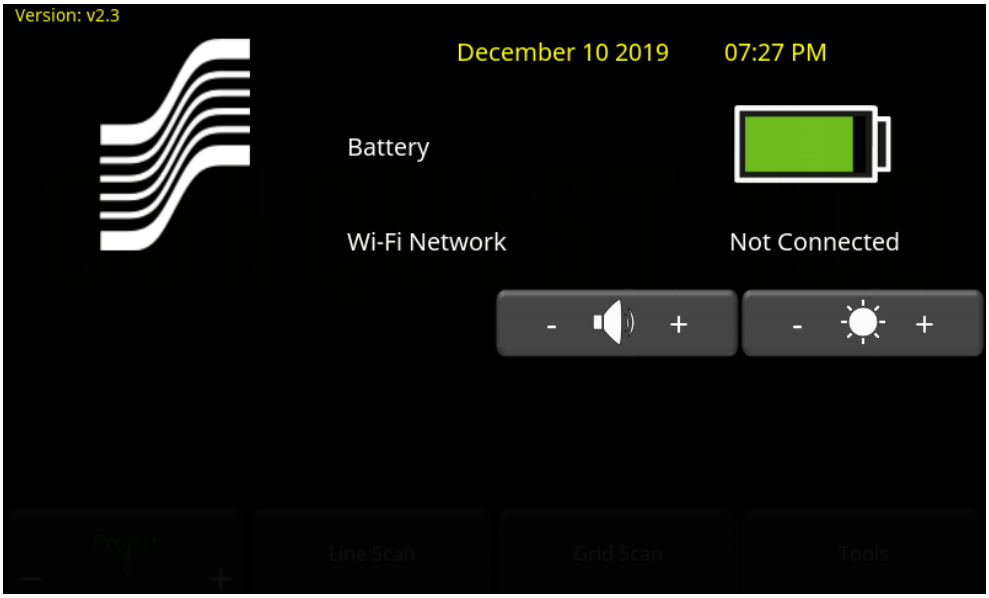


Figure 4-4: Swipe Down Menu

The version number of the embedded software is displayed in the top left corner.

To close the Swipe Down menu, touch anywhere on the screen below the Swipe Down menu.

5 Tools & Setup

Press **Tools** to enter this menu, shown in Figure 5-1. Here you can set preferences (Section 5.1), perform system tests (Section 5.2) and manage files (Section 5.3).

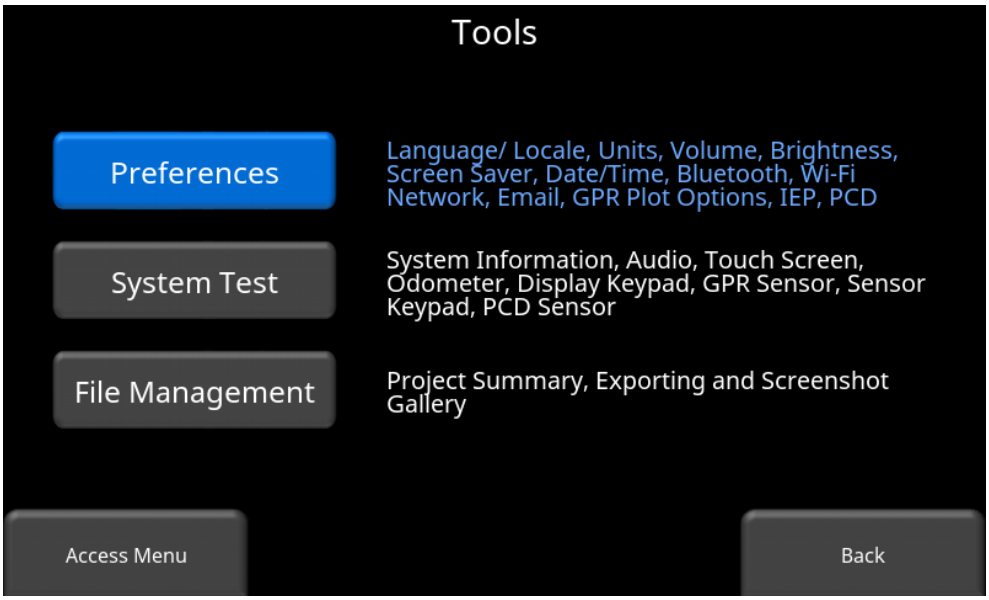


Figure 5-1: Tools menu

5.1 Preferences

Press **Preferences** to enter the sub-menu as shown in Figure 5-2. Each parameter is described below:

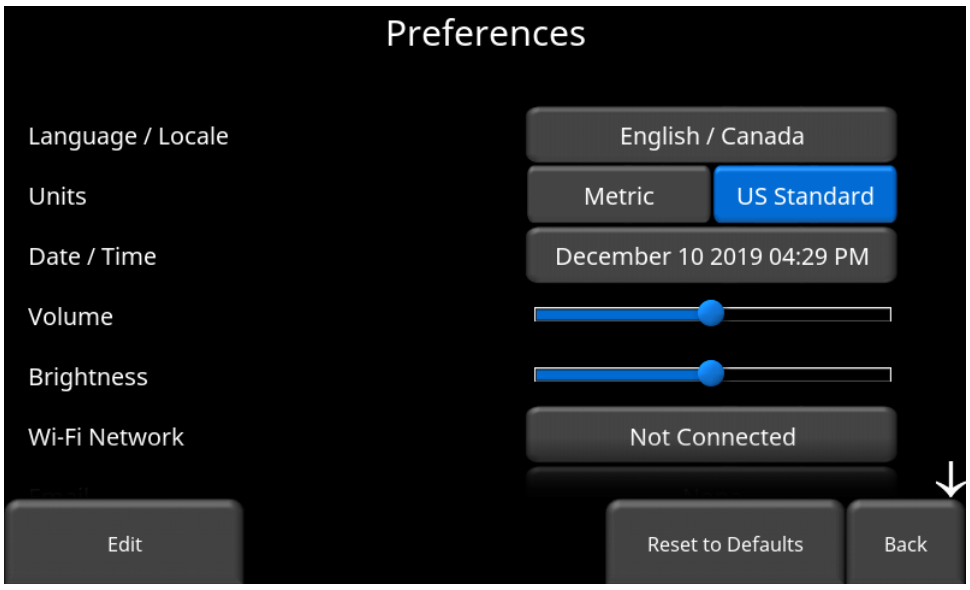


Figure 5-2: Preferences menu

5.1.1 Language

Selecting this language will display the screen shown in Figure 5-3. The current language is displayed; pressing the **+** and **–** buttons on either side of the language will cycle between the languages currently available: English, French, Spanish, German, Japanese and Chinese. All text and functions will be displayed in that language.

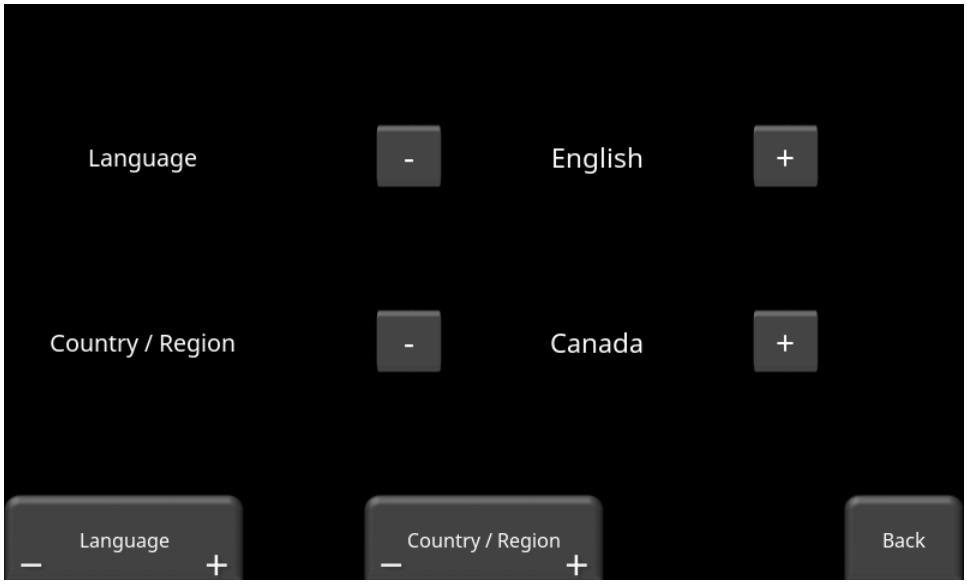


Figure 5-3: Setting language and country/region

Note: If the language gets accidentally changed to something unfamiliar, pressing the following buttons from the main menu will bring you back to this option: **8** then **1** then **1**. Then press **+** or **-** repeatedly until the desired language shows up.

Below that, the Country/Region is displayed. Press the **+** and **–** buttons on either side of the displayed Country/Region to alphabetically move to the next or previous country or region.

Alternatively, both Language and Country/Region can be changed by pressing the **+** and **–** buttons on the bottom of the screen. Press **Back** when you are done.

5.1.2 Units

Select desired units by pressing the **US Standard** or **Metric** button.

5.1.3 Date/time

Selecting this option takes you to a screen where the date and time can be set. The time is manually set and will not automatically correct for daylight savings time.

5.1.4 Volume

Scroll bar for adjusting the volume of clicks and beeps heard during operation. This can also be changed by using the Swipe Down menu (Section 4.1) anytime the system is not collecting data.

5.1.5 Brightness

Scroll bar for adjusting the brightness of the screen. This can also be changed by using the Swipe Down menu (Section 4.1) anytime the system is not collecting data. Note that increasing the brightness consumes more battery power.

5.1.6 Wi-Fi Network

Connecting to a wireless network allows you to send a screenshot as a mini-report to someone by e-mail. This connection can be through a standard Wi-Fi network or through a hotspot on your mobile device while in the field.

Note that Conquest 100 CANNOT connect to Public Hotspots (typically restaurants, hotels and airports) that require a web-based login and acceptance of their Terms & Conditions. It also CANNOT connect to unsecured networks (networks that do not require a password).

If you are already connected to a Wi-Fi network, the name of the network is listed beside the Wi-Fi Network field. Selecting **Wi-Fi Network** takes you to a sub-menu (Figure 5-4) for connecting to available Wi-Fi networks.

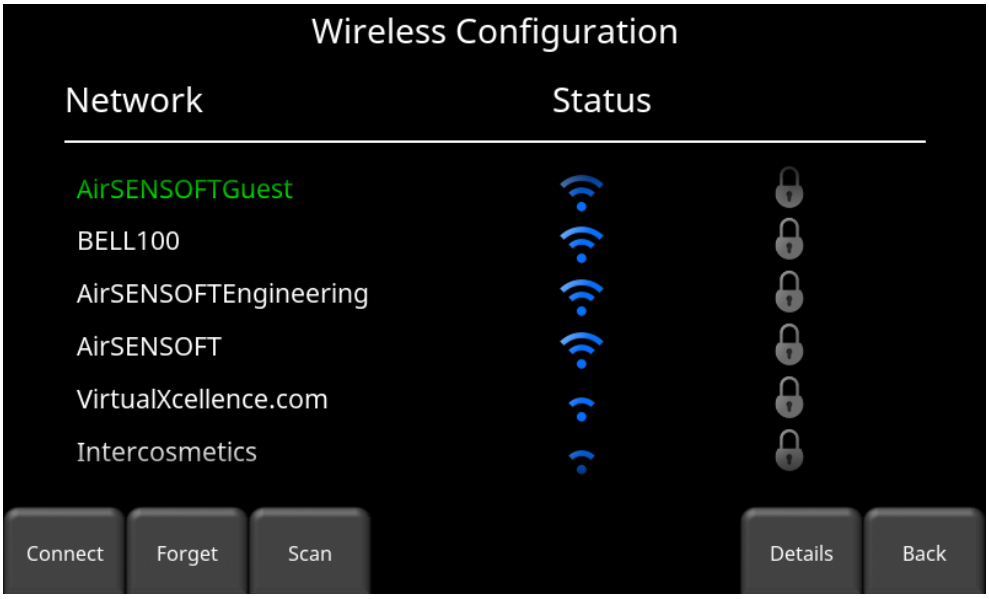


Figure 5-4: Select from available Wi-Fi networks

Use the 4-way directional arrows or touchscreen to select the network. The color of the Network Name indicates the status:

- Green = Connected
- Yellow = Not currently connected, but remembered from before when you previously connected and entered a password.
- White = Not connected

The buttons at the bottom of the screen perform the functions described below:

- **Connect** – Select the desired network and press Connect. If the connection is successful (this can take a minute or so) a screen appears asking for the password for that network. If the network name is yellow (from a previous connection to this network), it will not ask for a password because it is a remembered network. Once it connects the Network Name will turn green.
- **Forget –** Use the Forget button to remove the password for connected or remembered networks (text in green or yellow). Once the 'forget' button is pressed on a selected network it will remove the password and the Network Name will turn white. You will also be disconnected if you are currently connected to that network.
- **Scan –** Scans for any available networks in the area and displays them in order of strength of signal. You may need to press this button a second time if you don't see the network you are looking for.
- **Details –** Pressing this button displays the security settings and device addresses related to the selected network.
- **Back –** Press this button to return to the Preferences screen.

5.1.7 E-mail

Press the button on the right (which may have an existing e-mail address or say None) to arrive at a sub-menu where you can setup and configure a sending e-mail address. Ensure that this e-mail address already exists. This is the sending account where messages will originate from. All mini-reports received by the recipient will appear to come from this account.

NOTE: you must be connected to a wireless network before you setup an E-mail address.

Using GMAIL

The system is already pre-configured to use GMAIL as the e-mail provider for the sending account (Figure 5-5)

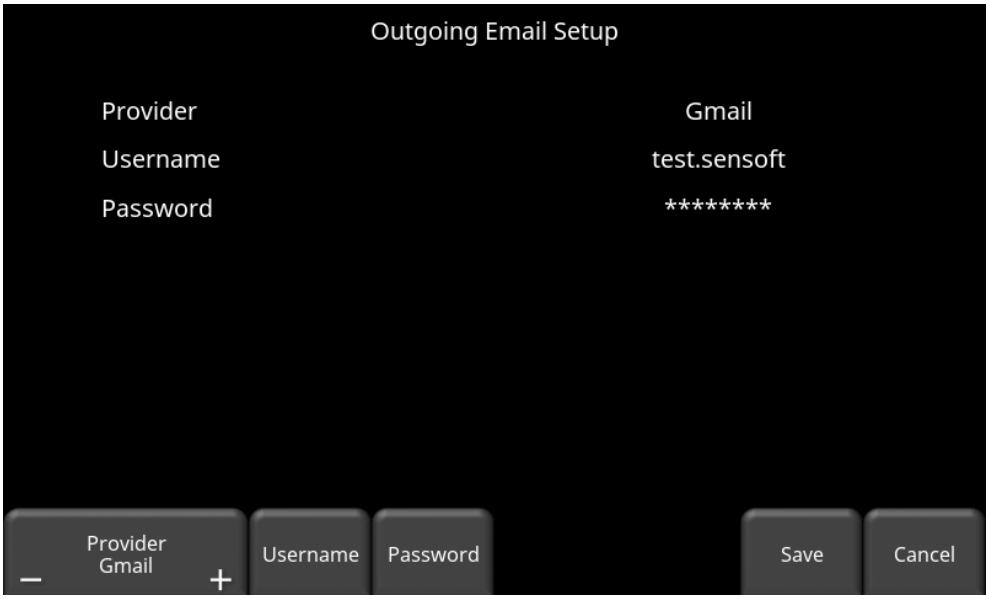


Figure 5-5: Using Gmail as e-mail provider

- Press **Username** to display a keyboard where you can enter your GMAIL user name only; you do **not** need to enter @gmail.com. Then press OK when done (Figure 5-6)
- Press **Password** to display a keyboard where you can enter your GMAIL password. Then press OK when done (Figure 5-6).
- Press **Save** when both Username and Password have been entered.

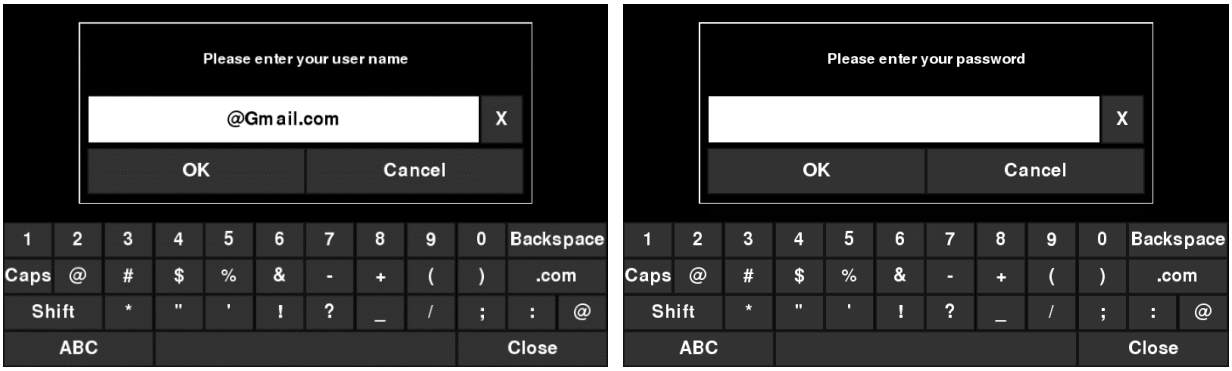


Figure 5-6: Entering e-mail address and password

If there are no warning messages, the e-mail address is setup properly and you are ready to e-mail mini-reports from the field. If this does not work, see the Failed Setup section below.

Using Another Provider

Note: It is highly recommended to use a GMAIL account as the system is pre-configured for this. If you choose to use another provider, you will have to contact that provider if you have any issues with the settings.

To use another e-mail provider, press the **+** and **–** buttons under **Provider** until it says **Custom.** This will display the screen shown in Figure 5-7, allowing you to setup and configure a different e-mail provider:

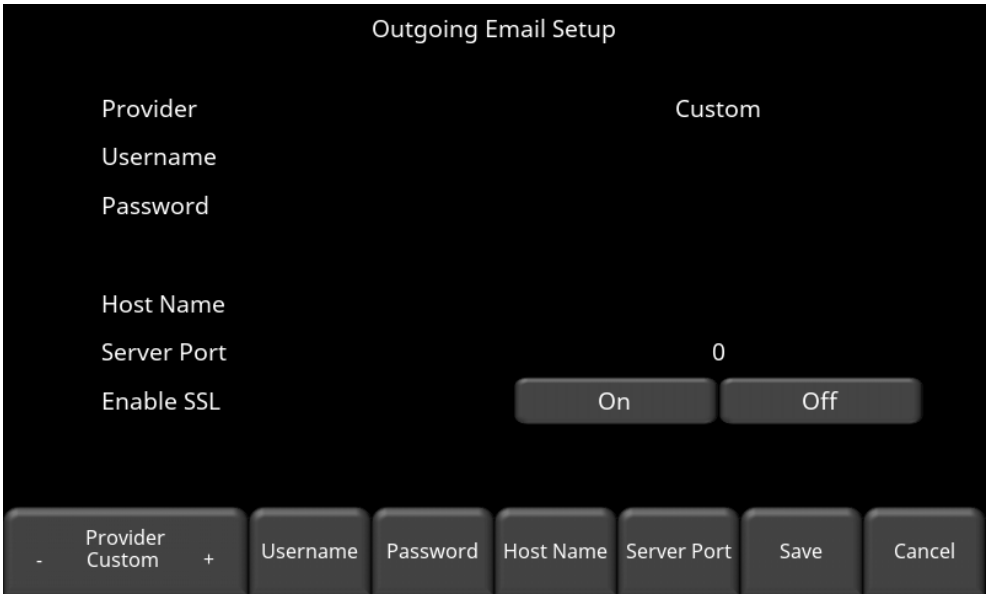


Figure 5-7: Entering e-mail address and password for another e-mail provider

- Press **Username** to display a keyboard where you can enter the complete e-mail address, then press OK when done.
- Press **Password** to display a keyboard where you can enter the password, then press OK when done.
- Press **Host Name** to display a keyboard where you can enter the name of the server address handling the outgoing mail. See chart below for some common e-mail providers. If your provider is not listed, it can usually be found by searching online for "SMTP host name <provider>", where provider is the host name e.g. Yahoo or AOL. Press OK when done.
- Press **Server Port** to display a keyboard where you can enter the port number used by the e-mail server. Searching online for host name will usually provide the port number for that e-mail provider. In most cases, it's usually 465 (if SSL is enabled, see next bullet point), or 587. See chart below for some examples. Press OK when done.
- Enable SSL – you can select **On** or **Off** on the display. SSL provides encryption security. Some e-mail providers require this set to ON. This will usually be indicated on the same online search page that was used above. See the chart below for examples.
- Press **Save** when all the information is entered and correct.

Below is the chart for some common e-mail providers:

Provider	Host name	Server Port	Enable SSL
Yahoo	smtp.mail.yahoo.com	465	On
Hotmail/Outlook	smtp.live.com	587	Off
iCloud	smtp.mail.me.com	587	Off
163.com	smtp.163.com	465	On
Yandex	smtp.yandex.com	465	On

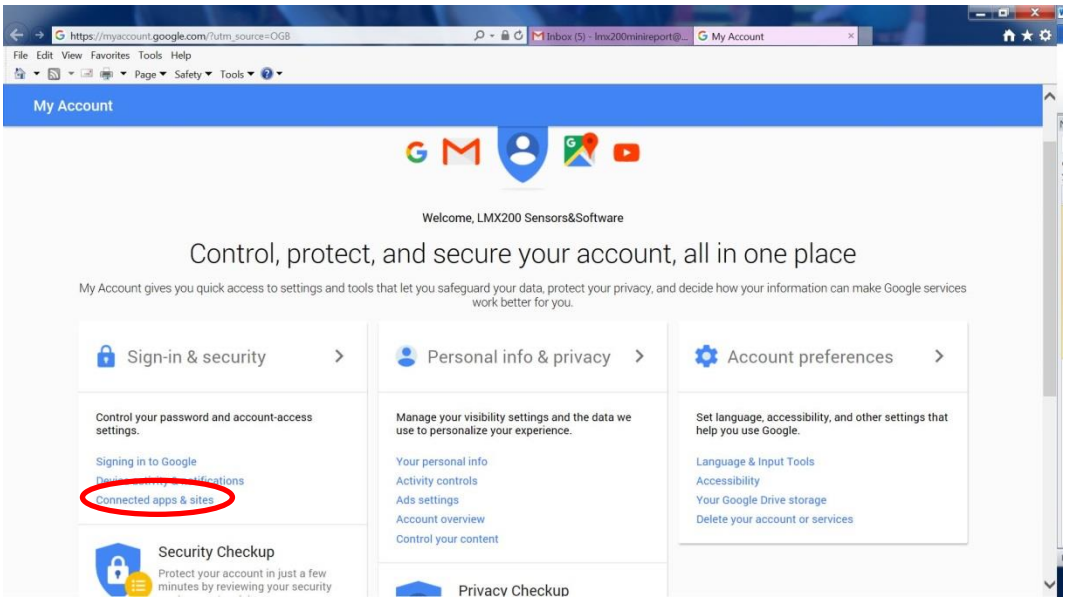
If there are no warning messages, the e-mail address is setup properly and you are ready to e-mail mini-reports from the field.

Failed Setup

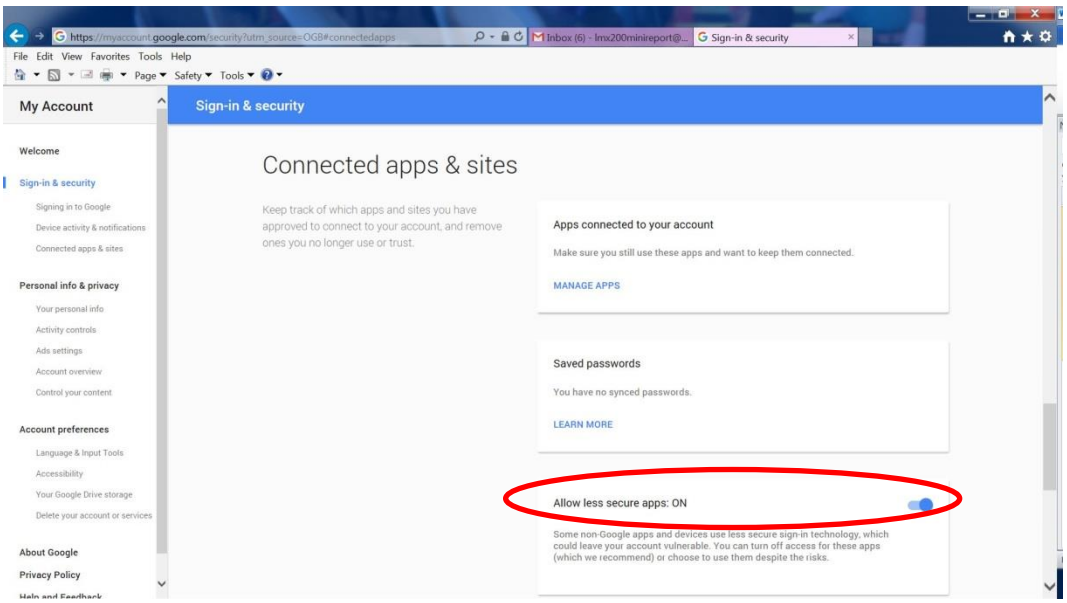
If setup failed, possible reasons include:

1. E-mail address or password was entered incorrectly – try re-entering these fields.
2. Hostname, port or SSL setting are incorrect
3. Your e-mail security settings **may need** to be adjusted, which may require you to login to your e-mail account from a PC or mobile device. An example of the GMAIL security settings is shown below (current as of writing this manual). For other e-mail providers, you may need to modify the settings accordingly.

   To edit the GMAIL security settings, visit https://myaccount.google.com/ and sign into your account. You will then see the screen below. Click on “Connected apps & sites”



On the page that follows, ensure the setting “Allow less secure apps” is set to ON.



5.1.8 Bluetooth

This option allows you to connect a Bluetooth trigger, which can be used to collect data in Line and Grid Scan modes. The configuration screen is shown in Figure 5-8.

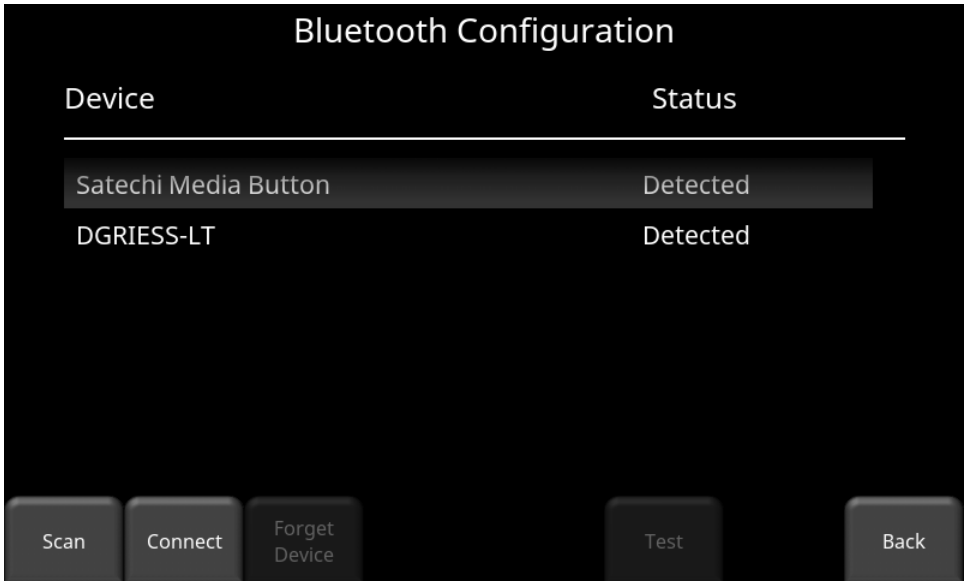


Figure 5-8: Bluetooth menu

Upon entering this menu, the system will scan for any Bluetooth devices. The color of the device name indicates the status:

- Green = Connected
- Orange = Paired previously, but not currently connected.
- White = Detected, but not connected

To turn the trigger on, press and hold the center button of the trigger. You will see a blue light flash once; the trigger is now on. The trigger will automatically shut down after a few moments of inactivity. At any time to confirm if the trigger is on or off, press the center button briefly. If the blue light flashes, then it's already on.

To connect a device, it must first be paired to the Display Unit. To put the trigger in pairing mode, press and hold the small recessed button (Figure 5-9) on the back side using a pen or other sharp object until the blue light on the front starts flashing rapidly. The device is now in pairing mode.

Figure 5-9: Red arrow pointing to the button to put into pairing mode

Press **Scan** to re-scan for devices. Once it locates that device, it will indicate that it's paired (Figure 5-10). The device will exit pairing mode if you don't pair to it within about 30 seconds. You will need to put it into pairing mode again and re-try.

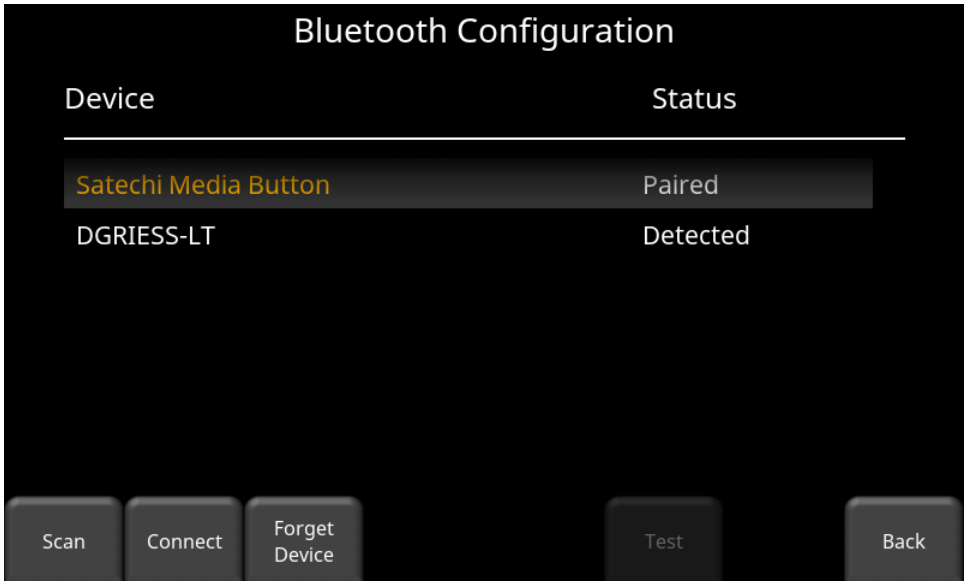


Figure 5-10: Paired to a device

Use the 4-way directional arrows or touchscreen to select that device, then press **Connect** (Figure 5-11).

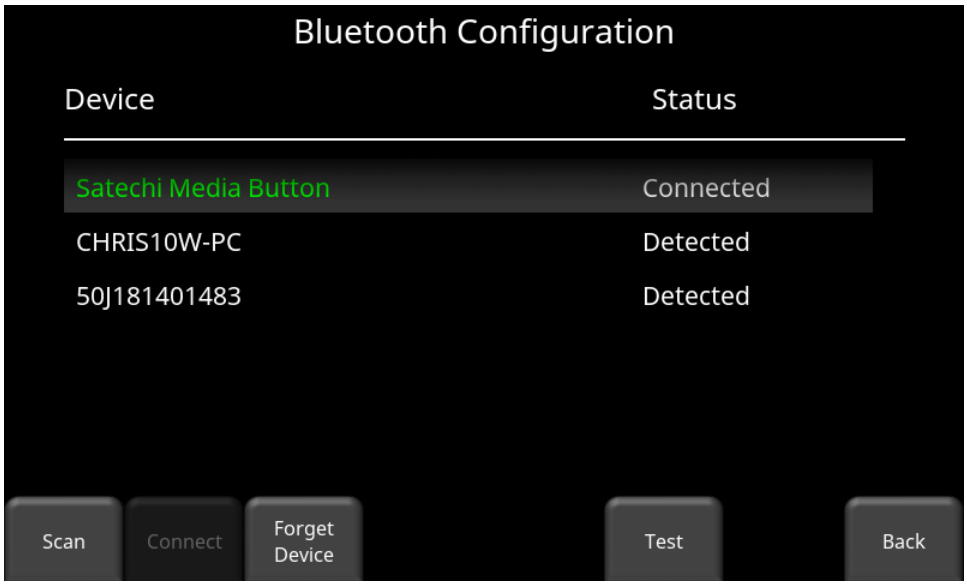


Figure 5-11: Connected to a device

After connecting, the system will confirm connectivity by asking you to press a button on a device (Figure 5-12)

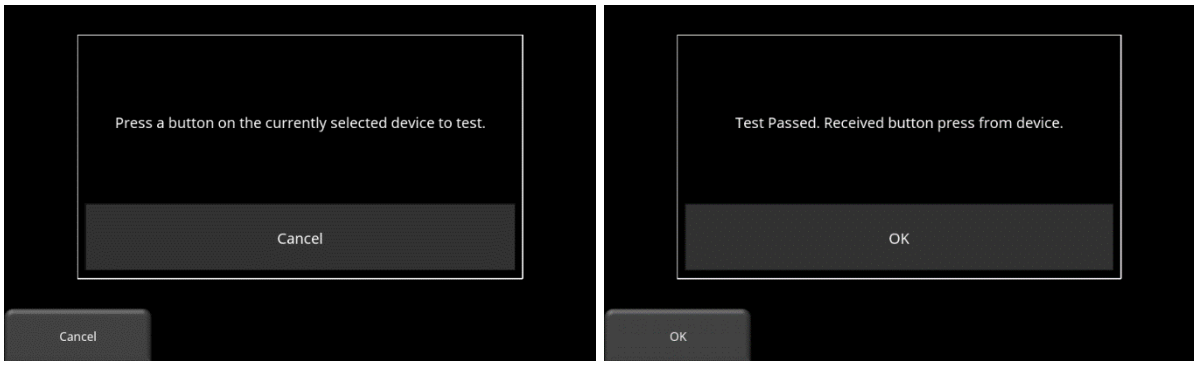


Figure 5-12: Confirming Bluetooth connection and operation.

The buttons at the bottom of the screen are explained in detail below:

- **Scan** – looks for any Bluetooth devices within range, and displays their status: Detected, Paired or Connected. In some cases, you may need to re-scan a second time to find devices.
- **Connect** – to connect a listed device, make sure the device status is Paired. Then select the device and press the **Connect** button. It will then ask you to press a button on the device to confirm a successful connection (Figure 5-12).
- **Forget Device** – will disconnect from device, forget its status and the name will turn white. To use this device, you will need to pair it again.

- **Test** – to confirm that everything is working, press this button. You will see a message on the screen to press a button on the Bluetooth device. If received on the Display Unit, a message will indicate that you are successful (Figure 5-12).

5.1.9 Screen Saver

A screen saver can be setup to turn off the Display Unit screen after a period of inactivity to save power. The Screen Saver can be set to turn the screen off after 1 minute, 5 minutes or never (OFF setting). Pressing this button cycles between those three options. When the screensaver is activated and the screen shuts off, touch anywhere on the screen to turn it back on again.

5.1.10 IEP – Image Enhancement Processing

The IEP option ensures that Conquest 100 always collects the highest quality data and displays the most accurate images. It should generally always be left on, unless advised by Sensors & Software. For this reason, **IEP will always default to ON when Conquest is powered on**. The IEP feature automatically and continuously tests the system for proper calibration during operation. If the system is ever found to be out of calibration, the user is immediately prompted to run the System Test for the Sensor (Section 5.2.7) and re-calibrate.

5.1.11 PCD Frequency

Depending where you live, the power grid may be on **60 Hz** (North America, parts of South America, Philippines) or **50 Hz** (Europe, Asia, Australia). Ensure the PCD setting is set to the frequency in your location; the PCD feature will not work if the frequency is set incorrectly.

5.1.12 Reset to Defaults

There are three sequential screens that appear, each allowing you to reset or clear particular settings. For each screen you can select **Yes** or **No**, then move onto the next screen.

Preferences

This will reset all preferences back to the initial settings when the system was shipped (Figure 5-13).

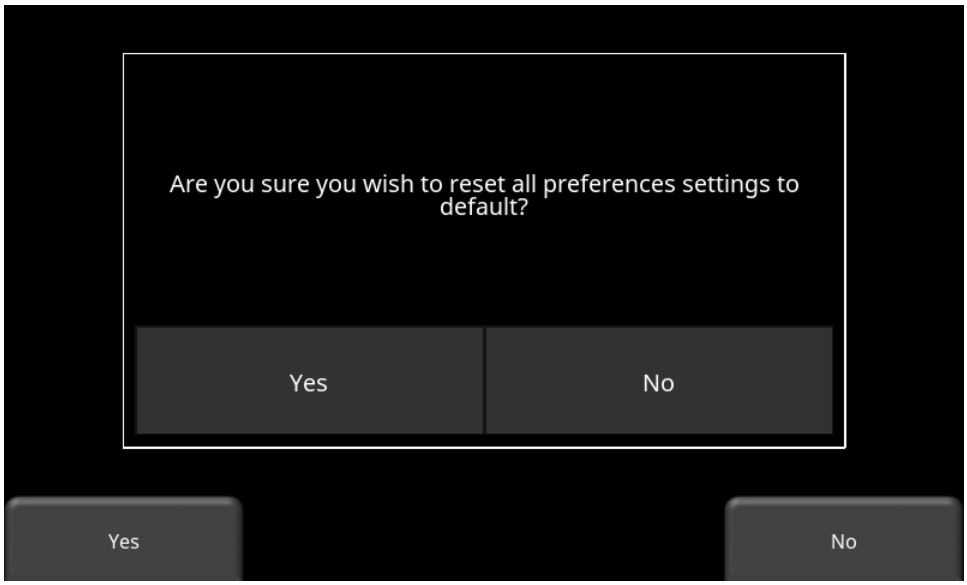


Figure 5-13: First screen: Confirming preferences reset to default

E-mail and Wi-Fi Settings

The next screen will ask if you would like to remove the saved e-mail address and wireless settings (Figure 5-14).

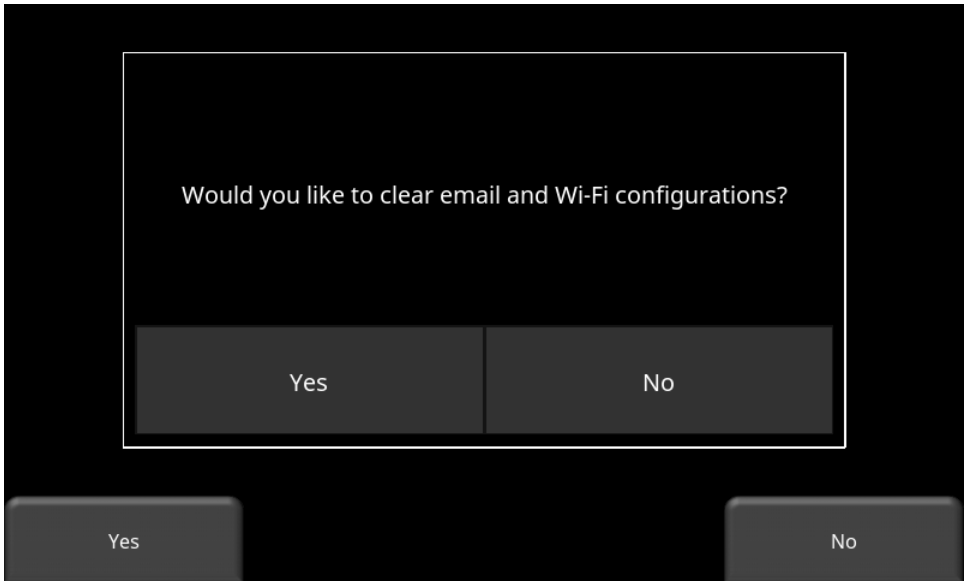


Figure 5-14: Second screen: Clearing e-mail address and wi-fi information

Bluetooth Devices

The third screen will allow you to clear the list of paired Bluetooth devices (Figure 5-15).

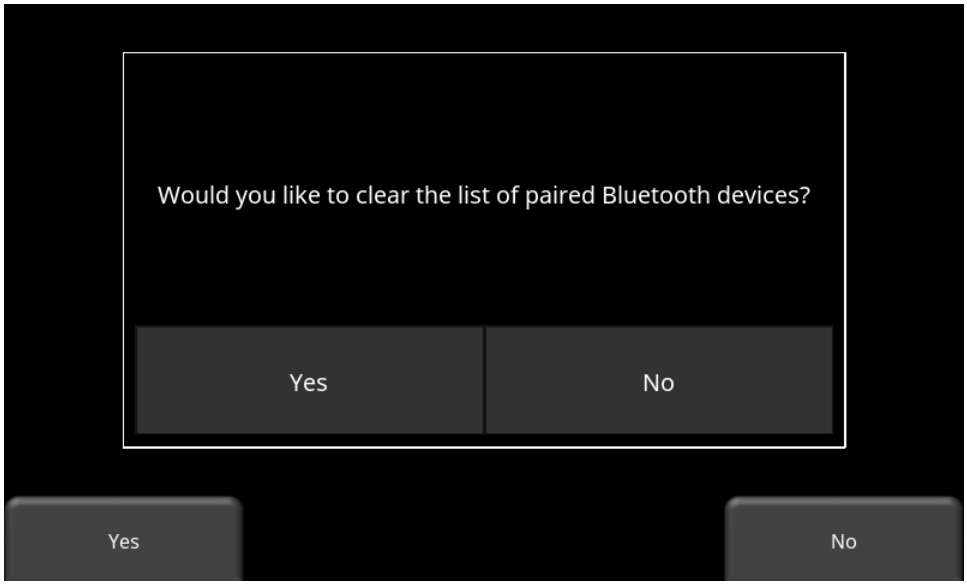


Figure 5-15: Third screen: Clearing all paired Bluetooth devices

5.2 System Test

The System Test menu allows the user to perform certain tests to ensure proper operation of the Conquest 100 (Figure 5-16). Once in this menu, select the component to test then press **Start**. After completing a test there is an indication of whether the system passed or failed the test. Each test is described below in more detail.

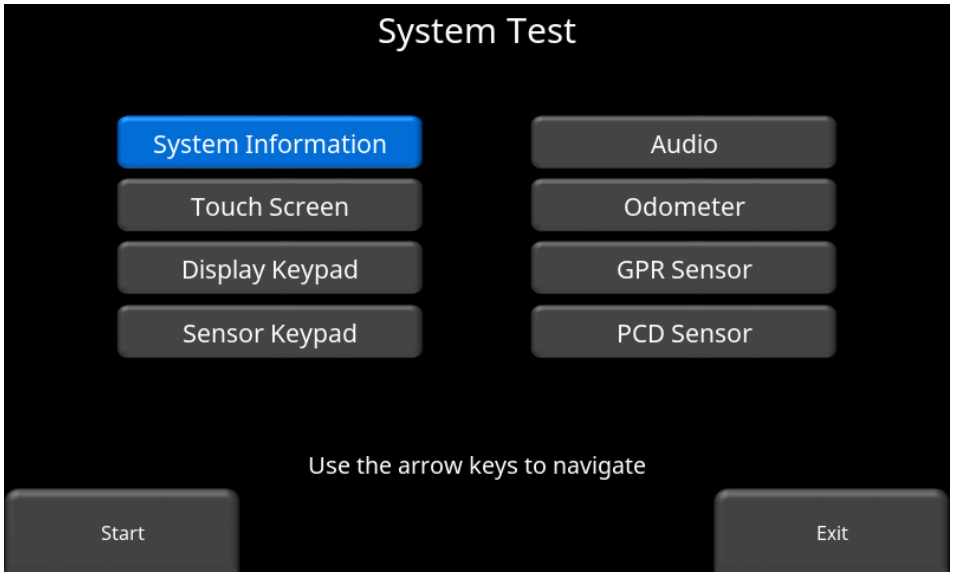


Figure 5-16: System Test menu

5.2.1 System Information

System Information is the only option in System Test which is not actually a test. Here information such as the version, serial numbers, temperature and battery power are displayed (Figure 5-17).

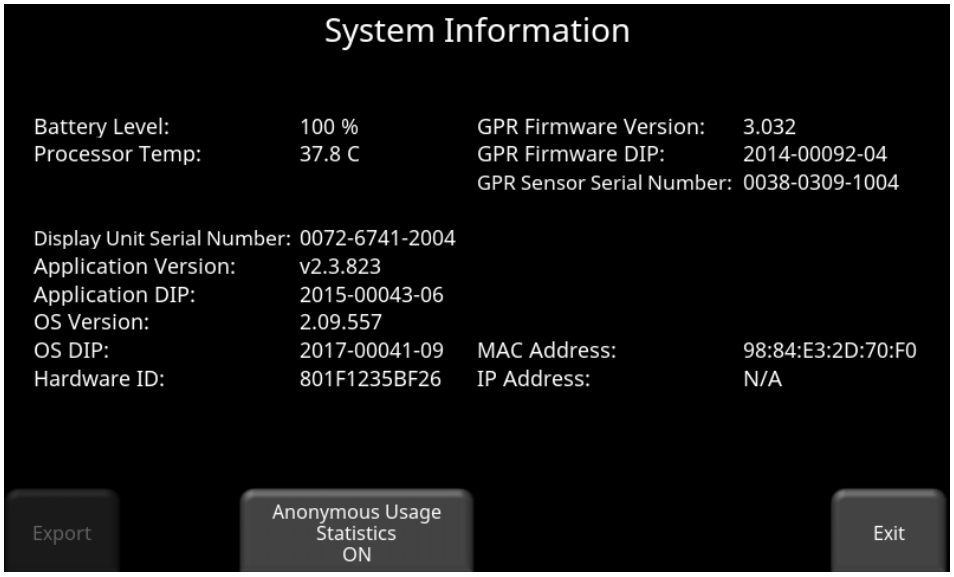


Figure 5-17: System Information screen

There are two options at the bottom of this screen:

- **Export** - If a USB key is currently inserted, pressing Export will export the System Log and Summary Files only
- **Anonymous Usage Statistics** - When this is set to ON and the user is connected to a wireless network, any system malfunctions will trigger an automatic notification to Sensors & Software. This is to help with gathering information about any system irregularities. As the name suggests, the notification is completely anonymous and no personal information is sent.

5.2.2 Touch Screen

The test checks proper operation of the touch screen (Figure 5-18). It allows you to test the screen (by pressing **Test**) or perform a quick calibration followed by a test (by pressing **Calibrate**). Both involve touching targets on the screen in the allotted time.

Figure 5-18: Touch Screen test

5.2.3 Display Keypad

The keypad test ensures that all buttons on the keypad are working. Press **Start** to begin the test which requires the user to press each button once, within a 20 second timeframe (Figure 5-19). Button images will disappear from the screen as they are pressed.

Once that is complete, a short LED test will ensue, which checks the proper operation of the LED.

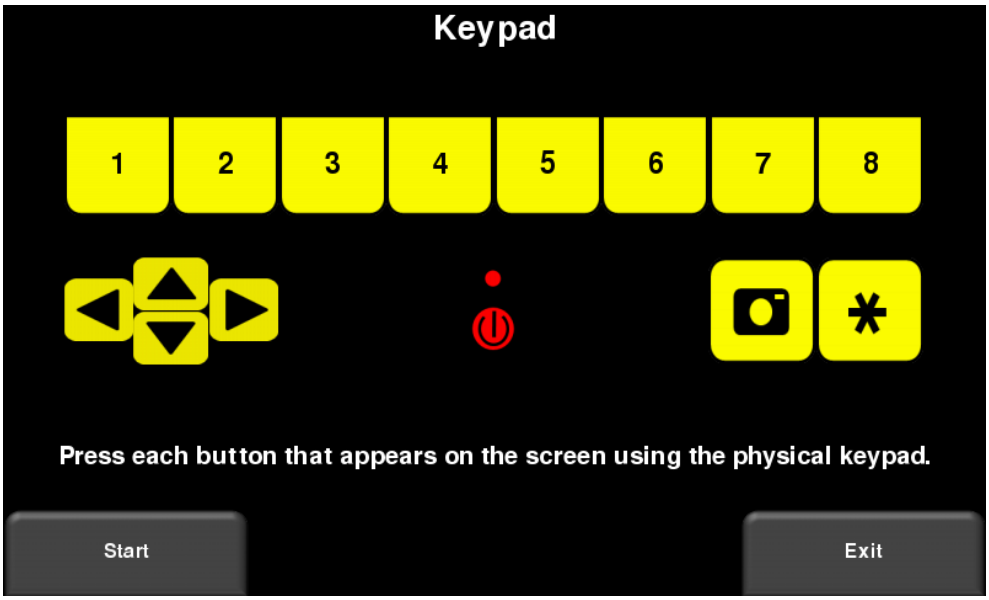


Figure 5-19: Preparing to do the Keypad test

5.2.4 Sensor Keypad

This test will require the user to press all the buttons on the sensor keypad within a 20 second timeframe (Figure 5-20). Following that, it will also test the audio component and LED lights on the sensor, as per the directions on the screen.

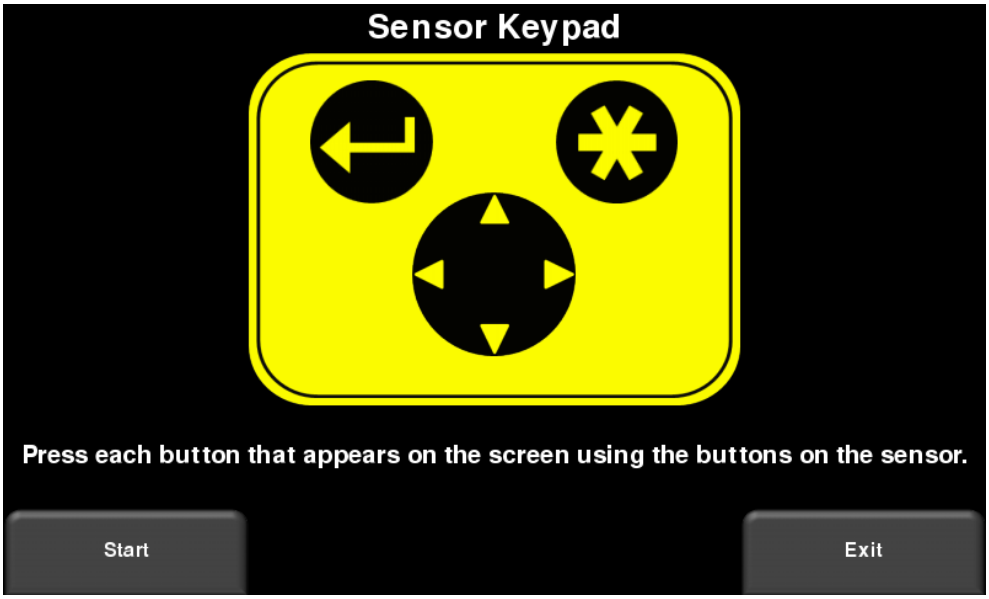


Figure 5-20: Testing the Sensor keypad

5.2.5 Audio

This test ensures that the speaker is operating properly. After starting the test, you should hear a sound with an increasing pitch (Figure 5-21).

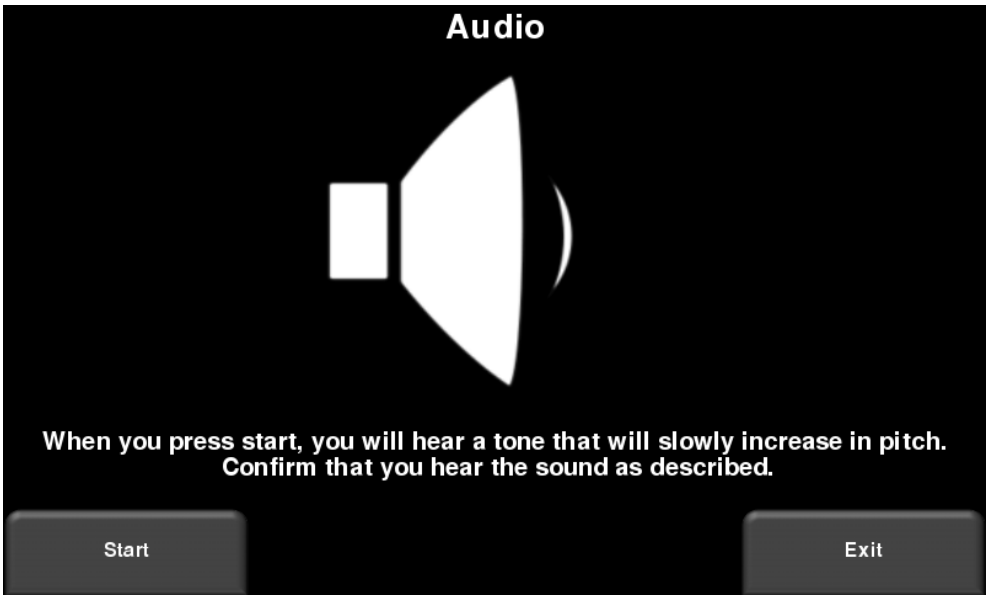


Figure 5-21: Audio Test

5.2.6 Odometer

This test will ask you to spin the yellow odometer wheel 5 times and then press the finish button to check proper operation of the odometer (Figure 5-22).

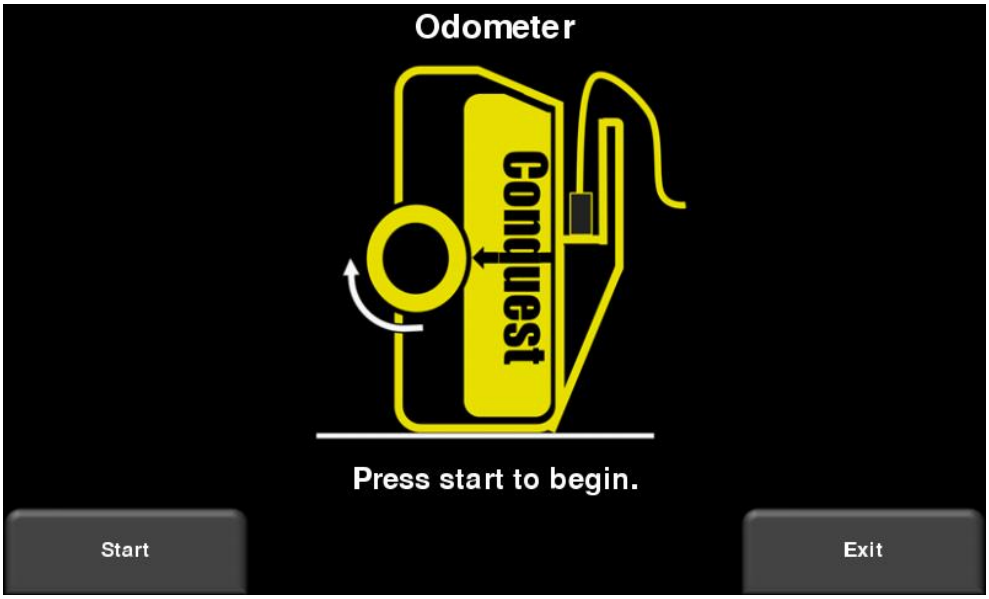


Figure 5-22: Running the Odometer Test

5.2.7 GPR Sensor

From time to time, it may be necessary to perform a sensor test. This test is mandatory on bootup if any situation exists as described in Section 3.5.1. This test calibrates the internal functions of the Sensor Head and ensures optimal performance (Figure 5-23).

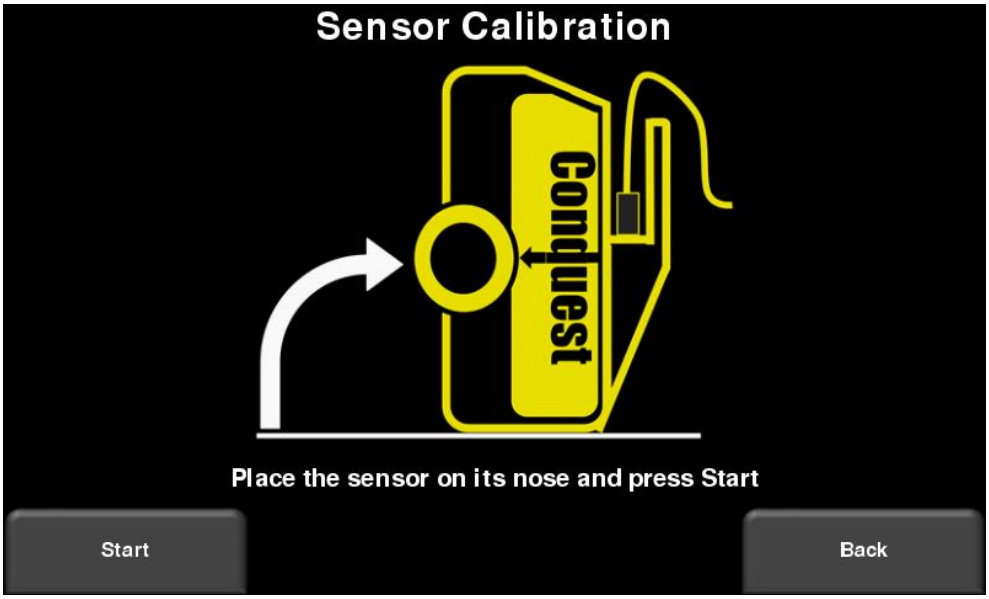


Figure 5-23: Running the GPR Sensor Test

Simply turn the Sensor Head such that it rests on the front (as shown in the image above) and follow the instructions. There should be no objects near the bottom of the Sensor Head, as this will affect the calibration results.

5.2.8 PCD Sensor

Ensures proper operation of the Power Cable Detector. The user will need the battery charger to be plugged in and connected to the display unit for this test. Lower the sensor head down on the battery charger and change the orientation of the sensor head with respect to the battery charger (Figure 5-24). A successful test will show the Field Strength varying with the movement of the sensor head, confirming proper operation. Press **Stop** then **Exit** when this has occurred.

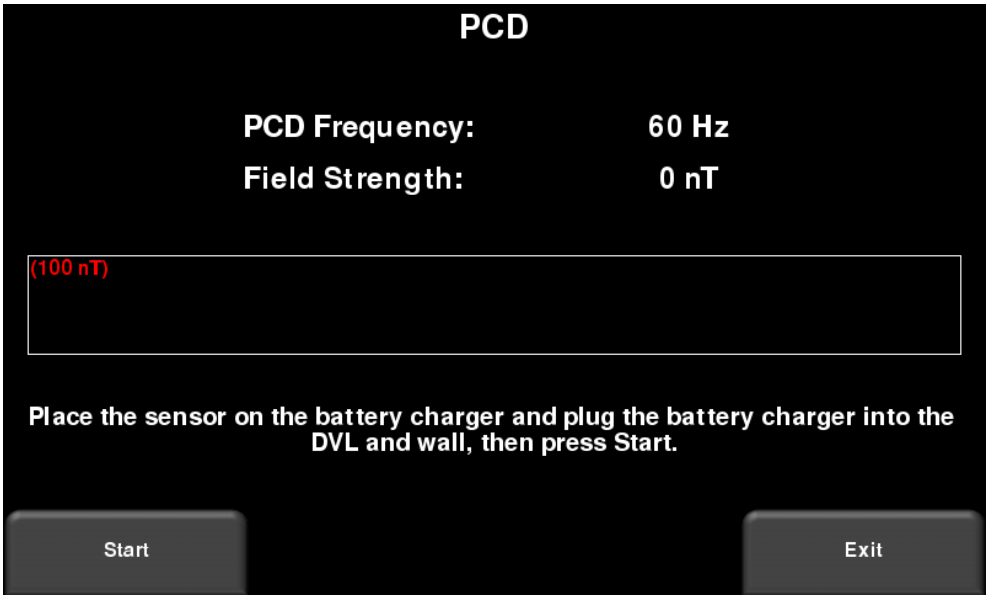


Figure 5-24: Testing the PCD

5.3 File Management

Press **File Management** to enter this sub-menu. From here, the user can view screenshots, export data and delete all data. If you have the Conquest 100, you will see the image in Figure 5-25. If you have the Conquest 100 Enhanced, you will see the image in Figure 5-26.

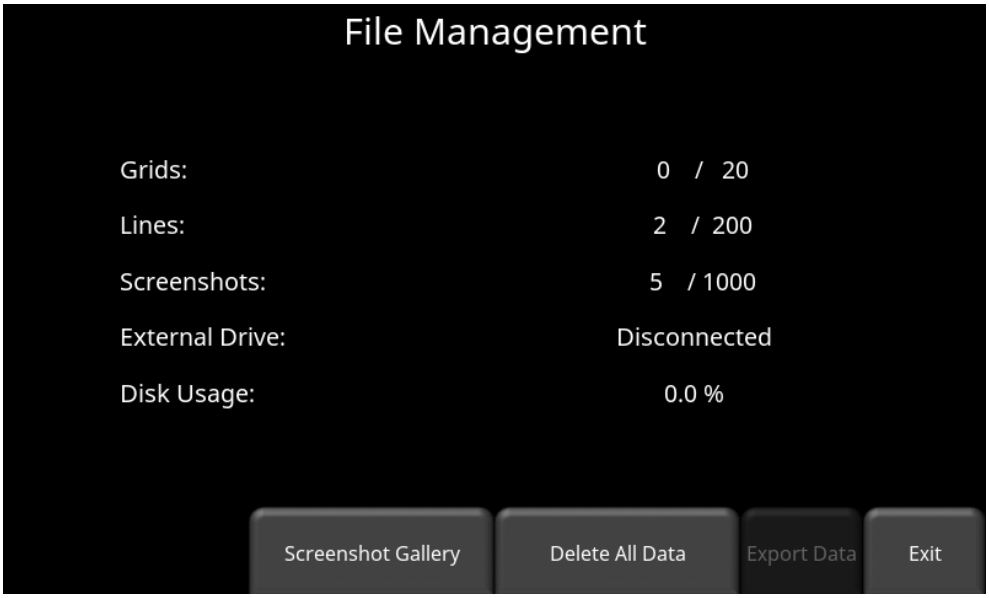


Figure 5-25: File Management menu for Conquest 100

Figure 5-26: File Management menu for Conquest 100 Enhanced

A description of each of the buttons is given below:

5.3.1 Project -/+

Press the **minus** or **plus** buttons to change the active Project

5.3.2 Screenshot Gallery

Pressing this button allows the user to view all screenshots that were previously saved by pressing the Camera button (Section 3.3.1). The display will show a Tile View of four screenshots per page (Figure 5-27). If there are more than four screenshots, swipe the screen from right to left to view the rest. The number of total screenshots is displayed at the bottom of the page. Alternatively, you can also use the **Left** and **Right** arrow keys on the 4-way directional keypad

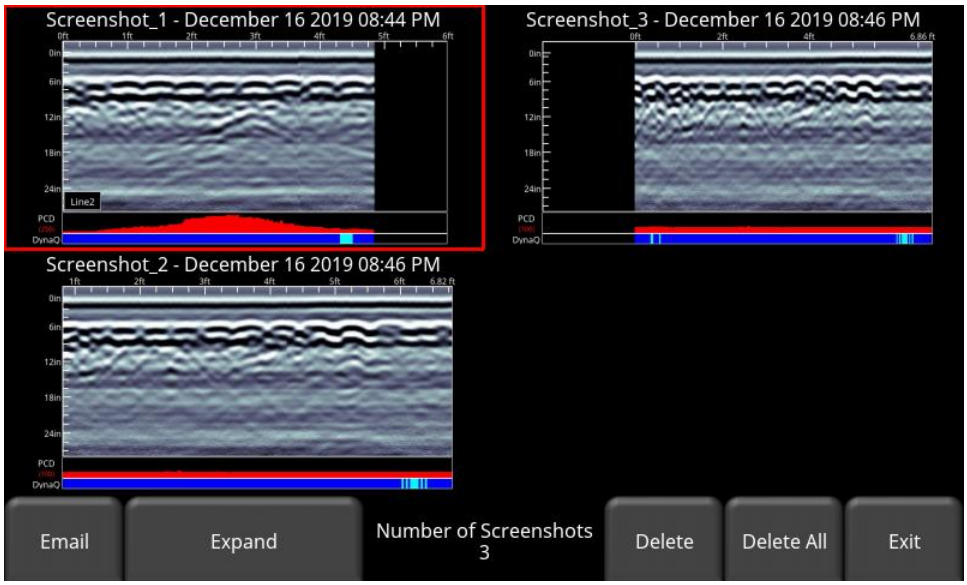


Figure 5-27: Tile View in Screenshot Gallery

From this screen, the user has the following options:

- **E-mail** – pressing this button will e-mail the selected screenshot (provided you are connected to a wireless network and have setup an e-mail account to send from). You will be prompted to enter a destination e-mail address, or you may use the most recent one which will be listed by default.
- **Expand** – press this button to show the selected screenshot as a full screen image. On the subsequent screen, press Tile View to return to the screen displaying four screenshots per page.
- **Delete** – pressing this button will delete the displayed screenshot.
- **Delete All** – pressing this button will delete all the screenshots in the current Project.
- **Exit** – press this to exit the Screenshot Gallery and return to the File Management main menu.

5.3.3 Delete Project

Pressing this will delete all the data (including screenshots) in the current Project.

5.3.4 Export Data

Screenshots and data are always saved to the internal memory of the Display Unit. If a USB-drive (memory stick) is inserted into the USB port on the Display Unit, pressing the **Export Data** button will copy all the data files to the USB-drive. If no USB-drive is inserted, this option will be greyed-out.

6 Line Scan

Line Scan data collection mode is useful for reconnaissance surveys to get an idea of what lies inside the concrete before starting a grid survey. Line Scan allows the operator to acquire data along a straight line and examine it as a cross-section image.

In Line Scan mode, the objectives are:

a) to obtain a sense of the site structure;
b) to assess the orientation of any rebar mats or conduits;
c) to get an idea of the depth of exploration.

To collect a Line Scan, select **Line Scan** from the main menu**.** If you have the Conquest 100 Enhanced, ensure you are in the Project you want to work in. You will see the screen in Figure 6-1.

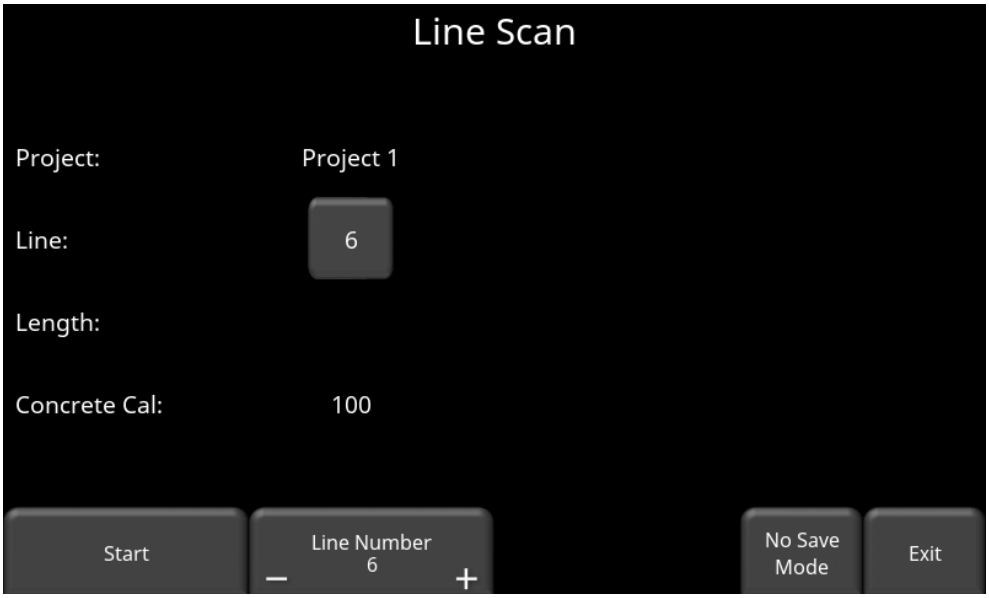


Figure 6-1: Line Scan menu

6.1 Selecting a Line

To select the desired line, press the **+** and **-** buttons under **Line Number** on the bottom of the screen. Alternatively, pressing the line number button itself will show the screen in Figure 6-2. From here, you can go directly to any line number. If the line number is white, then that line is empty, whereas lines that already contain data are shown in red.

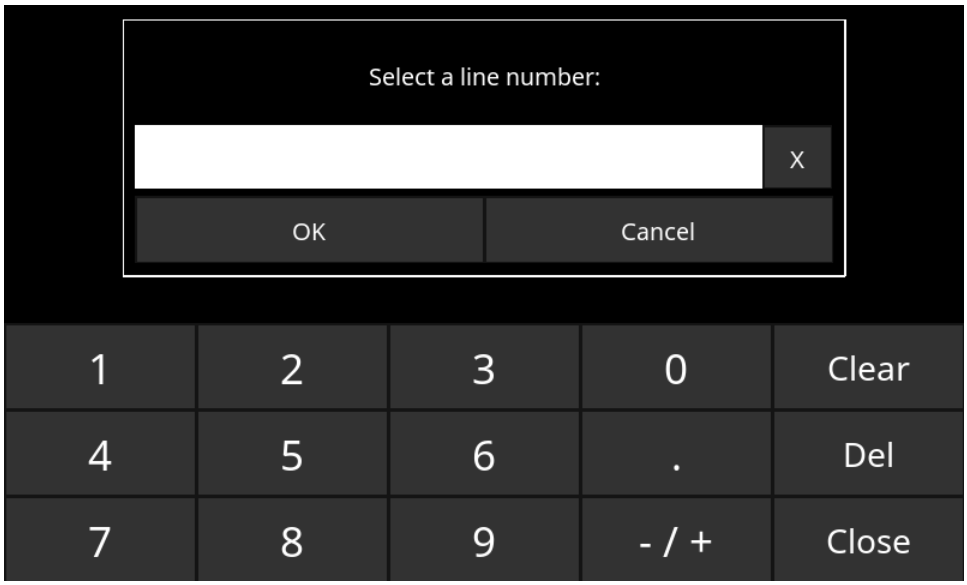


Figure 6-2: Input a line number to go directly to it

To collect data without saving it, press **No Save Mode**. Any data collected will NOT be saved, but screen shots can still be taken with the **Camera** button. These screenshots get placed in the currently selected project.

If the line number is white (Figure 6-1), Press **Start** to enter data acquisition mode. All data collected will be saved under this line number.

If the line number is shown in red (Figure 6-3), you will see the data preview on the right side of the screen. If it's a long line, only the last part of the data will be shown. From this screen, you will have the following additional options available:

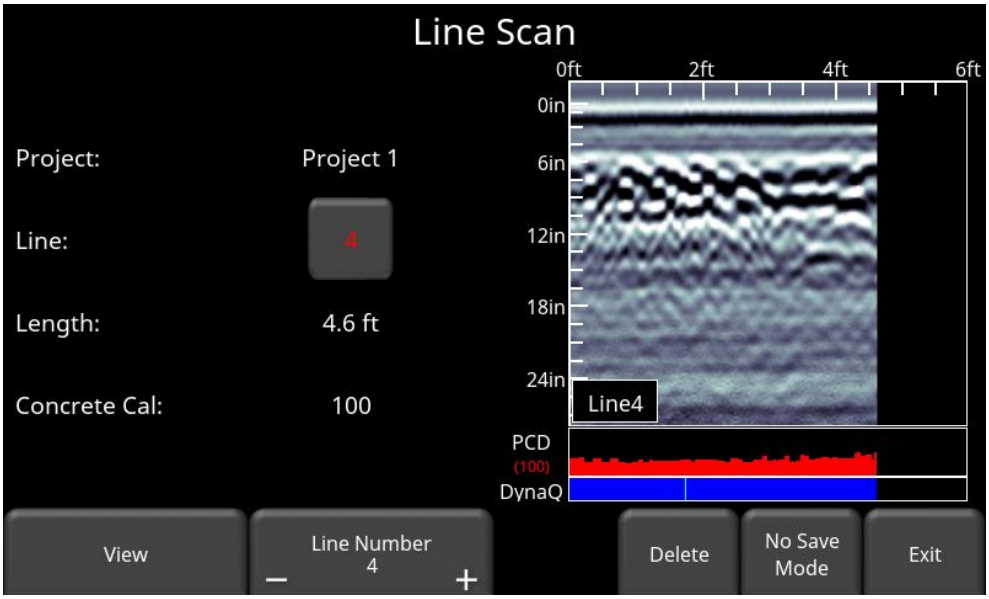


Figure 6-3: Line Scan menu showing a line previously collected

- **View** - press this button to review the previously collected line.

- **Delete** - pressing this will delete the line. It will prompt you to confirm before deleting.

6.2 Acquiring Data

From the Line Scan menu in Figure 6-1, there are 3 ways to start collecting data:

- Press **Start** on the Display Unit
- Press the **Enter** button on the Sensor Head
- Press the **Bluetooth Trigger**

The screen will change to the Line Scan data acquisition screen (Figure 6-4). The system beeps once and the red light by the star key on the Sensor Head turns on. You will see a depth scale along the left side of the screen. The position scale will be on the top once acquisition begins. The measurement units on these axes (Metric or US Standard) are based on the setting in the Preferences menu (Section 5.1.2).

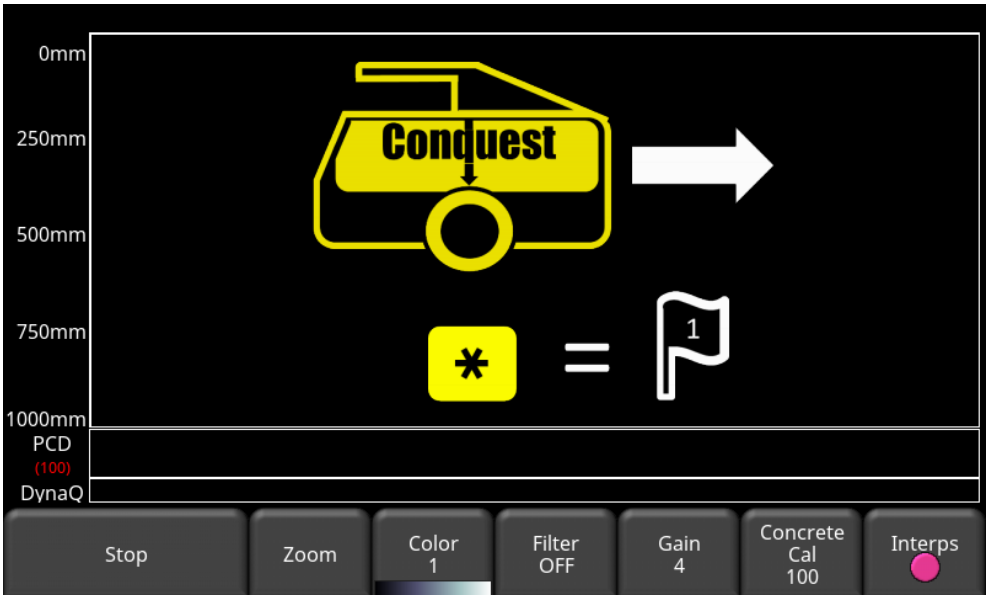


Figure 6-4: Commencing data acquisition

As the Sensor Head is pushed along a straight line, the GPR Line image scrolls onto the screen from the right and moves to the left (Figure 6-5). The data will scroll as fast as you move. It is best to go at a uniform speed because irregular motion may reduce data quality.

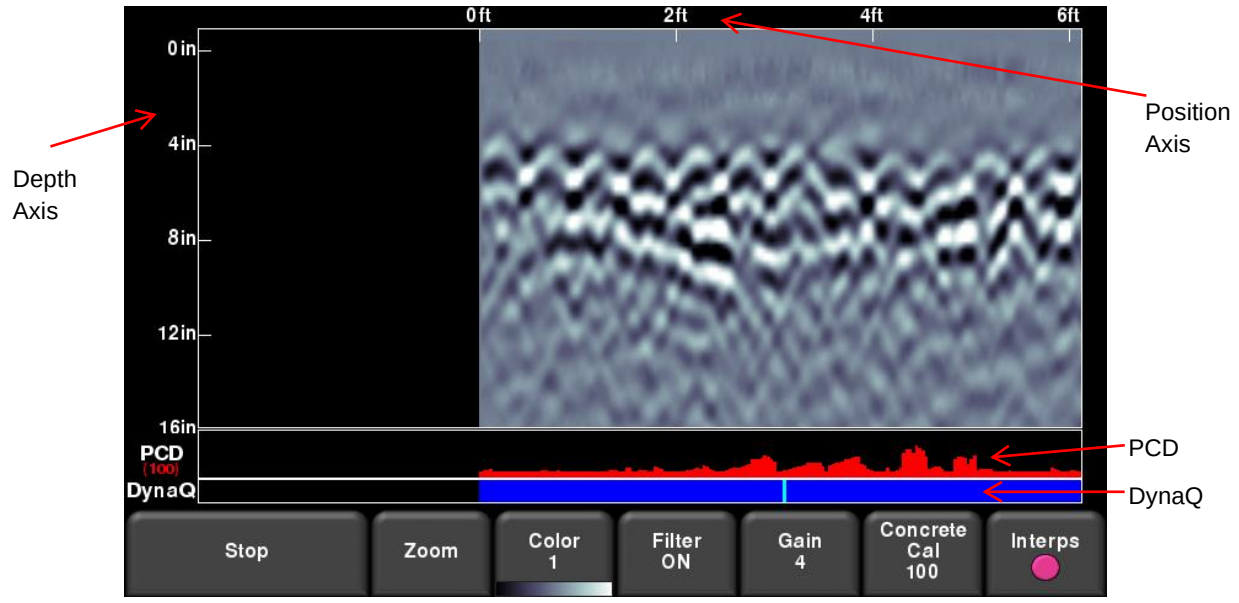


Figure 6-5: The Line Scan screen. The Line Scan image is displayed with a position scale along the top, and a depth scale (based on the current Concrete Cal) on the left. The PCD response is plotted as a red graph underneath with the maximum scale value (in nT) displayed as a red number on the left. The DynaQ status is shown beneath that.

From Principles of Operation (Section 2), you will have a sense of the information that you will see on the screen. Flat boundaries such as the bottom of the concrete will appear as flat bands and localized features such as rebar and conduits will appear as inverted V's (hyperbolas).

6.3 PCD (Power Cable Detector) Response

The PCD response is displayed as a red graph under the Line Scan image. The PCD graph indicates the strength of the magnetic field produced by AC current flowing near the Sensor Head. Strong peaks may indicate the presence of a cable with flowing AC current.

The PCD scale is displayed in red below the PCD label. The units are nanoTesla (nT) and it defaults to 100. If the magnetic field exceeds the maximum scale during collection, it will scale automatically and the new maximum value will be displayed in red.

6.4 DynaQ Index Bar

Conquest uses DynaQ, an advanced patented technology that adjusts data quality as the Sensor Head movement speed varies. In most situations, moving the Sensor Head at a comfortable speed generates data of good quality. In situations where target resolution or maximum penetration depth is critical, moving slower increases data quality.

As the Line Scan data scrolls on the screen, the DynaQ Index Bar is displayed along the bottom of the screen (Figure 6-5).

The color of the bar indicates the quality of the data at that point along the line:

White = No Data (too fast!)
Yellow = moderate quality
Light blue = better quality
Dark Blue = highest quality

In general, avoid collecting data at extremely high rates of speed. The system senses if the Sensor Head is moved too quickly and will beep three times to indicate that a data quality issue has been detected.

6.5 Back-Up Indicator

Line Scan mode incorporates a back-up feature to enable you to accurately locate targets and mark them on the ground. After acquiring some data on the screen, move the system backwards and crosshairs will appear over the collected data showing the current position of the Sensor Head (Figure 6-6).

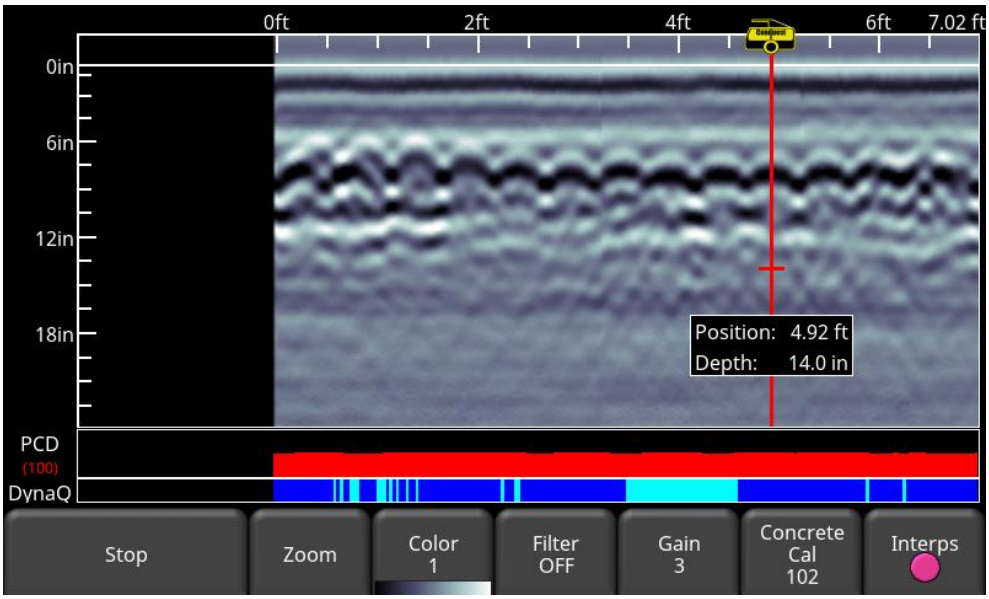


Figure 6-6: Line Scan mode data display. Moving the Sensor Head backwards during data collection displays a Back-up indicator with crosshair, used to pinpoint the position and approximate depth of an object.

For example, if you pass an object in the concrete, simply roll the Sensor Head back along the same path until the vertical red line appears exactly over it. The object is located at the center of the Sensor Head (Figure 3-19). You can mark the position of the object on the surface and continue data collection. On the bottom of the screen, your horizontal position is indicated (top number), relative to the start of your line.

To determine the depth of an object, move the small horizontal crosshair up or down using the keypad buttons on the Display Unit, or just drag the crosshair up or down on the screen. Measure depth to the top of the highest band in the object response. Note: make sure you have done a Concrete Cal to ensure depth accuracy (Section 6.8.6).

Move the Sensor Head forward again and the arrow moves to the right. New data will not be collected until you reach the point where you stopped and backed up.

Note that the user can only scroll back the last 10m (33 feet), provided their zoom is set appropriately. To view or back-up the sensor more than 1 screen of data, you need to swipe from left to right. However, it is not advisable to back up too far when marking out objects, as it's difficult to get the sensor back to the same location.

You can obtain depth and position anywhere on the Line Scan by touching the **screen** for about two seconds and releasing. A crosshair appears where you touched the screen, along with a dialog box displaying the position and depth. To get the position and depth information about a different point on the screen, simply drag the box or crosshair to the desired position (Figure 6-7).

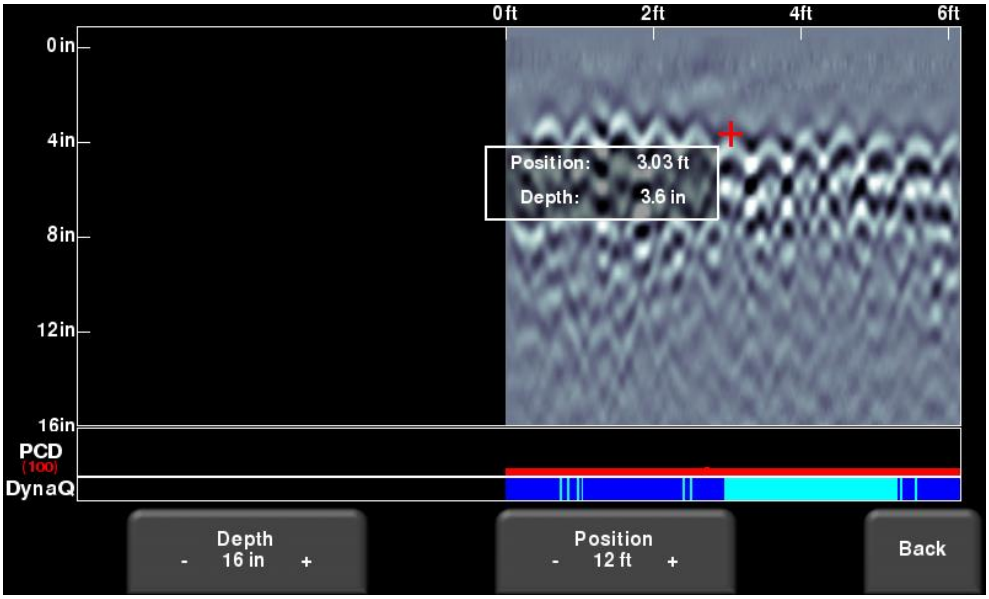


Figure 6-7: Touching the screen for a second at a specific location in back-up mode shows the position and depth of that point. The crosshair can be dragged to any desired position on the screen

6.6 Flags

Flags can be added to the Line Scan image by pressing the **Star (*)** key on the Sensor Head or the Display Unit keypad during data collection (Figure 6-8). These are used to indicate significant positions on the line, for example, when crossing an object that is visible on the surface or the change from one surface material to a different one.

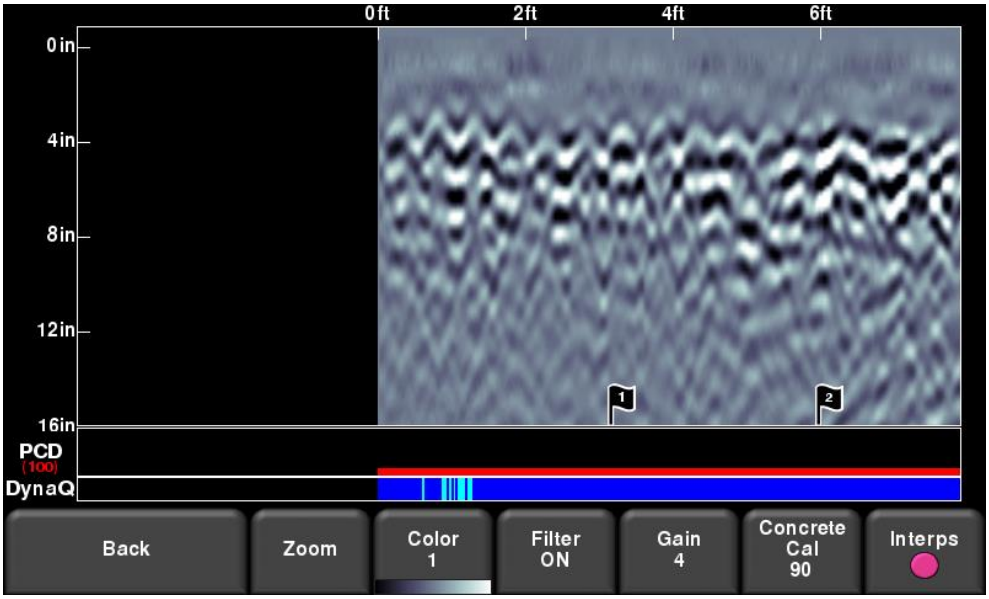


*Figure 6-8: Pressing the * button while collecting Line Scan data plots a flag at that location in the data. Flags are sequentially numbered. Flags are used to indicate a significant position in the data, for example, a target or a place where the surface material changes.*

Flags can be added when the Sensor Head is actively collecting data while being pushed forward or when using the Back-up Indicator. The flag is added at the exact position of the sensor head.

Flags are sequentially numbered, 1, 2, 3 etc. for each Line Scan.

6.7 Stopping Line Scan

There are three ways to stop the current Line Scan:

- Press the **Stop** button on the Display Unit
- Press the **Enter** key on the Sensor Head
- Press the **Bluetooth Trigger**

The Line Scan will also stop when you reach the maximum scan distance of 150’ (50m).

6.8 Line Scan Menu Options

During data collection or when a line scan is ended or opened for review, a menu appears along the bottom of the screen that allows the user to modify the current image. These menu options are explained below:

6.8.1 Start / Stop / Back

Start data collection (if stopped) and **Stop** data collection (if started). If you are stopped (or in review mode) and want to view data that has scrolled off the screen, use the left and right

arrows on the keypad. If you are stopped, you can press the **Back** button at the bottom of the screen to exit Line Scan mode.

6.8.2 Zoom (changing Depth and Position scales)

Pressing **Zoom** switches the menu at the bottom (Figure 6-9) allowing you to change the horizontal and vertical scaling of the data you are viewing.

- **Depth**: Conquest always collects to a depth of about 36" (90 cm). However, you may choose to display less depth to make targets easier to see. In general, it's a good idea to set your displayed depth to 1.5 - 2 times the depth of your expected deepest target.

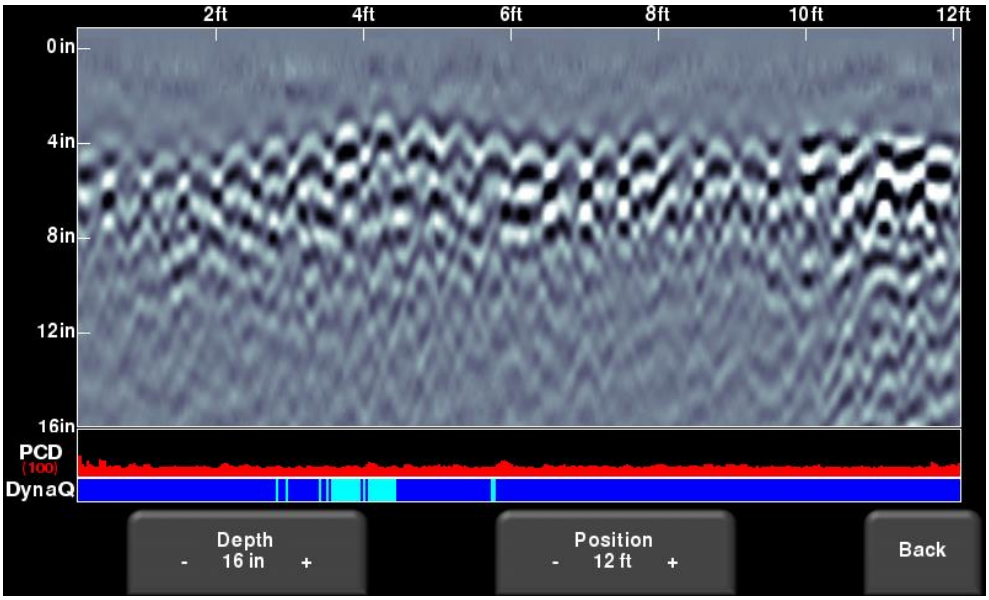
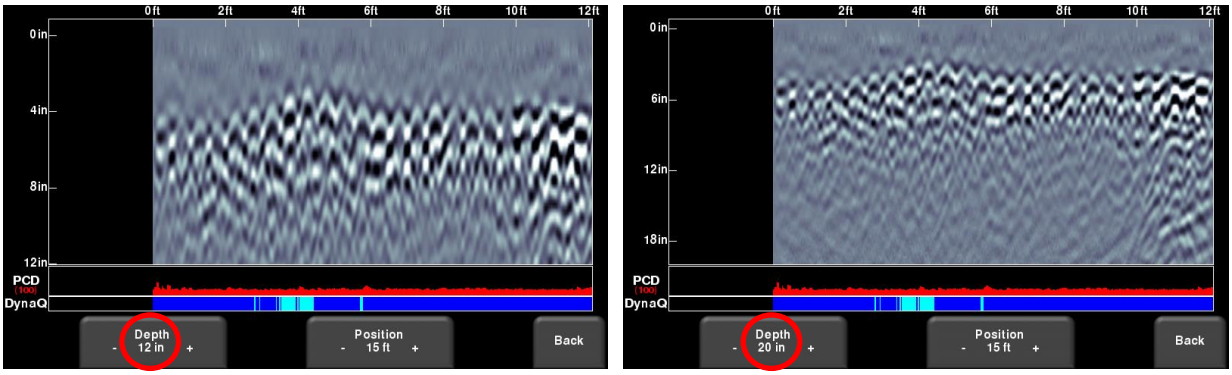


Figure 6-9: Menu seen when Zoom is pressed

Pressing **+** and **–** under the **Depth** button allows you the change the displayed depth. The pre-set values range from 12" to 36" (300mm to 1000mm). Figure 6-10 shows the effect of varying the depth value.



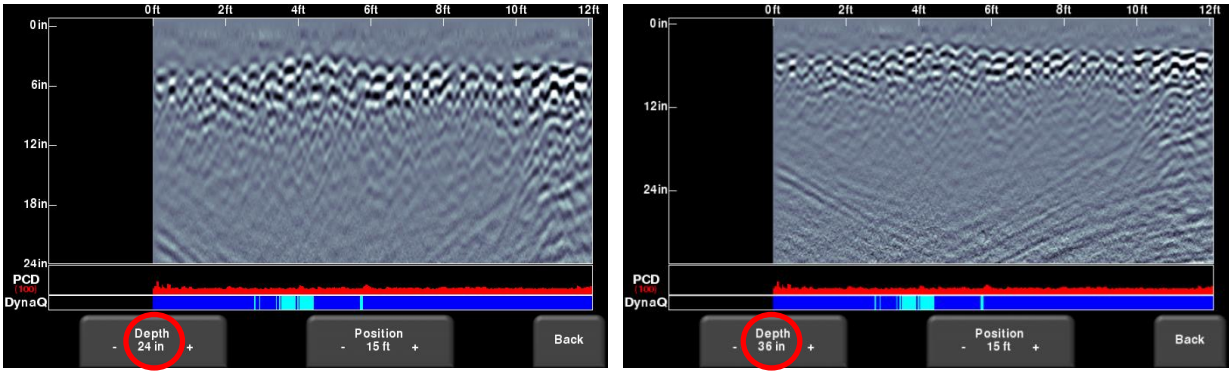


Figure 6-10: Varying depth

- **Position** - Pressing **+** and **-** under the **Position** button allows you to change the length of data display on a single screen. This is also known as horizontal scaling. The pre-set values range from 6' to 30' (2m to 10m). One reason for setting this value larger would be to fit more data on the screen and look for consistency among hyperbolas that were crossed. Figure 6-11 shows the effect of varying the position value.

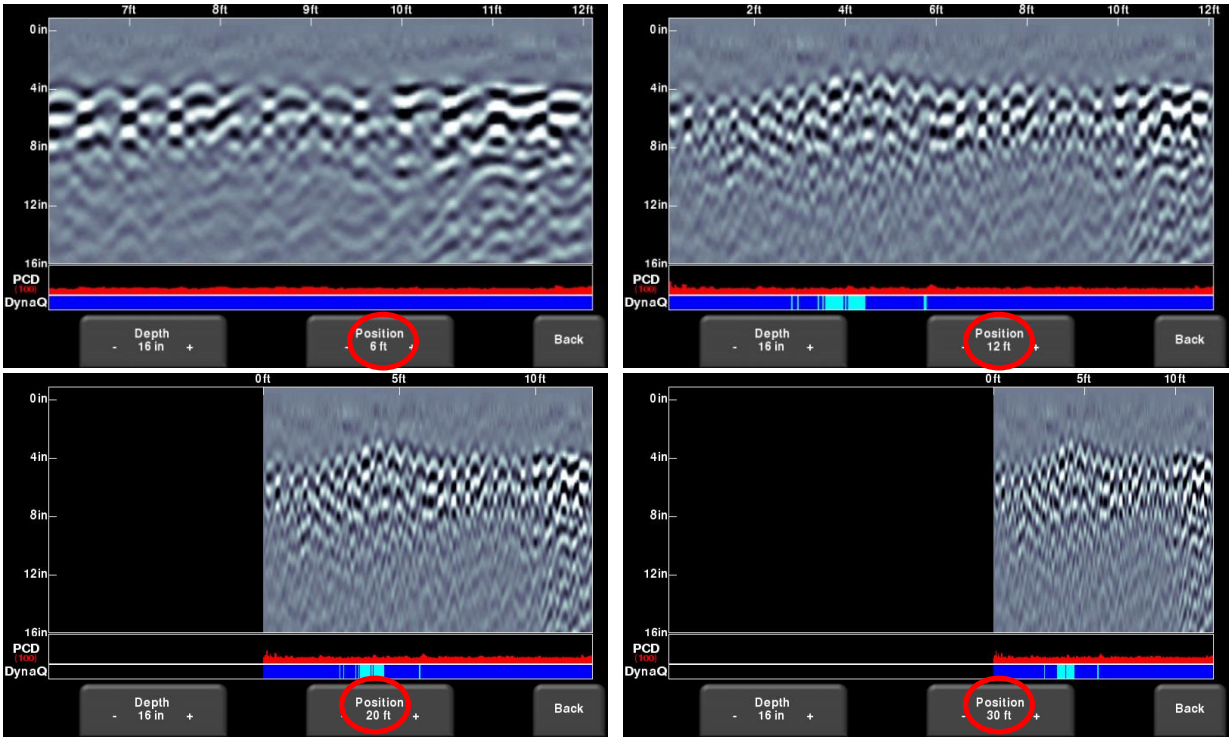


Figure 6-11: Varying position, or horizontal scaling

6.8.3 Color

Pressing this button changes the color palette for the GPR Lines. There are 9 different color palette options.

6.8.4 Filter

When the filter is on, flat-lying responses in the data (like the surface response described in Section 2.2) are filtered out so that shallow hyperbolic responses from objects like rebar and conduits are enhanced. It will also filter out other flat-lying responses, such as bottom of concrete, so be careful when using this option (Figure 6-12). The filter is set to OFF by default.

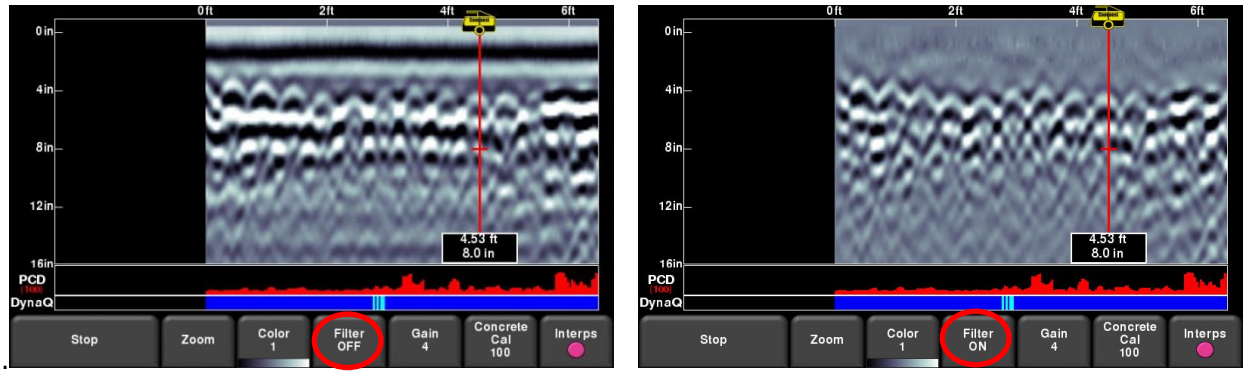


Figure 6-12: Left image shows Filter Off, while the right shows the same data with the Filter On

6.8.5 Gain

Gain is used to amplify the response to enhance weak features in the data image. Gain values vary from 1 to 8 with 1 meaning a minimal amplification has been applied and 8 meaning that maximum amplification has been applied. Pressing this button increments the gain; once you reach 8 it cycles back to 1. Avoid over-gaining the data as it can make interpretation difficult (Figure 6-13).

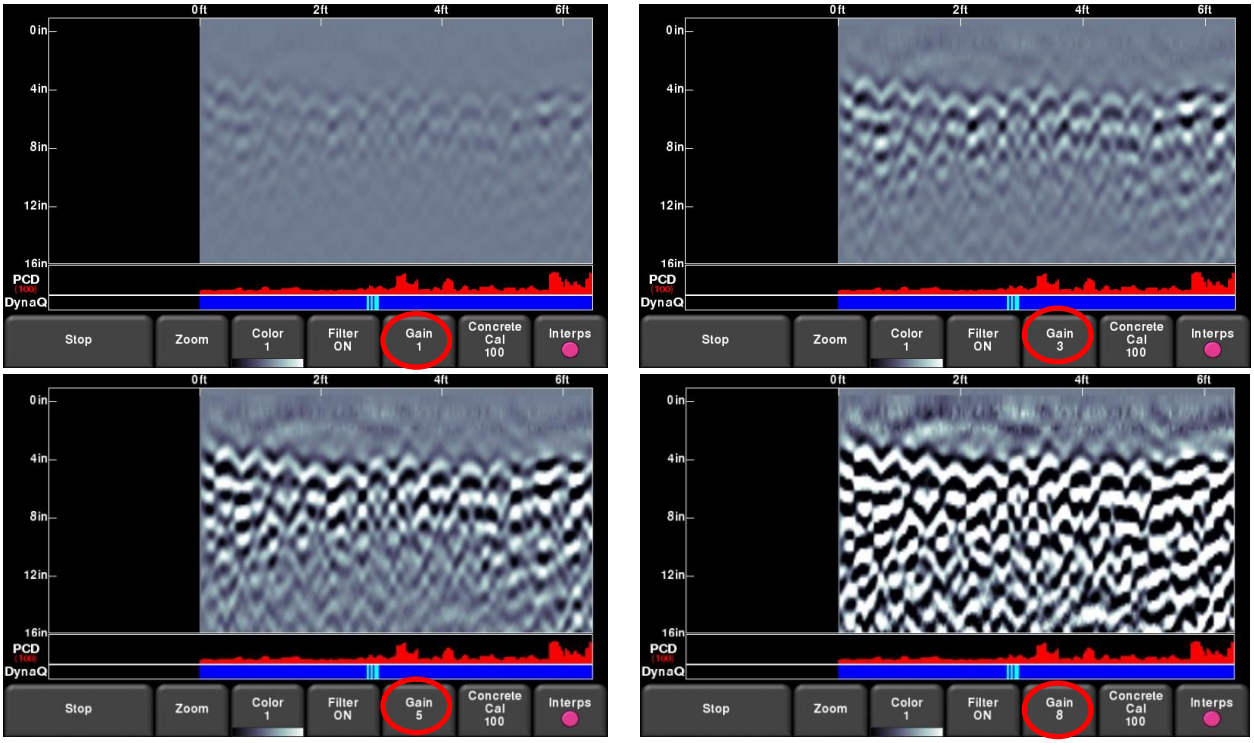


Figure 6-13: Gain is used to amplify the signal to enhance the weaker targets. The same GPR Line is displayed with gain values of 1, 3, 5, and 8. A gain of 1 is under-gained and you might miss something. A gain of 8 is over-gained and difficult to interpret.

6.8.6 Concrete Cal

An accurate Concrete Cal is critical for determining the depth of an object in the subsurface (Section 2.3 explains the rationale of doing Concrete Cal). You should adjust this value whenever you move to a different site (or different concrete pour).

The last used Concrete Cal is displayed on the Concrete Cal button. Once you have collected data with one or more hyperbolas on the screen, press **Concrete Cal**; this can be done during data collection, back-up mode or when stopped. You will see the image in Figure 6-14.

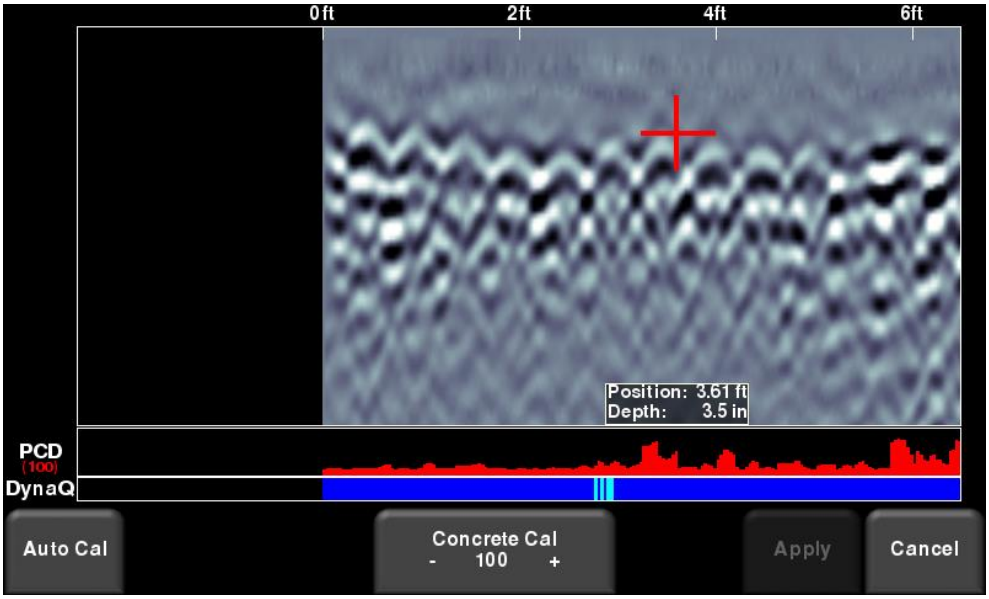


Figure 6-14: Concrete Cal menu

A red crosshair will appear on the screen, along with a dialog box showing the position and depth to the center of the crosshair. Once you have determined the Concrete Cal (see below), you can touch the screen and drag the crosshair to accurately determine the depth and position of any object.

The Concrete Cal can either be manually set by pressing **Concrete Cal -/+** or set automatically by pressing **Auto Cal**.

Pressing **Auto Cal** will analyze the hyperbolas on the screen and determine the proper Concrete Cal value. If you are satisfied with this value, press **Apply** and it will re-display with a new depth scale (Figure 6-14). If you don't want to change the value, press **Cancel** instead. Note: in most cases, the Concrete Cal value should typically be between 85 – 130.

You could manually set the Concrete Cal if you've verified the depth of the concrete or an object, by moving the crosshair to the top of that object response and adjusting the Concrete Cal until the depth indicator matches what you've measured (also known as " ground-truthing"). Press **Apply** to accept this value and it will re-display with a new depth scale (Figure 6-15).

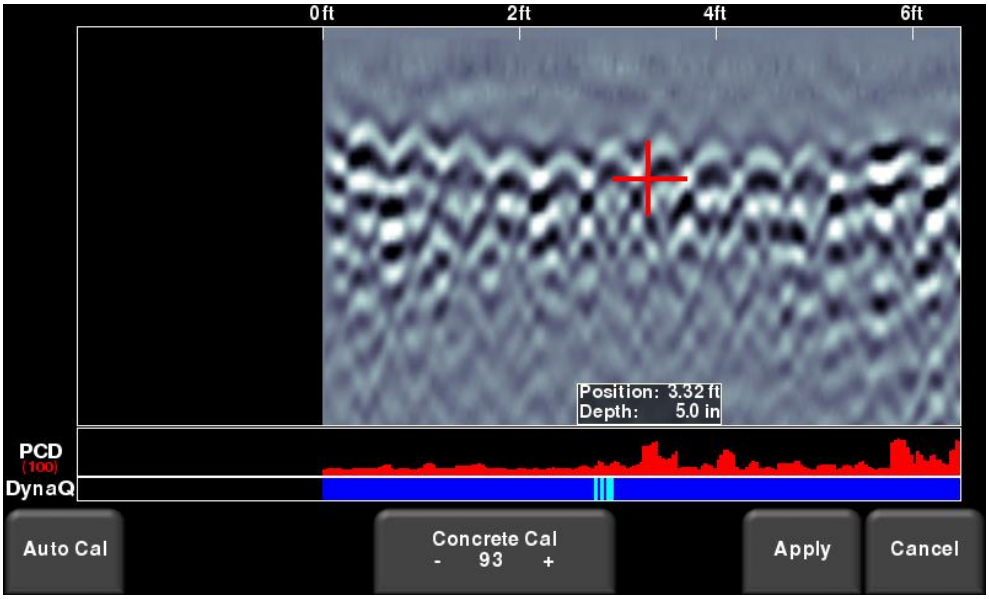


Figure 6-15: After you have adjusted the Concrete Cal, press Apply to accept the new value.

Lines should NOT be used for the Concrete Cal calculation if they have any of the following features:

1. Very shallow targets, less than 2” deep.
2. Targets that are not crossed at a 90° angle; crossing at an angle changes the shape of the hyperbola, resulting in a calibration value that is too high.
3. Data with no targets.
4. Complex data with multiple targets close together, where the hyperbolas overlap.

In these cases, the user should collect more lines to find a suitable one for determining the Concrete Cal and then manually apply that value to other Line Scans in the same area.

6.8.7 Interps

Short for field interpretation, Interps are used to mark subsurface features. Seven colors are available, which allow you to designate different types of subsurface objects.

Either during collection, back-up or review, you can simply touch anywhere on the screen to add an Interpretation (Figure 6-16). This appears as a dot of whatever color is selected. To change the color, press the **Interp** button to see a selection of colors and to select a new one (Figure 6-17).

To remove an Interp, ensure the same color is currently active and simply touch the dot to remove it. These Interps get exported as a .CSV file during data export (Section 11.3).

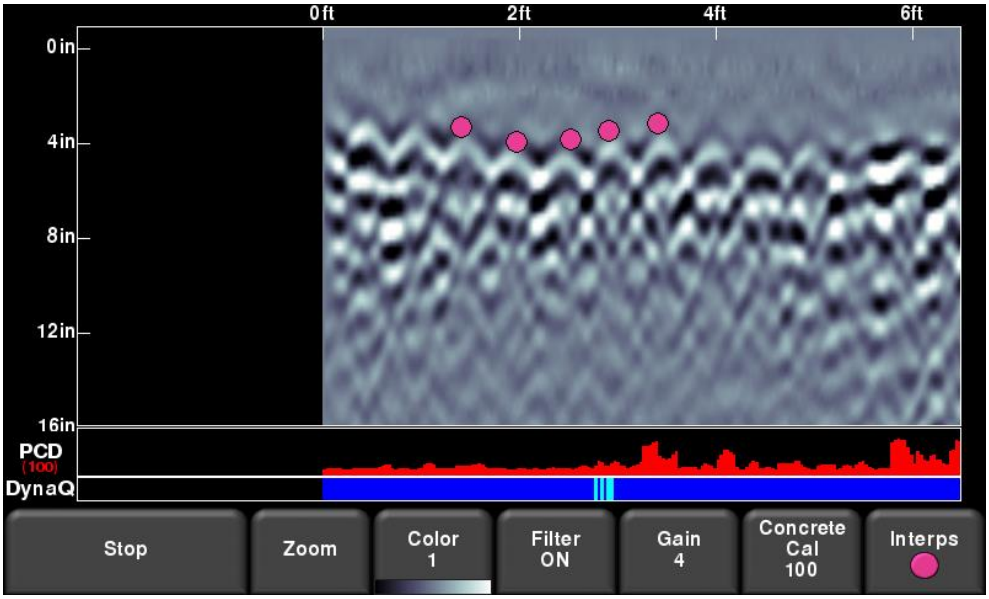


Figure 6-16: Adding Interps over rebar

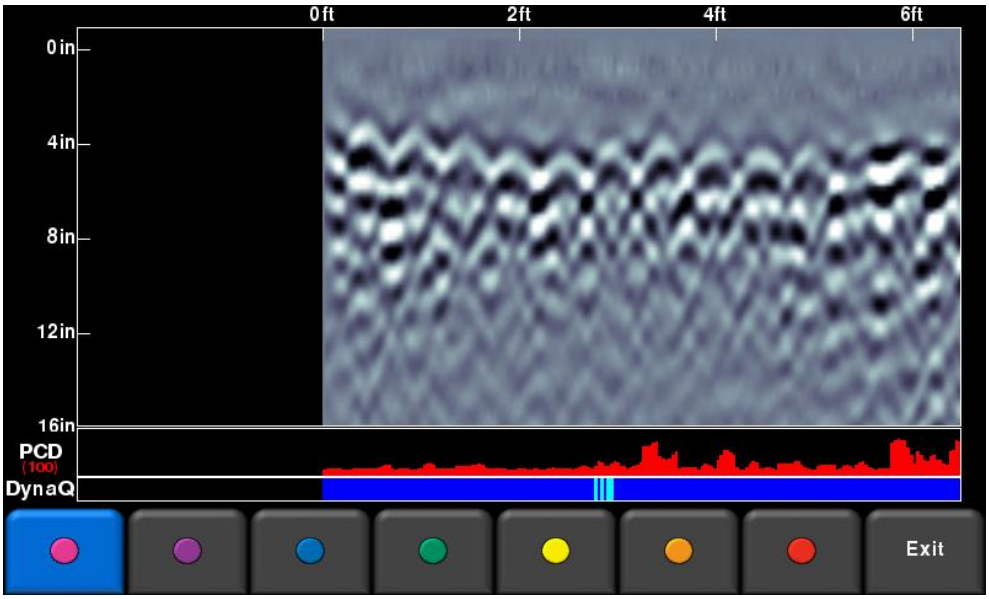


Figure 6-17: Available colors for Interps

6.9 No Save Mode

No Save Mode allows you to acquire data without saving it. Everything operates the same as in Line Scan mode, with two differences:

1. There is no Interps button.
2. You can draw arrows to highlight features. Touch the screen where you want the head of the arrow to appear, and then swipe away in the direction of the shaft. In the example in (Figure 6-18), the user touched near the hyperbola, then swept their finger towards the top left to create the arrow. Just like Interps, any number of arrows can be drawn on this screen. Touch any arrow to remove it.

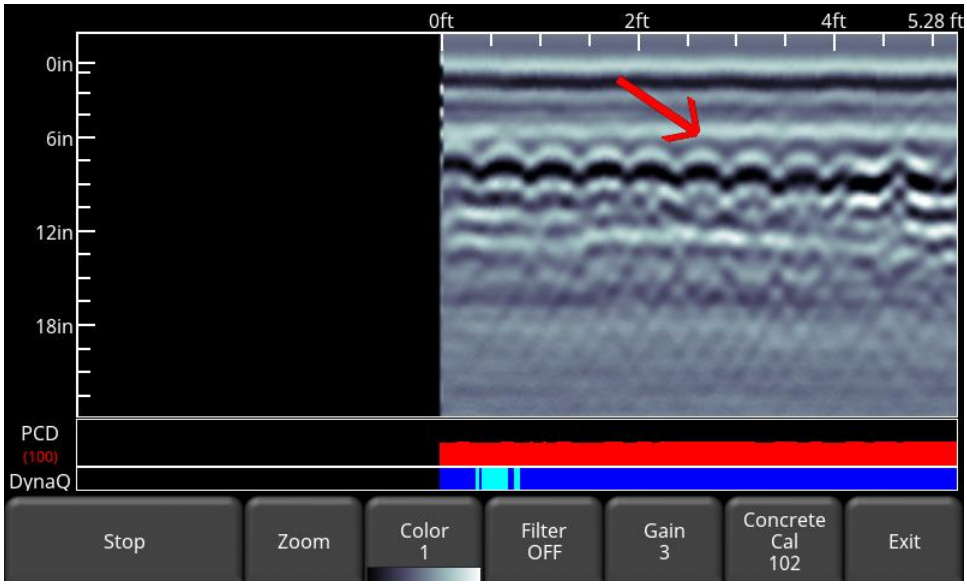


Figure 6-18: Drawing an arrow on the screen in No Save Mode

Pressing the Camera button will take a screenshot and save it in the currently selected project.

7 Grid Scan

Grid Scans are collected to ultimately image structures at various depths in the concrete. Embedded features are revealed as deeper layers (or depth slices) of concrete are viewed.

The following is a simplified step-by-step approach that can be used to investigate a site and setup a grid using your Conquest 100 system.

7.1 Define Area of Interest

The area of interest can be where you need to drill, cut, or where general information is desired for a variety of purposes. To make depth slice images, Conquest 100 must acquire data in a grid pattern. The standard grids can be either metric or imperial units.

The grid sizes available are:

US Standard	Metric
24” x 24”	600 mm x 600 mm
48” x 48”	1200 mm x 1200 mm
48” x 24”	1200 mm x 600 mm

If you have the Conquest 100 Enhanced, there are two additional grid sizes available:

US Standard	Metric
96” x 24”	2400 mm x 600 mm
96” x 96”	2400 mm x 2400 mm

Your specific site will dictate what is practical and where you can operate. In tight corners and spaces, it may not always be possible to lay out a grid. In this case you may have to collect a partial grid or use Line Scan mode only.

7.2 Place Grid Mat

Use Line Scan to determine the optimum orientation for grids. For the best resolution of targets, the survey grid should be aligned perpendicular to any embedded objects in the concrete. If there are features which run at oblique angles, select the predominant orientation of the rebar for aligning the grid.

The grid mat should be taped to the structure with duct tape to prevent it from moving during the grid scan.

7.3 Standard Grids

Conquest comes with US standard (24” x 24”) and the metric equivalent (600 mm x 600 mm) grid mats (Figure 7-1). The units are labeled in the bottom right corner of the grid (make sure the units on your grid sheet match the units set in Preferences (Section 5.1.2). This is the

minimum suggested survey size for local area investigations. These grids can be taped together to create larger sizes explained in the section below.

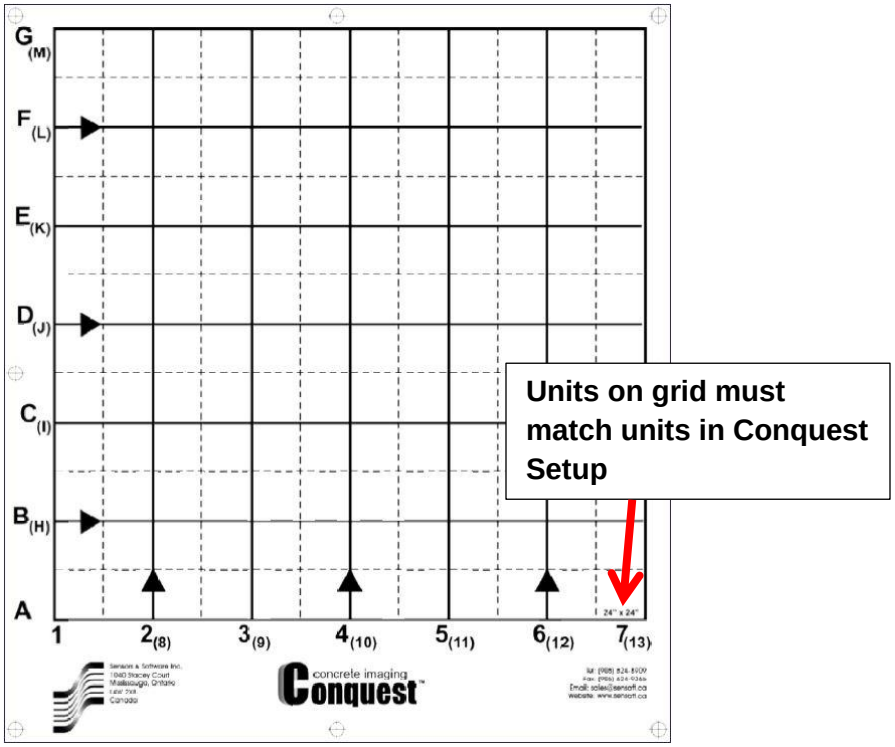


Figure 7-1: Grids are 24" x 24" or 600 x 600 mm. Alpha lines are labeled A, B, C etc. and Numeric lines are labeled 1, 2, 3 etc. and spaced 4 inches (100 mm) apart. High resolution lines are dotted and spaced every 2 inches (50 mm).

The grid mats are labeled with numbers and letters. Survey lines which run vertically on the sheet are labeled 1 through 7, and lines which run horizontally on the sheet are labeled A through G. These solid lines are spaced 4 inches or 100 mm apart and are used for normal resolution surveys. Dotted lines are shown halfway between these lines and are used in addition to the solid lines in high resolution surveys.

The lettering (Alpha lines) and numbering (Numeric lines) provides a grid coordinate system. This same coordinate system shows up on the images created by Conquest for easy reference back to the grid.

7.4 Larger Grids

Larger areas can be surveyed by taping multiple grid mats together to produce 48" x 24" (1200 x 600 mm) and 48" x 48" (1200 x 1200 mm) survey grids. If you are collecting the larger sizes (available only with the Enhanced model), you may need to layout or "chalk-out" your own grid on the floor.

On Conquest grid sheets, the line numbers past the edge of the first grid sheet are indicated on the second grid sheet mat in brackets. When joining multiple sheets, make sure they overlap

such that the sheet edges won't catch the bottom of the sensor (Figure 7-2) and that the sequential numbers / letters are aligned.

Where possible, it is recommended that 48" x 48" (1200 x 1200 mm) size Grid Scans are completed to provide a better understanding of the concrete's internal features.

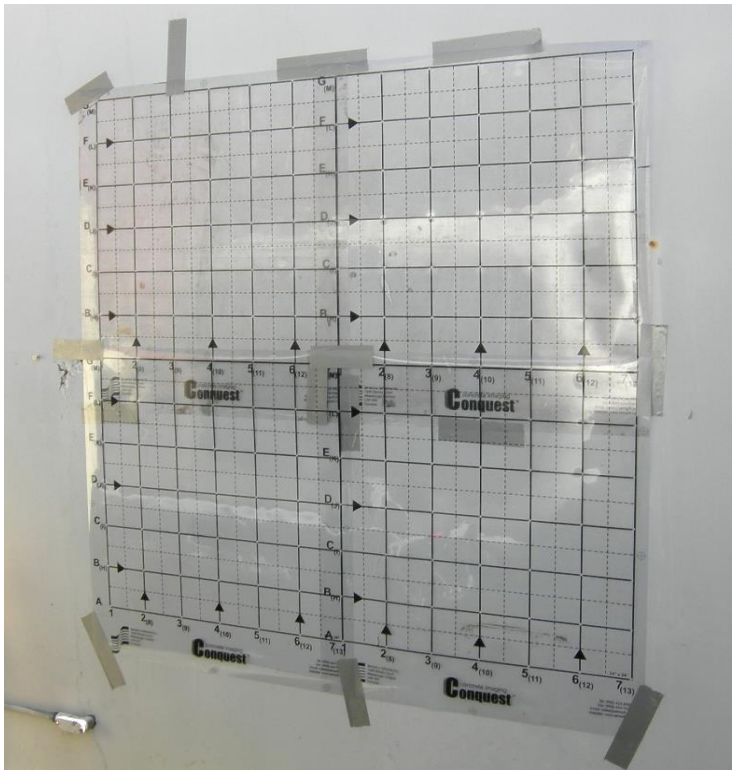


Figure 7-2: 4 Conquest Sheets taped down to make a 48" x 48" (1200 x 1200 mm) grid.

7.5 Grid Scan Setup

Once you have your grid mat in place, you are now ready to acquire Grid Scan data. Press **Grid Scan** from the main menu, this will take you to the menu in Figure 7-3. If you are using the Conquest 100 Enhanced system, ensure you are in the Project that you want to work in.

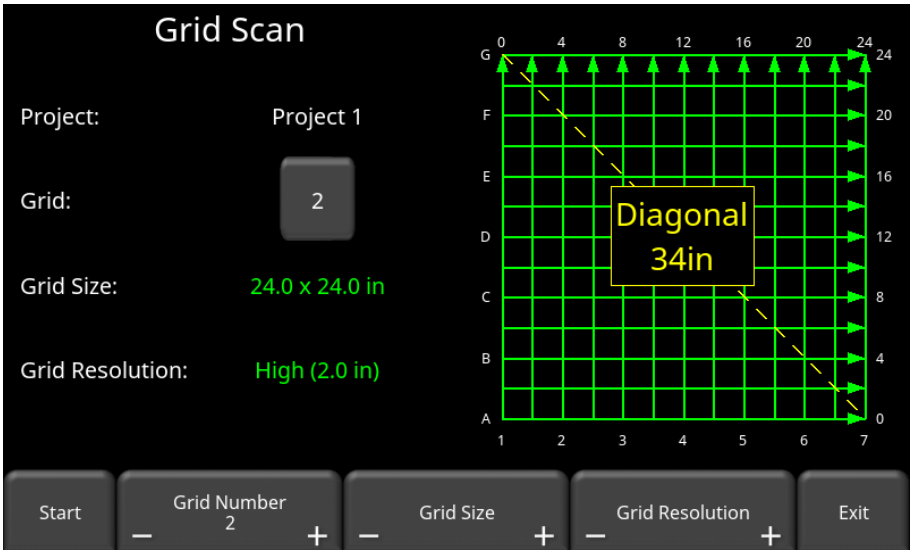


Figure 7-3: Grid Scan menu lets you configure parameters for Grid Scan.

- **Grid Number** - Grid Scans are numbered from 1 to 20. Pressing **+/-** on the bottom menu will increment/decrement the grid number. Alternatively, pressing the grid number button itself will show the screen in Figure 7-4. From here, you can go directly to any grid. If the grid number is in green, then no data exists in that grid. However, if the grid number is in red then data already exists in that grid; see Section 7.6 below.

- **Grid Size** – press **+/-** under **Grid Size** on the bottom menu to cycle between the available sizes. The grid size cannot be changed once data collection has started.

- **Grid Resolution** – press **+/-** under **Grid Resolution** on the bottom menu to toggle between normal and high resolution. Normal resolution grids acquire data on the solid grid mat lines labeled 1, 2, 3 etc. and A, B, C etc. spaced 100 mm (4 inches) apart (Figure 7-1). High resolution grids also acquire data on the dashed lines in-between. These lines are called 1h, 2h, 3h etc. and Ah, Bh, Ch etc.

  High resolution grids are recommended for complex situations where:
  - There are many objects in the survey grid
  - Plastic or deep conduits are expected
  - When objects are curving, diagonal or changing direction

  The grid resolution cannot be changed once data collection has started.

- **Start -** when you are ready to scan, press the **Start** button on the bottom menu.

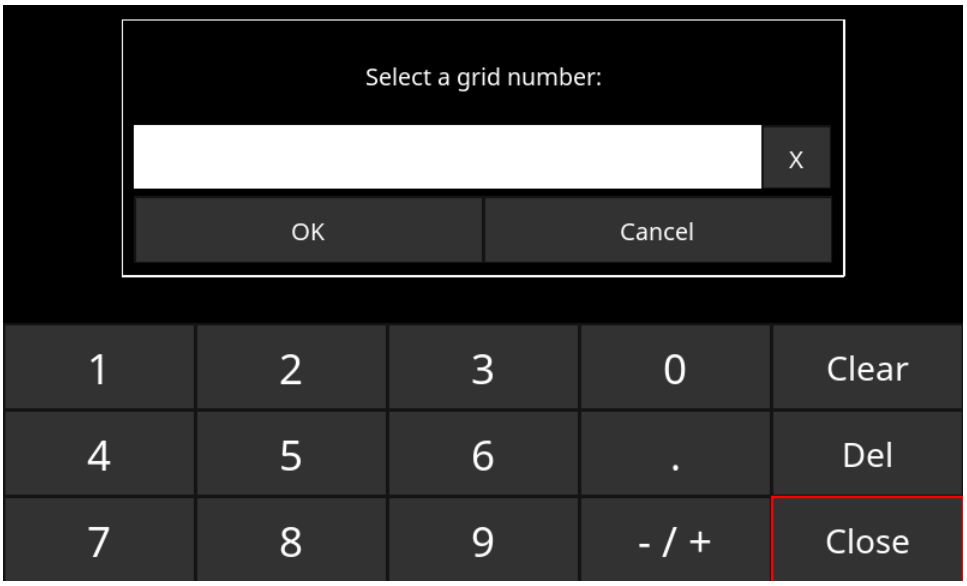


Figure 7-4: This screen allows the user to directly input the grid they wish to go to

7.6 Grids Containing Data

If the grid number is in red, then some data exists in that grid (Figure 7-5). This may be either a fully collected grid, or a partially collected grid. Press start to continue data collection on a partially collected grid or re-collect one or more lines if they were done in error.

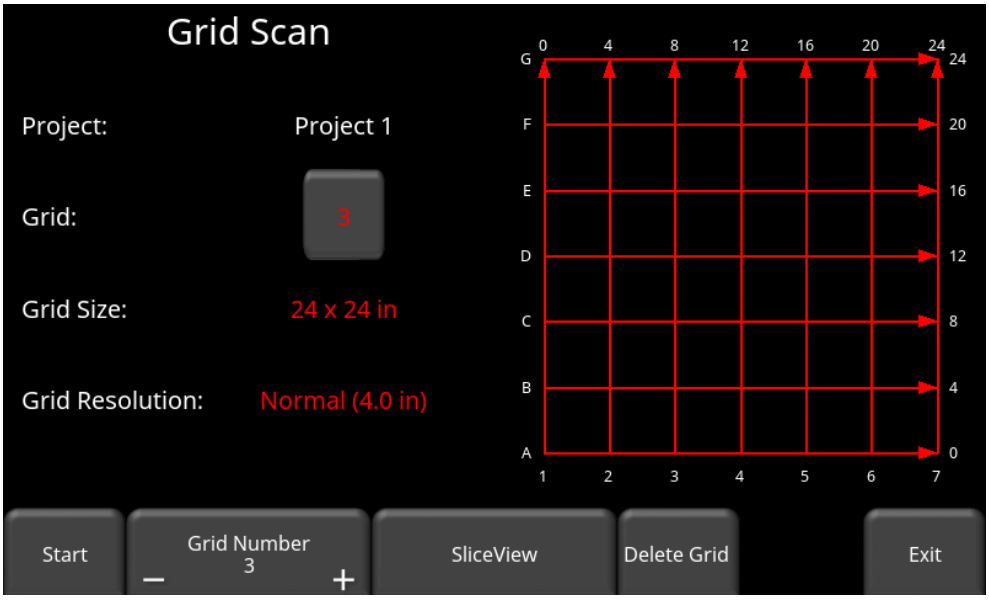


Figure 7-5: A grid already containing data, with different options on the bottom menu

If the grid number is in red, the bottom menu changes slightly, giving you these new options:

- **SliceView** – Press this to view the depth slice images for the grid.

- **Delete Grid** – Press this to delete the grid data. You will be prompted to confirm again.

7.7 Surveying the Grid

Once your grid parameters have been set, press **Start** to open the grid collection screen (Figure 7-6).

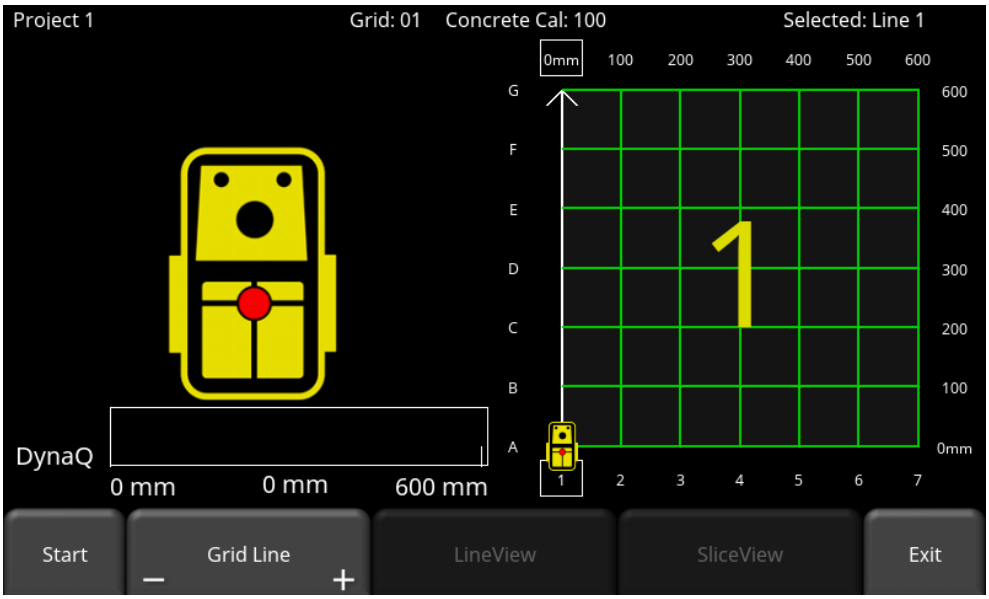


Figure 7-6: Screen shown during grid collection.

The Grid Scan screen guides the user through proper data collection. On the right is a graphic representation of the grid, illustrating the size of the grid, the lines that need to be collected (in green), the current line (in white) and the lines that have already been collected (in red). The left side is reserved for the display of the most recently collected Line data.

7.8 Positioning the Sensor

At the start of every grid line, it is important the sensor be properly positioned before pressing the Start button. Measurements are based on the center of the sensor moving along the line.

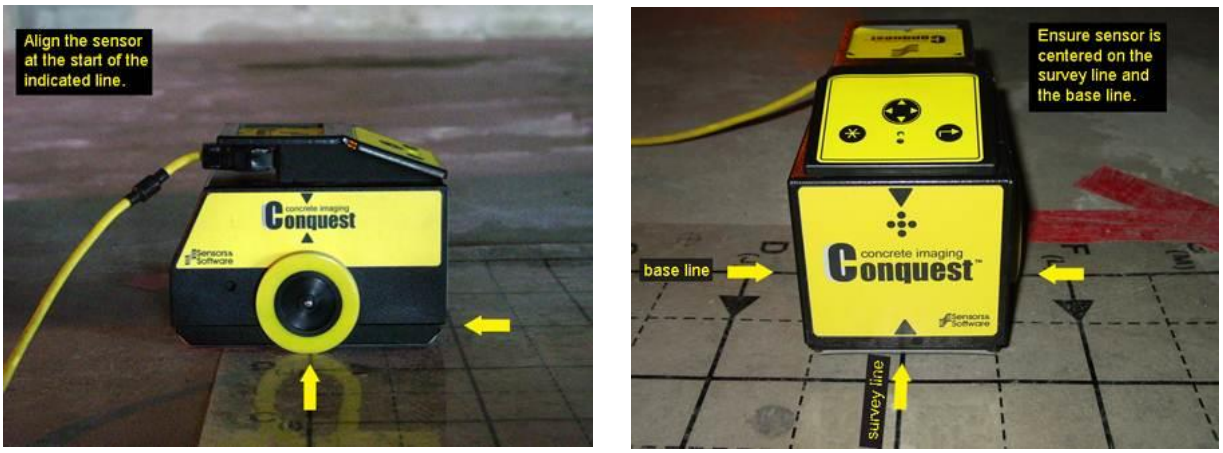


Figure 7-7: Properly position the Sensor Head on a grid line before scanning.

Position the center of the Sensor Head at the start of the line number indicated on the screen. Use the arrows on the sides and top to center it on the base line and the arrows on the top and ends to center it on the line to be collected (Figure 7-7).

Always collect lines in the direction indicated by the arrows on the grid mat (Figure 7-1).

Do not back up the Sensor Head while collecting a grid line.

7.9 Collecting Grid Lines

Select **Start** on the screen, the **Ente**r key on the Sensor Head or the **Bluetooth** Trigger. The system will beep once when ready to collect the line. Move the sensor along the survey line to the end. Move the sensor at a steady pace, keeping it centered on the grid line. As a grid line is collected, a graphic of the Sensor Head moves along the white line on the right side. On the left side, the DynaQ color is shown as the line progresses towards completion.

The Sensor Head must be pushed slightly beyond the end line on the far edge of the grid mat (1-2 cm) before the survey line stops and the system beeps twice.

In situations where the line must be stopped before the end of the grid is reached, press **Enter** on the Sensor Head, **End Line** on the Display Unit or the **Bluetooth** Trigger.

Once you have finished the line, it will automatically move you to the next line on the grid illustration, as well as displaying the line number/letter overlaid on the grid. The line scan from the most recently collected line is displayed on the left side (Figure 7-8).

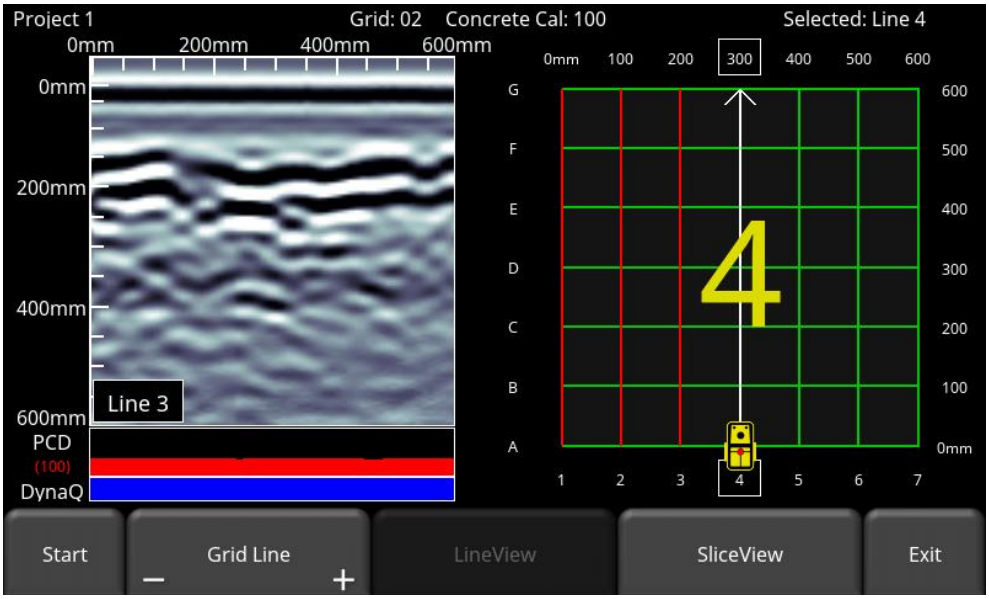


Figure 7-8: After collecting a line, the collected data is displayed on the left

Under the GPR Line image, the PCD response is shown in red and DynaQ line under that.

The color of the DynaQ bar indicates the quality of the data at that point along the line:

White	=	No Data (too fast!)
Yellow	=	moderate quality
Light blue	=	better quality
Dark Blue	=	highest quality

In general, avoid collecting data at extremely high rates of speed. The system will beep three times to indicate that a data quality issue has been detected.

Flags can be inserted to mark noteworthy surface features, such as cracks in the concrete or if the surface material changes. These markers may help you correlate subsurface targets with above ground features.

Pressing the **asterisk** button on the keypad will insert a flag at your current position. The flag is displayed on the line scan image and will also show up on the depth slices in SliceView (Section 8). Flags are sequentially numbered.

7.10 LineView

To display the currently selected grid line on the full screen, press the **LineView** button (Figure 7-9).

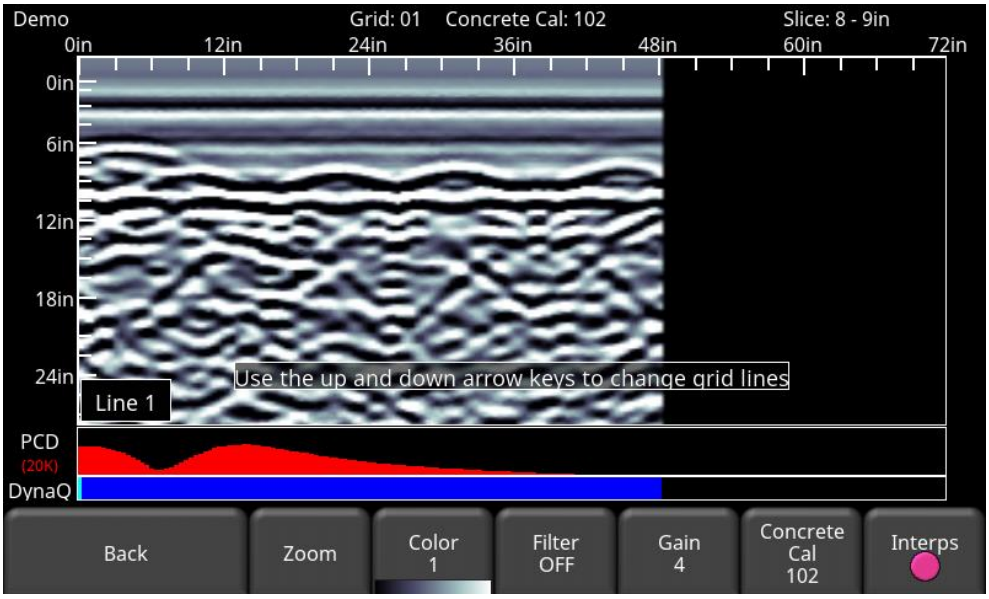


Figure 7-9: Switching to LineView from within Grid Collection.

This displays the grid line along with the Zoom, Color, Filter, and Gain menu options for modifying the image (Section 6.8).

It is also possible to switch to other collected grid lines using the keypad arrow buttons.

To exit from the LineView screen and return to Grid View (Figure 7-8), press the **Back** button. The Grid View screen respects any display settings changed while in LineView.

7.11 Reviewing, Re-collecting & Skipping Lines

During grid collection, if you need to review a previous line:

1. Press **Grid Line +/-** on the Display Unit or
2. Use the **4-way directional arrows** on the Display Unit or Sensor Head

The white line on the grid will correspond to whatever line is selected, and the GPR Line is displayed (if that line has been collected).

Occasionally, there may be a need to re-collect a line of data, if you went too fast, veered off the line, or knew that your starting position was off. Go to the line that requires re-collection and press **Start** on the Display Unit**, Enter** on the Sensor Head or the **Bluetooth Trigger**. You will be prompted to confirm that you would like to overwrite the line (Figure 7-10).

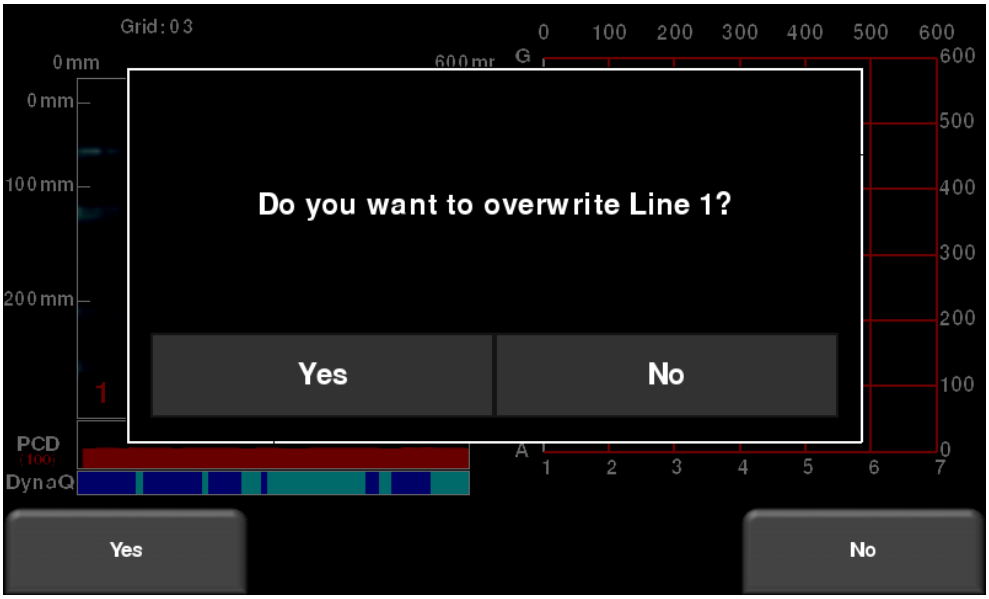


Figure 7-10: Overwriting a grid line.

If you need to skip a series of lines (due to an obstruction, for example), move to the desired grid line using any of the methods above. You can still process the data to create depth slices even if you are missing lines in the grid; there will just be a blank area where no data was collected.

7.12 SliceView

Once you have finished collecting the grid, press the **SliceView** button to generate depth slices (Section 8 explains viewing depth slices). Before the data is processed, the Concrete Cal is automatically calculated from all the grid data. This value is the speed the GPR signal travels in the concrete and an accurate value is important for processing the data to create images with the highest clarity.

8 SliceView

A key feature of Conquest is its ability to transform the raw sensor information into a series of depth-based slice images cutting down through the concrete (Figure 8-1). In general, depth slice images are generated after all the lines in the grid have been collected, but images can also be generated when a partial grid (minimum 3 lines) has been collected. This is useful when the grid area is smaller than the grid mat or when part of the grid is obstructed and not all the lines can be collected.

The best way to think of the depth slices are as photograph-like views from above slicing 1 inch (25 mm) at a time into the subsurface.

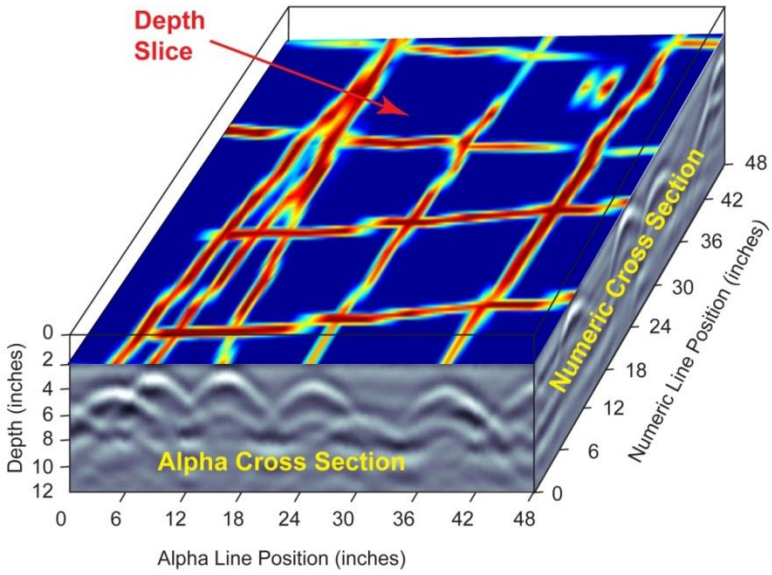


Figure 8-1: A conceptual Conquest Grid Scan image to understand the relationship between depth slice images, Alpha GPR Lines and Numeric GPR Lines. The rectangular regions to the bottom and the right should be thought of as GPR Lines through the concrete in each direction at the positions of the crosshairs.

After a Grid Scan is complete and SliceView selected, the data are processed and depth slices are generated and displayed.

The PCD data are also processed to generate a PCD slice image that is displayed in the SliceView menu.

It is not necessary to reprocess data every time you want to view it. Once a grid has been processed, the images are always immediately available by selecting **SliceView** from the **Grid Scan** menu.

8.1 SliceView Screen

The SliceView screen is shown in Figure 8-2:

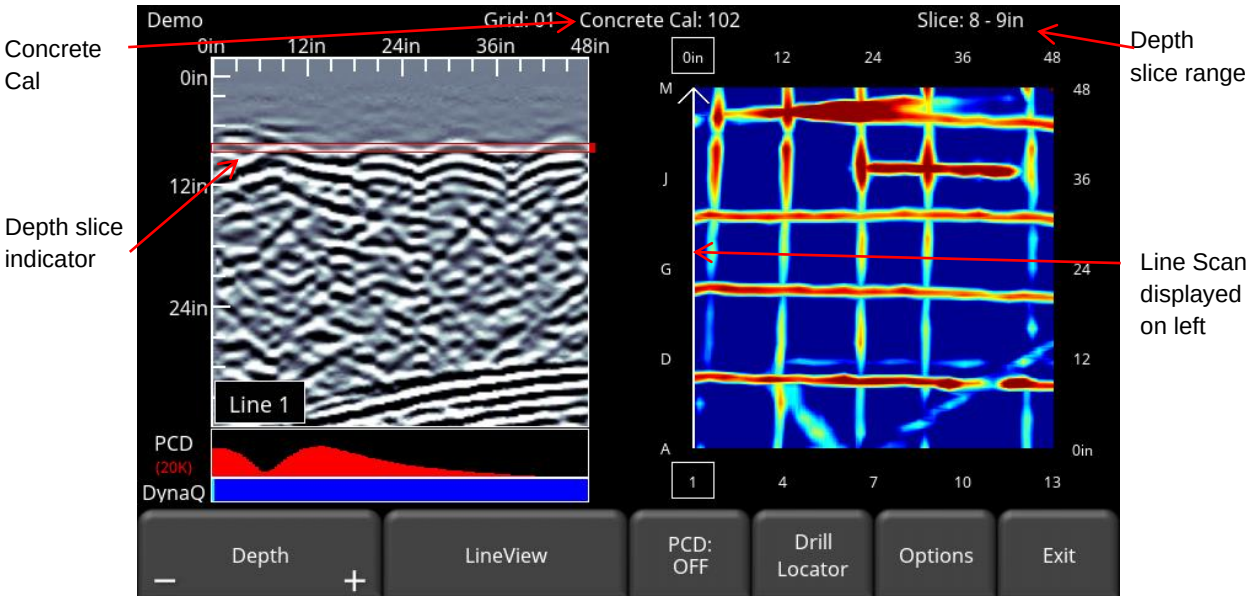


Figure 8-2: The SliceView screen displays a 1 inch (25mm) thick depth slice on the right and a GPR Line on the left. The depth slice range is indicated by 2 red lines on the GPR Line and numerically displayed above the grid image.

One of the GPR Lines is displayed on the left side of the screen with the line number or letter displayed on the bottom of the image. To move to another GPR Line in the grid, use the **4-direction arrows** on the Display Unit or the Sensor Head keypad.

The depth slice image is on the right side of the screen. Depth slices are 1" or 25mm thick, starting with the first slice, 0"–1" (or 0-25mm). The depth slice image shows the alpha line labels on the left side and the numeric line labels on the bottom, while the top and right sides show the distance (in inches or mm).

Menu options are available on the bottom of the screen:

- **Depth** – pressing **-/+** will move the depth slice down or up by 1" (25 mm). As the depth slice changes, the red depth lines on the Line image also changes. It is important to move through all the slices to ensure that all features are noted. You can also change the depth by touching and moving the depth slice indicator on the Line image on the left side.

- **LineView** – Press this button to display the currently selected grid line on the full screen (Figure 8-3).

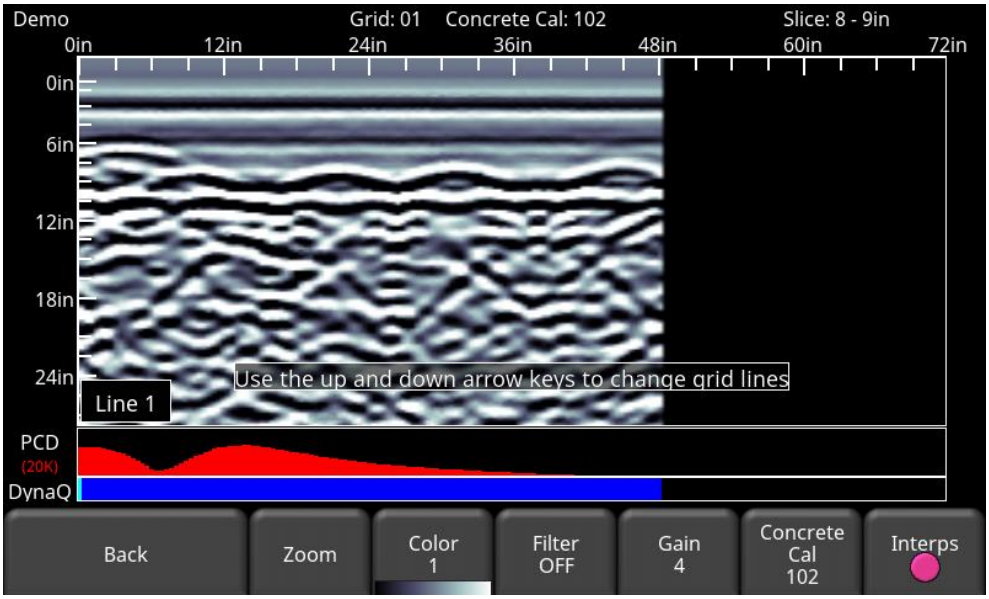


Figure 8-3: To display a Grid Line in full screen, press the LineView button

This displays the grid line along with the Zoom, Color, Filter, Gain, and Concrete Cal menu options for modifying the image (Section 6.8).

It is also possible to display other collected grid lines using the **keypad arrow** buttons.

To exit from the LineView screen and return to SliceView, press the **Back** button. The SliceView screen respects any display settings changed while in LineView.

If the value of the Concrete Cal is changed in LineView, the grid data will be reprocessed when you return to SliceView.

- **PCD** – pressing this button toggles between the PCD image and the depth slice images (Figure 8-4). Note that when viewing the PCD image, the depth -/+ button is greyed out, because the PCD image is a single image of the magnetic field at the surface (The principles of PCD are explained in Section 2.6).

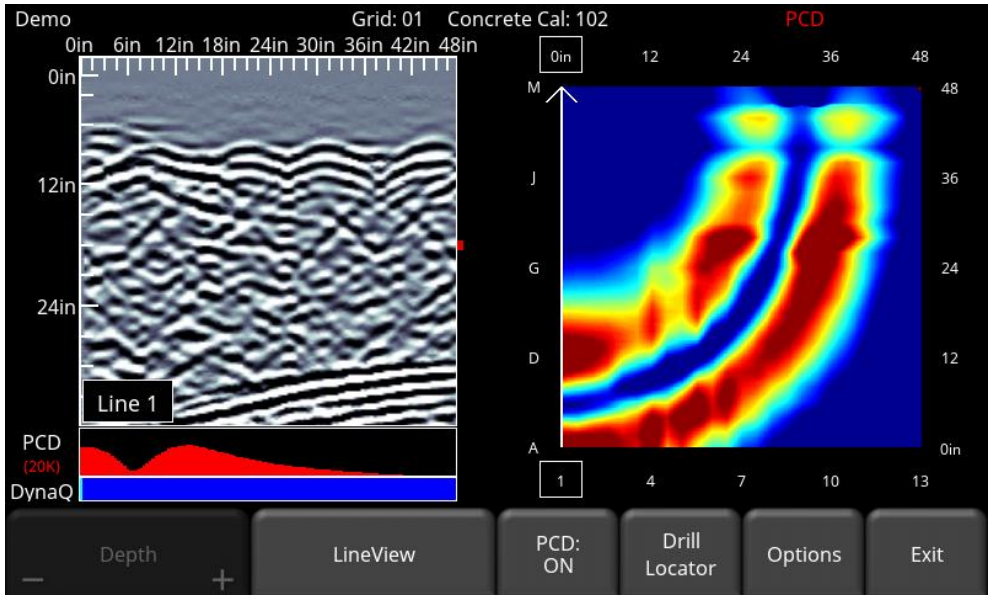


Figure 8-4: Screen image after switching from depth slice view to PCD view

- **Drill Locator** – pressing this takes you into modified menu which shows a drill hole superimposed over the data. The drill size can be changed by pressing the **Drill Size -/+** button. The drill size is independent of the units used to scan. The user can cycle through the sizes until the units change, allowing the use of metric drill bits on a U.S. Standard grid or vice versa. Figure 8-5 illustrates a 4-inch diameter drill hole.

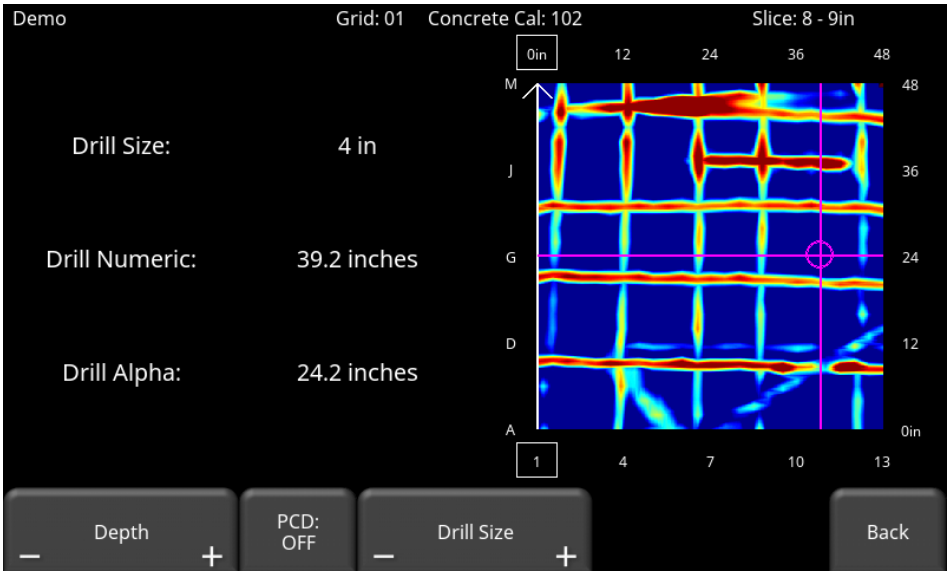


Figure 8-5: Drill Locator

The position of the drill locator can easily be moved by simply touching anywhere on the screen and the drill locator will move to that location. Alternatively, using the 4-directional arrow button on the Display Unit or the Sensor Head keypad will move the

position of the drill locator. The alpha/numeric coordinates and the drill diameter will be listed on the left. While the drill locator is on, switch to the PCD display or cycle through the depth slices to make sure you aren't going to hit an embedded object at any depth.

- **Options** – pressing this takes you to a sub-menu where you have the following options for viewing the depth slice image (Figure 8-6):

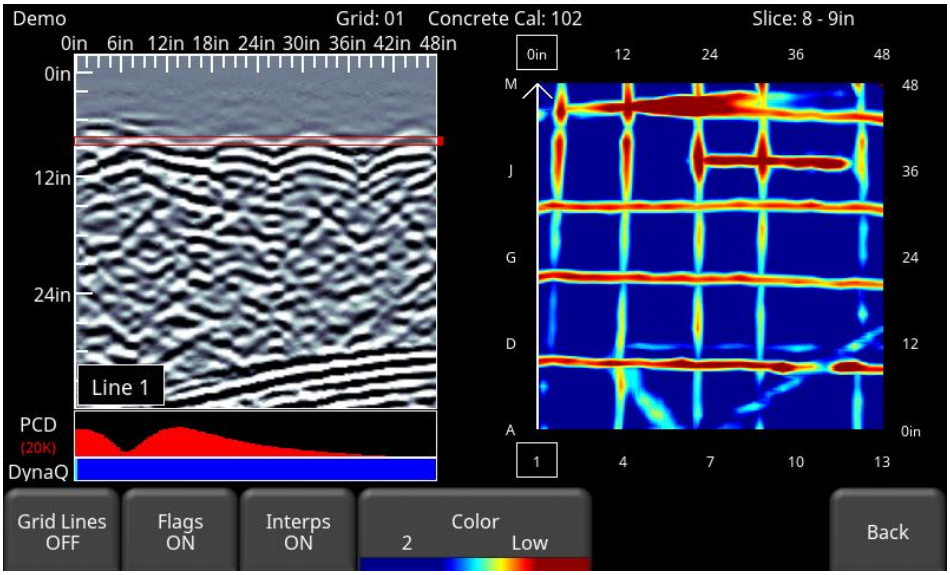
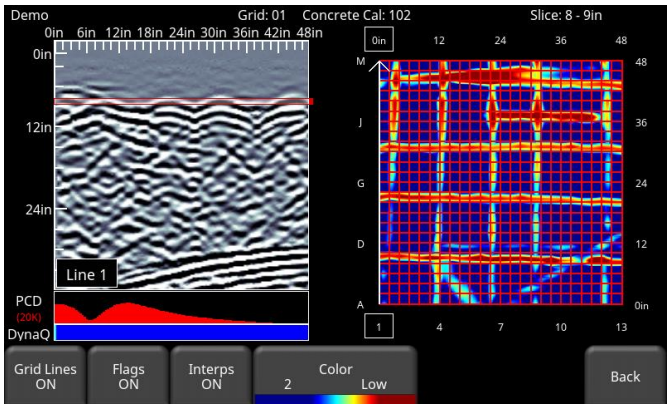


Figure 8-6: Pressing Options displays a different menu at the bottom.

  - **Grid Lines -** press this button to overlay the grid lines on the depth slice image. It is useful to see grid lines, so you know the position of the GPR Line in the grid (displayed in white). Pressing this button cycles between ON, PARTIAL or OFF. When set to ON, all the collected lines are displayed. When set to PARTIAL, only some of the grid lines are displayed. This may be necessary for some larger grids as having all grid lines ON tends to obscure the image beneath (Figure 8-7)



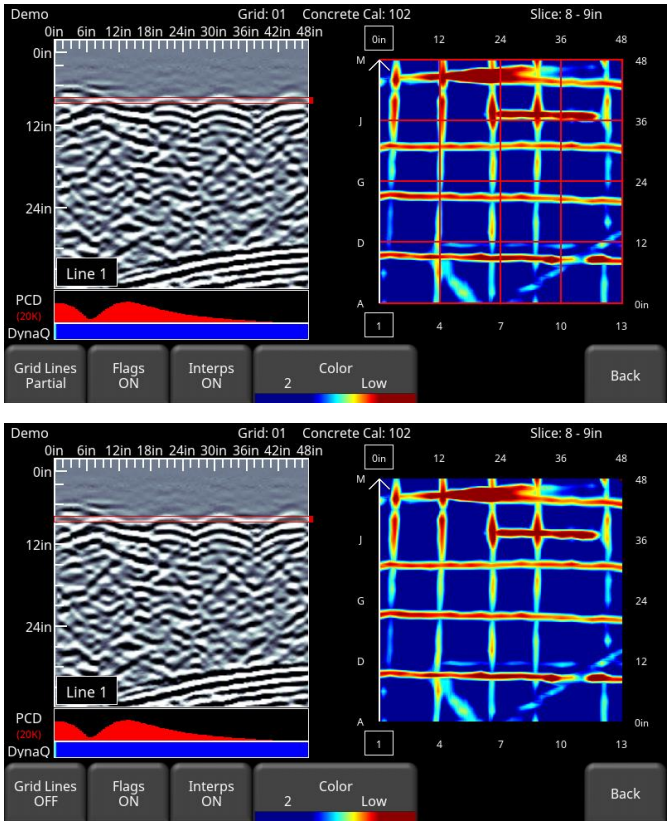


Figure 8-7: With Grid Lines ON (top), the grid lines are superimposed on the grid image. With Grid Lines set to PARTIAL (middle), lines are only displayed every 12 inches (or 300 mm). The position of the currently displayed GPR Line on the left is indicated by a white line on the depth slice on the right.

- **Flags –** any flags that were inserted during grid collection will appear on the depth slices. Press this button to toggle between displaying Flags (**ON**) or not (**OFF**)
- **Interps –** any Interps that were inserted during grid collection will appear on the depth slices. Press this button to toggle between displaying Interps (**ON**) or not (**OFF**). See Figure 8-8.

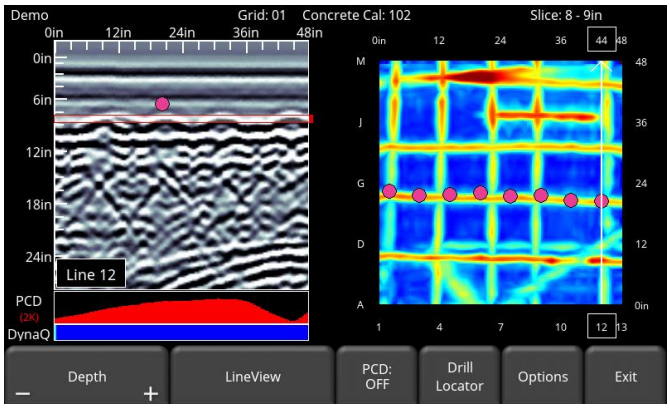


Figure 8-8: Interps displayed on depth slice

- **Color (left side)** – change the depth slice color palette, cycles between 1-9
- **Color (right side)** – cycles between LOW, MEDIUM and HIGH sensitivity display of the depth slice. A setting of HIGH is useful for revealing weaker targets in the concrete, like non-metallic conduits which can sometimes be difficult to see. Setting to LOW will help "clean up" the data and only show the strong targets, but will hide some of the weak signals (such as conduits), so be CAREFUL when setting to LOW (Figure 8-5).

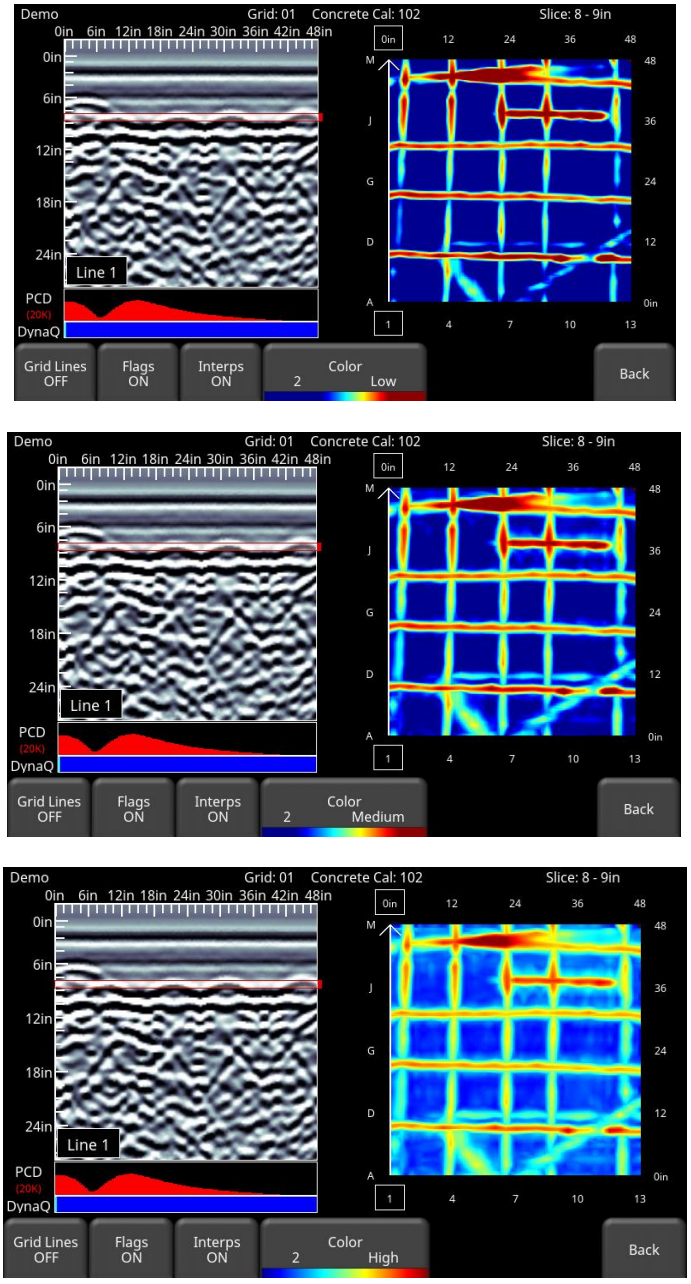


Figure 8-9: The Sensitivity button plots the data with Low, Medium or High Sensitivity (from top image to bottom).

- **Back** – press this to return to the SliceView main menu.

8.2 Recollecting Lines in the Grid Scan

After looking at the grid data in SliceView you may discover that one or more grid lines need to be re-collected (maybe the starting position was off or rebar appear to “bend” in the depth slices when they shouldn’t). If so, you will need to enter the Grid Scan menu again and select the grid (the grid number will be in red, since data exists).

Select the grid line that needs to be re-collected. When you press **Start**, it will display a prompt confirming if you want to overwrite the line, as shown in Figure 7-10.

After recollecting the grid lines, go back into SliceView and reprocess the grid data.

8.3 Depth Slice Interpretation

8.3.1 Conquest Resolution

One of the first things to note when looking at depth slices is the resolution of Conquest. Features will show up with a minimum size of about 1.5 inches (40 mm). This is a fundamental limit of the antenna response characteristics. You should not interpret a Conquest feature to be fully representative of the dimension in the Depth Slice image. The object may be 1 inch in diameter or 1/8 of an inch in diameter but it still will result in a 1.5 inch wide event on the depth slice image. Be careful about interpreting sizes of features.

8.3.2 Orientation

Scroll through the depth slices and look for patterns. Normally regular patterns of rebar will appear at different depths. Sometimes when a bar or conduit has a dip or a tilt, it will show up partially at one depth and then show up at another depth more clearly as the bar or conduit cuts down through the selected depth range.

8.3.3 PCD Image

Notice that, similar to GPR responses from rebar and other objects described above, the PCD response is broad compared to the actual size of the cable. The width of the PCD response has no relation to the size of the cable. In fact, sometimes the PCD response from a cable can appear so broad in width that a 2’ x 2’ (600 x 600 mm) grid may not show the edges of the response and the whole image appears as one strong color. In this case it may be necessary to collect a larger grid to see the edges of the PCD response.

8.4 Marking the site

It is necessary to view the depth slices through the total depth range in order to mark the site. The normal process is to step down through each depth and look for linear features which may indicate rebar, post-tension cables, pipes and conduits. At each depth, mark the location of the feature on the surface using the grid as a guide.

Marking the site will obviously be dictated by the site conditions. In an open concrete structure at a construction area site you can use chalk or a crayon to mark the surface. In finished floor areas one may want to use a washable marker, tape, or some other type of easily removable indicator. You will no doubt need to adapt for your specific site condition.

Make sure to document all site markings using a digital camera, hand drawn maps and measurements for future reference.

9 Demonstration Data

Demo Data is pre-loaded on all Conquest 100 systems, and is found in the Demo Project folder (from the main screen, press the minus button when you are in Project 1). The Demo Project folder contains 1 line and 1 grid.

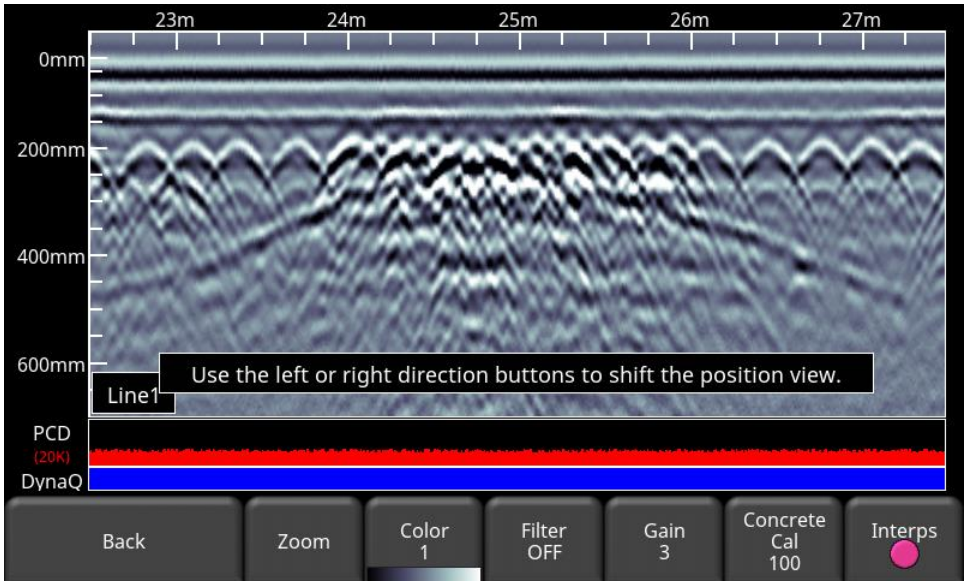
From a learning point of view, it is recommended to see the effect of changing display parameters (zoom, depth, calibrating velocity) on the line data. For the grid, it is useful to move down through all the depth slices to see how features come into focus, then disappear. As well, correlating hyperbolas on the line scans and seeing how they appear on the depth slice images helps to build confidence in what you are seeing.

The following is a brief description of what the data contains:

Line 1

The 30m long line shows data collected on a concrete deck. There is a top mat of rebar spaced about 25cm apart, as well as some randomly spaced rebar located beneath it. There are two sections (centered at 6.5m and 25m) where the rebar spacing gets close together. In particular at the 25m position, the rebar is noticeably much denser. This area is located over a column and there is also a post-tension cable running along the collected line. This is the angled feature which slopes away from the column, as the GPR sensors runs parallel to the post-tension cable. This is very typical of construction practice where:

a) Areas over a column are more heavily reinforced
b) Post-tension cables move lower in the slab between columns

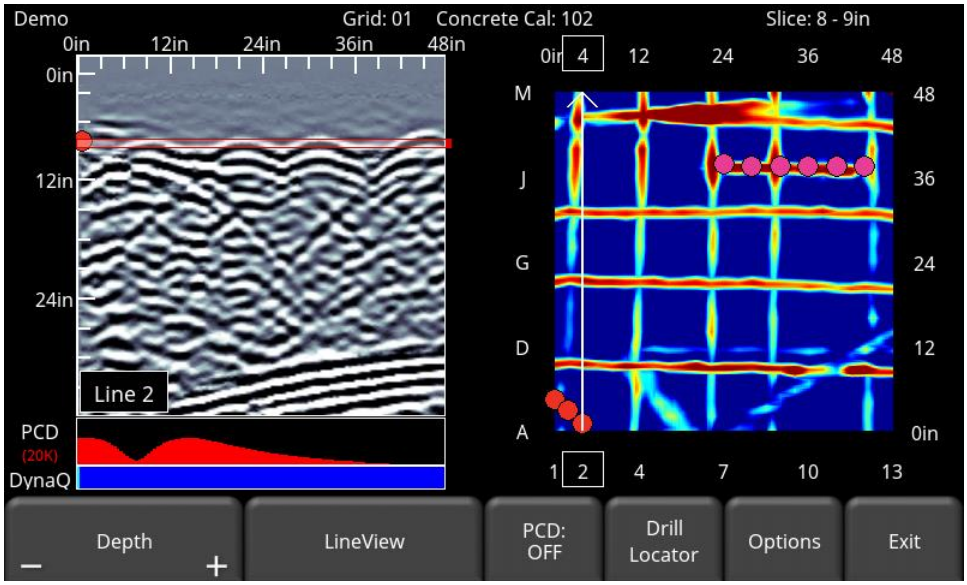


Grid 1

The dimensions of the grid are 48” x 48”, with lines collected every 2” apart. This was collected on a suspended concrete slab. As we slice down from the top, the first feature is visible on the 5-6” depth slice in the lower left corner. Interps have been added to highlight this feature on the line scan, which are also displayed on the depth slices.The majority of reinforcement is seen on the 8-9” depth slice.

Slicing down to the 11-12” depth slice, there is a curved feature visible. Turning the PCD on reveals a PCD repsonse that lines up exactly with the feature on the radar data. These were electrical conduits mounted on the underside of the slab, also known as surface mounted conduits.

This example highlights the importance of going through all the depth slices to locate features at different depths in a concrete slab.



10 Capturing Screens and Emailing Mini Reports

10.1 Capturing Screens

If you would like to save an image of the current screen, press the **camera** button on the Display Unit.

If you are not connected to a Wi-Fi network, a message appears confirming the name of the file the image was saved to (Figure 10-1).

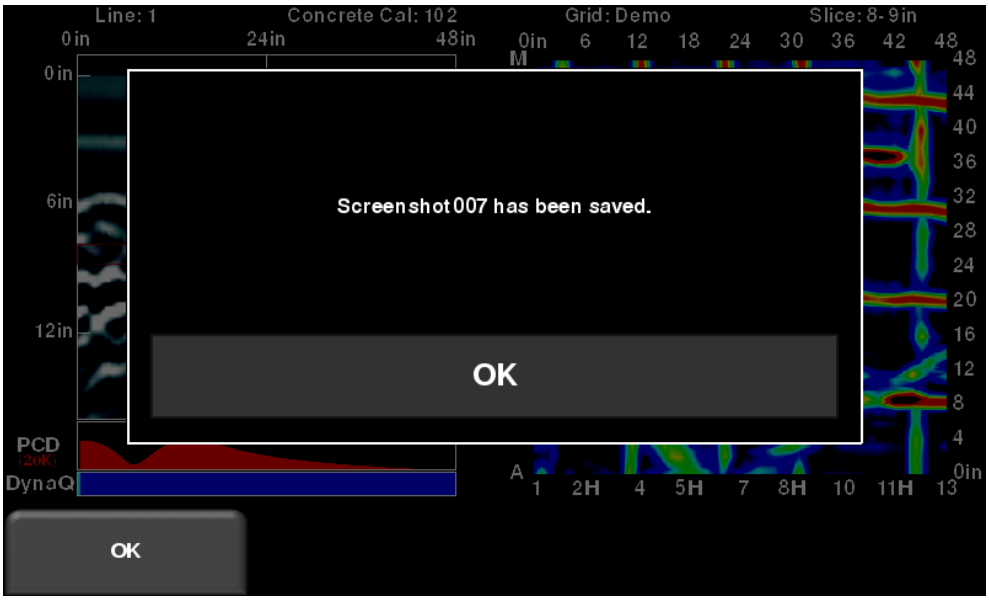


Figure 10-1: Message after pressing the camera button on the Display Unit to capture the screen (no Wi-Fi).

If you are connected to a wireless network and have an e-mail address configured, the user will see the message in Figure 10-2, asking if you would like to e-mail the data and prompts you to enter the e-mail address. This may take a few seconds to display the message. The e-mail address defaults to the last one entered. Tapping on the address box brings up an on-screen keyboard and allows you to enter a new e-mail address. Pressing the "**…**" button to the left of the e-mail address displays the last 5 e-mail addresses used, allowing the user to easily select a recent e-mail address, rather than re-entering it.

Screenshots can always be e-mailed at a later time from the Screenshot Gallery (Section 5.3.2).

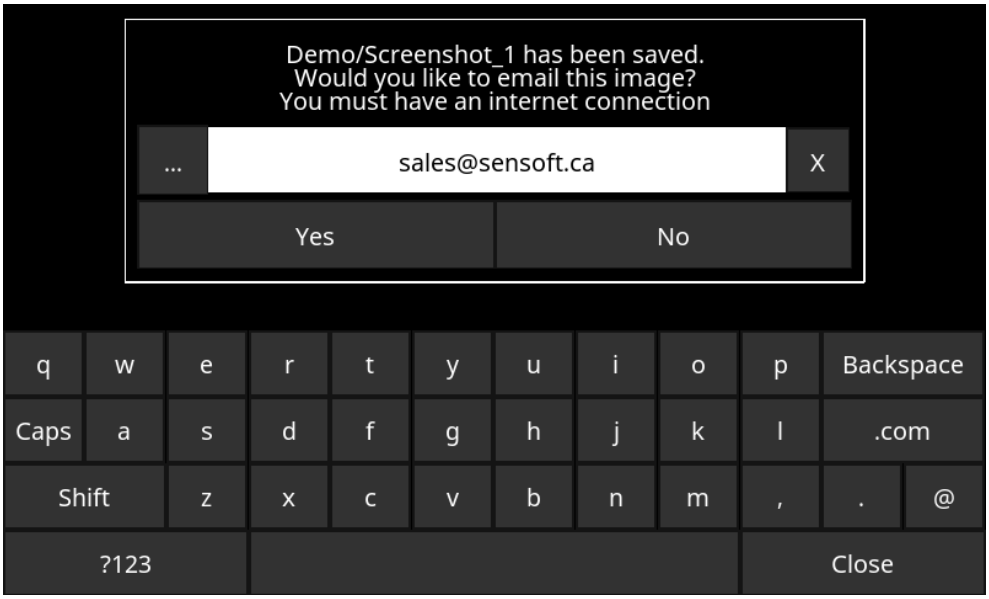


Figure 10-2: Message after pressing the Camera button on the Display Unit to capture the screen with Wi-Fi enabled and a connection to a wireless network. The user can enter an e-mail address to send the mini-report to.

10.2 Using the Hotspot on your Smartphone

If a Wi-Fi signal is unavailable, you may be able to use your Smartphone as a Wi-Fi access point, by creating a Personal Hotspot. If you are experiencing difficulty connecting to a cell phone Personal Hotspot, ensure that the phone is in discovery mode while connecting. On iPhone (iOS 13), for example, this involves going to **Settings - Personal Hotspot** (Figure 10-3). Ensure that the Personal Hotspot setting is turned on and wait on this screen until the connection has been established. Once you have received confirmation on the Display Unit, the cell phone can resume normal use.

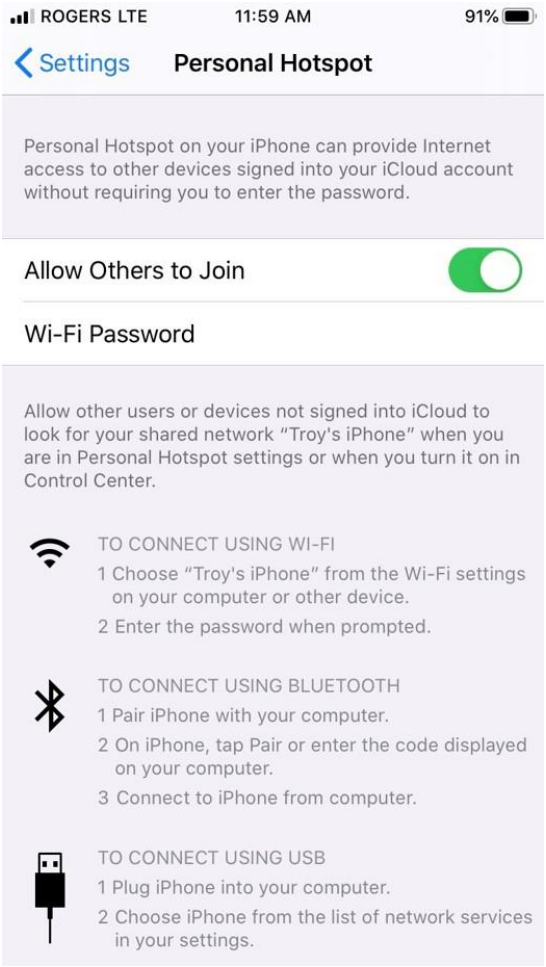


Figure 10-3: Setting up a Hotspot on an iPhone

Note that when setting up a Personal Hotspot, you may be disconnected from any Wi-Fi networks. Vice-versa, if you have a Personal Hotspot setup, attempting to connect to a Wi-Fi network may disconnect your personal hotspot.

10.3 Mini-Reports

When a screenshot is e-mailed, it is sent as part of a mini-report. This mini-report contains a table with information about the captured image such as the settings, date/time and the project number. An example of a Grid Scan mini-report is shown in Figure 10-4.

CONQUEST®100

Project	Demo
Screen Capture Number	2
Screen Name	Grid Scan
Date Collected	January 21 2020 11:36 AM
Mode	SliceView
Grid	Grid01
Grid Size	48 x 48 in
Grid Spacing	High (2.0 in)
Concrete Cal	102
Slice Depth	8 - 9in
Slice Color Palette (Gain)	2 (Low)
Grid Line Visibility	OFF
Selected Line	Line 1
Depth	36.0 in
Line Color Palette	1
Filter	ON
Gain Level	4

Sensors & Software

Your screen capture is attached to this email.

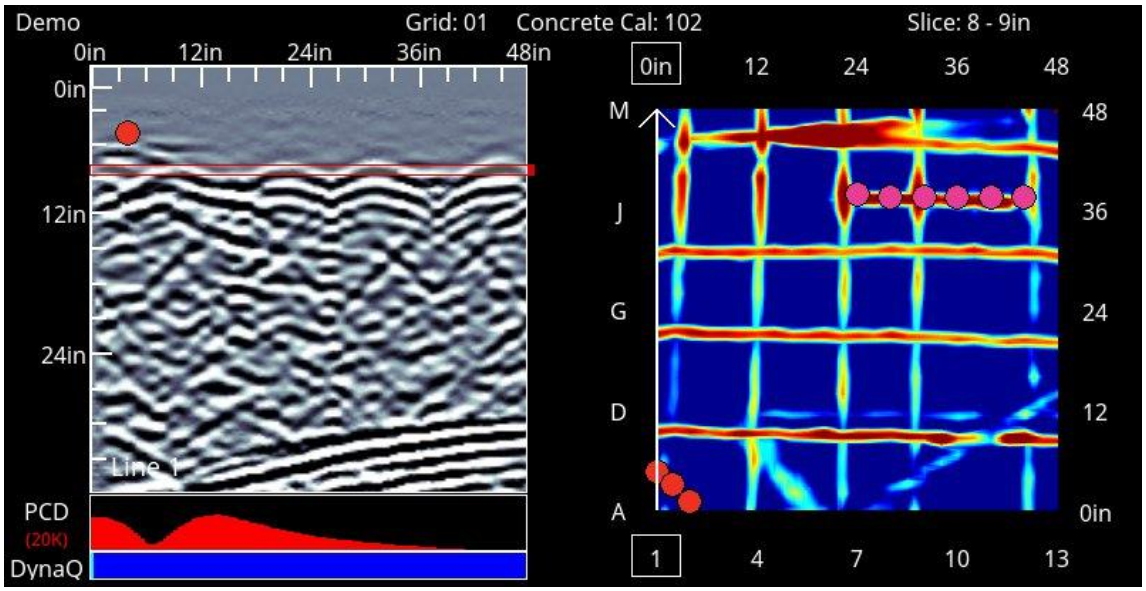


Figure 10-4: A Grid Scan mini report. The text is sent in the body of the e-mail and the image as an attachment.

11 Transferring Data to a PC

Data can be exported to a PC by inserting a USB drive into the USB port (Figure 11-1).

Figure 11-1: Insert a USB memory stick into the USB port on the Display Unit to export data.

Once the USB drive is recognized, a message will appear telling you that a drive has been inserted and if you wish to export your data now (Figure 11-2). Press **Yes**.

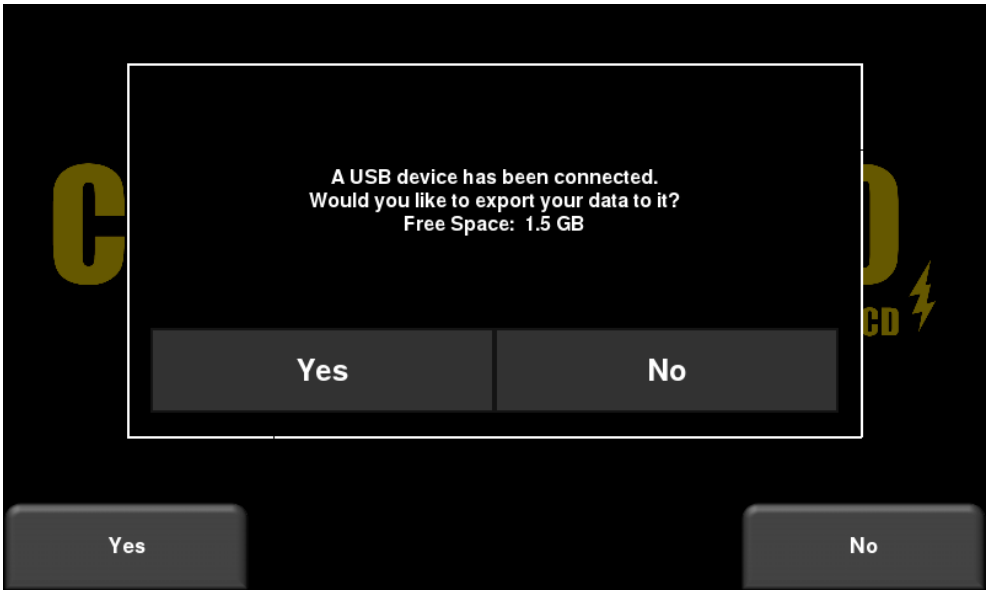


Figure 11-2: When a USB drive is connected to the Display Unit, a message opens asking if you would like to export all your data to it. Select Yes to transfer immediately. If you select No, you can export the data later by going to the ***Setup > File Management*** *menu option.*

Alternatively, if you want to export data from a specific Project (Conquest 100 Enhanced only), click **No** for now. Later on, when you are ready to export your data, from the main menu select **Setup > File Management** and press **Export Data** (Section 5.3.4).

11.1 Formatting USB Sticks

There may be times when a USB stick is not recognized by Conquest. In this case, you may need to format the USB stick. Ensure that it's formatted as FAT/FAT32 (NTFS will not work). Also ensure that there are no hidden or write-protected partitions on the USB drive.

If the problem persists after formatting, try another USB stick.

11.2 Directory Structure

The directory structure on the USB drive can be viewed on your PC, and will look as follows:

- GPR Data
  - Conquest 100
    - Export01
      - Project1
        - Screenshots
        - Project1 Field Interp Report.csv
        - Project1.GPZ*

*Only with Conquest 100 Enhanced

If your system is not a Conquest 100 Enhanced, then all your screenshots will be in the Project1 directory, and no .GPZ files will be exported.

Each successive export of data will create a new directory called ExportXX, where XX is incremented by 1 from the previous directory. This is to prevent over-writing data on the USB stick.

If any Field Interpretations were added during data collection, these are saved in a .CSV file. This is a spreadsheet file, which shows the positional information of any Interps made.

The System Info folder contains an APP.LOG file and a System Summary diagnostic report. The APP.LOG file contains important information about system operation and may be requested by Sensors & Software to help troubleshoot any issues.

Some of the output files are described and shown below.

11.3 Field Interpretations File

If any interpretations are made a Field Interp Report file is created. This file is a CSV (Comma separated values) format, most commonly opened with Microsoft Excel.

The file will list any Interps and Flags added to data in the field. The position, depth and color of each Interp is listed. A sample output for this file is shown in Figure 11-3.

	A	B	C	D	E	F
1	Name	Count				
2	Pink	6				
3						
4	Tool	Interpretation	GPR Line	Position (m)	Depth (mm)	Concrete Cal
5	Point	Pink	Lineset/line1	0.22	160.88	102
6	Point	Pink	Lineset/line1	0.62	164.8	102
7	Point	Pink	Lineset/line1	1.03	188.24	102
8	Point	Pink	Lineset/line1	1.54	207.71	102
9	Point	Pink	Lineset/line1	2.06	143.17	102
10	Point	Pink	Lineset/line1	2.51	184.34	102

Figure 11-3: Contents of a sample Field Interp Report file

11.4 System Summary Report

The System Summary report is a PDF file, which lists system usage information, serial numbers and when system tests were done and their pass/fail status. An example file is shown below:

Sensors & Software

CONQUEST®100

System Summary

System Information

Display Unit (DVL) Serial Number	0072-6741-2004
GPR Sensor Serial Number	0038-0309-1004
Application Version	v2.3.838 (2015-00043-06)
OS Version	2.09.557 (2017-00041-09)
GPR Firmware Version	3.032 (2014-00092-04)
Hardware ID	801F1235BF26

Usage Statistics

Data Exports	70
Grids Collected	37
Average Grid Area	0.3 m² / 3.4 ft²
Average Grid Collection Time	4 minutes 54 seconds
Total Grid Area	11.7 m² / 125.9 ft²
Total Grid Line Distance	302.5 m / 992.3 ft
Lines Collected	192
Average Line Length	5.1 m / 16.7 ft
Average Line Collection Time	49 seconds
Total Line Collected	977.8 m / 3207.9 ft
Screenshots Saved	32
WiFi Reports Sent	13
System Power Cycles	234
Operation Time	6 days 13 hours 15 minutes
Total Distance Collected	1280.2 m / 4200.2 ft

System Tests

Audio Test	26 November 2019	Passed
Touch Screen Test	26 November 2019	Passed
Odometer Test	26 November 2019	Passed
Display Keypad Test	26 November 2019	Passed
GPR Sensor Test	17/12/2019 15:03:12	Passed
Sensor Keypad Test	---	---
PCD Sensor Test	26 November 2019	Passed

11.5 EKKO_Project

If you have a Conquest 100 Enhanced system, any line and grid data collected in a project are saved as a single .GPZ file (e.g. Project1.GPZ). This file can be opened with the EKKO_Project PC software.

EKKO_Project is a powerful software that allows you to view, edit, process and ultimately create reports from your GPR data. From the main screen (Figure 11-4), you can access various views and launch modules that give you access to further functionality. Some features shown here are not part of the standard EKKO_Project base software. For more information, consult your EKKO_Project manual or contact Sensors & Software.

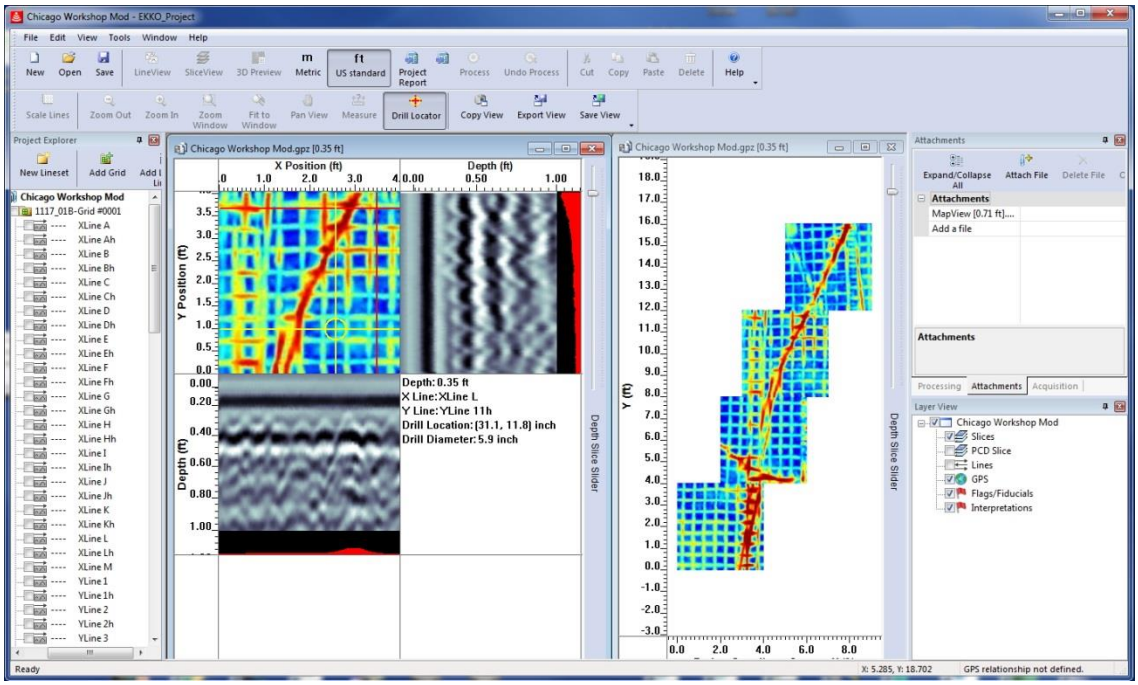


Figure 11-4: EKKO_Project software with Conquest data

12 Troubleshooting

Conquest systems are designed to minimize user problems; however, all electronic devices are subject to possible failure. The following are troubleshooting hints if your Conquest fails to operate or something operates incorrectly.

12.1 Restart the System

Most problems can be fixed by powering down the system, checking that all connections are tightly secured and not damaged and then powering back up again.

Frozen Screen: If the system is frozen, press and hold the red Power button for more than 5 seconds until the system shuts down.

Sometimes vibrations cause the cable connections to loosen just a bit and break contact, which can cause errors. Powering down the system and disconnecting cables and reconnecting them may provide better contact and solve the problem. Turn the system back on and try running again.

12.2 Power Supply

After several hours of usage, the battery may be dead or have low voltage. The system will abruptly shut off when the battery level reaches a critical state. Either recharge the battery using the optional desktop charger or plug in the AC adaptor to charge the battery in the Display Unit while you continue to work.

12.3 Lights on Sensor Head

The system will prompt the user if the Sensor Head is not detected during boot-up. If there is no prompt but the system still does not work, look at the lights on the Sensor Head. After boot-up the green light by the Enter key on the Sensor Head should be solid and the red light by the star key, should be off. After selecting Line Scan mode and pressing **Start** to collect a line, the red light turns on so both the red and green lights are on solid; if the lights do anything other than this, there is likely a hardware issue (problem with the Sensor Head or cable).

12.4 Cables

Check cables for problems like bent or recessed pins that can break the connection and cause system errors.

The Conquest 100 comes with a second Sensor Cable. Replace the current cable with the second cable and try running the system and see if the problem goes away.

If the power supply and cables are OK, the problem is likely a failure of the internal electronics. Contact Sensors & Software Inc.

12.5 Sensor Head Backwards Compatibility

The Conquest 100 is fully compatible with earlier versions of the Conquest Sensor Head and cable so if you have a Conquest Enhanced or Conquest SL Sensor Head available, try swapping these parts in one at a time and see if you can isolate the problem or solve it.

12.6 Warning Beeps

When acquiring data (either in Line Scan or Grid Scan modes), if the system starts to “beep” when it’s not supposed to, there are two possible causes:

1. The operator is holding down the **Enter** button or Display Unit key too long when starting the Line Scan. The system may register this as two button presses, resulting in the system starting and stopping immediately. In this instance the triple beep is occurring because the scan is being stopped. A lighter touch on the button is necessary.

2. The Sensor Head is being pushed too fast. In this case, the DynaQ will also show yellow and white. To ensure good data quality, simply slow down the speed of the Sensor Head. In Grid Scan mode, you may be prompted to re-collect that line.

12.7 Sensor Head Keypad Doesn't Respond

If the Sensor Head keypad does not respond, the usual reason is that the Sensor Head has come unplugged during operation. Power down the system, reconnect the Sensor Head and restart to restore full keypad functionality.

12.8 Constant Prompt to Perform System Test

If the operator is constantly prompted to run the System Test for the Sensor (Section 5.2.7) resulting in the inability to collect data, turn off IEP (Section 5.1.10) in the Preferences menu. If IEP is disabled, allow the system to warm up for 5 minutes before starting data collection. Also note that the next time Conquest is powered on, IEP defaults to ON.

If the system is constantly prompting to perform a system test, it may indicate a problem with the equipment. Scanning can be continued with IEP turned off but if the problem persists, it is recommended that Sensors & Software Inc. be contacted to help remedy the problem.

12.9 Collecting Test Data

One of the best ways of detecting problems with the Conquest system is by comparing data with data collected previously.

Soon after receiving the system and getting comfortable with its operation, collect a 24”x24” (600x600mm) grid of data at a convenient, easily accessible location. The grid should be saved electronically and perhaps plotted out on paper and dated. The test grid could be collected say,

every 6 months and, by reviewing the previous data, system problems can be detected early. As well, if there is a suspected problem with the system, this test grid could be collected and compared with earlier tests.

12.10 Contacting the Vendor for Service

When returning the system to the Vendor, have the following information available:

1) A brief description of when the error is happening and the operating conditions.

2) A screenshot of the System Information page (Section 5.2.1)

3) Include photos and/or videos to document the occurrence of error messages.

4) APP.LOG file – this is downloaded to your computer during data export

13 Care and Maintenance

13.1 Cable Care

Cables are designed to be as tough as practical.

Careless use of cables by making them carry loads for which they are not designed for can cause internal damage.

Connectors are weak points in any system. With the use of this product in rough, dusty and outdoor environments, users can minimize potential down time if they care for cables and treat connectors with respect.

Routine cleaning of cable connections (pins and sockets) using contact cleaner (e.g. MG Chemicals 404B or similar) is recommended for both the cable as well as the sensor and Display Unit connection points.

Cables and connectors are not designed to suspend, tow or otherwise carry the weight of systems. They are part of the electrical circuit and should be treated accordingly. When not in use they should be placed in their storage box.

13.2 Battery and Charger

The Conquest 100 is equipped with smart battery charging circuit to allow you to operate the Conquest 100 using the AC power while charging the battery inserted in the unit. The charging algorithms are designed to maximize battery life while ensuring the shortest possible charge time. The light on the back of the Display Unit beside the 3-pin power connector indicates if battery is charging (orange) or charged (green). It is safe to continue to operate the Conquest 100 on AC power even when the battery is fully charged – the battery will not be overcharged – the charging system protects the battery from over-charging by terminating the charge process when the battery is at maximum capacity.

It normally takes 3 to 4 hours to charge the battery while operating the unit in AC power. The battery charger will also not initiate charging process until the battery temperature is between 0^{o} C to 40^{o} C to avoid damaging the battery.

% Charge Completed	With Display Unit turned off	While Operating on AC power
100%	4 hours	6 hours
75%	2 hours	4 hours

Lithium-ion batteries reach their full performance after the first few full charge/discharge cycles.

13.3 Conquest Sensor Head Wear Pad

The bottom of the Sensor Head is covered with a wear-resistant skid pad. The skid pad is designed to take the majority of the abrasive wear. If the pad wears down enough, the less-

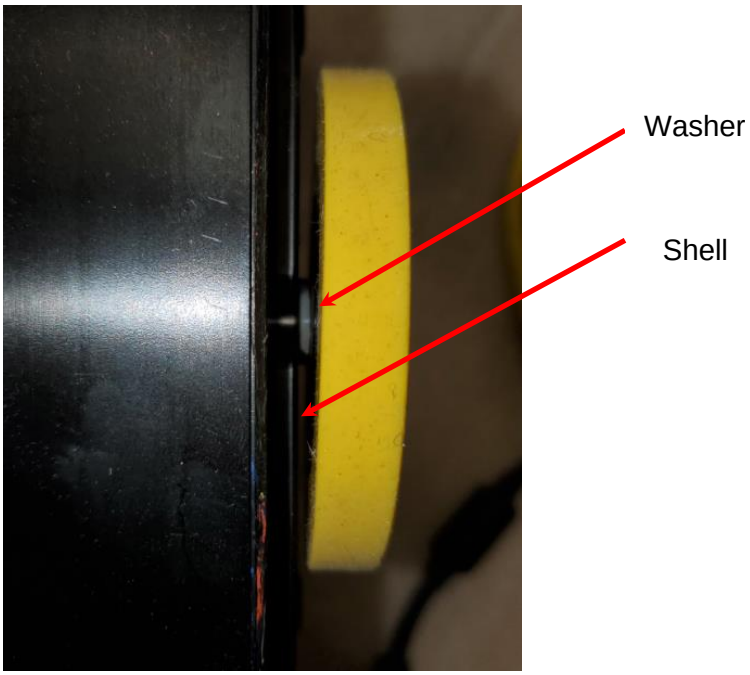
resistant plastic housing may start to wear. If this occurs, it is best to replace the skid pad. You can attempt this yourself by following the directions below or contact the vendor to get it replaced.

To replace the skid pad, perform the following steps:

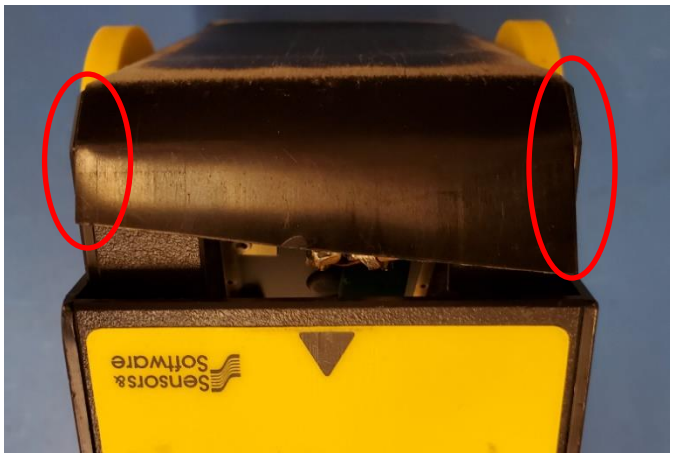
1) Ensure the Sensor head is not connected to power and data cable is disconnected.

2) With a #2 Philips screwdriver, remove the (4) screws that secure the outer shell to the sensor body (same on opposite side).

3) Turn the sensor upside down and refer to the image below. The washer is designed to move a little along the wheel axis. Ensure that the washer is between the sensor head shell and the wheel as shown below.



Carefully lift shell enough to access the skid pad at either one of the ends. Take note of the location of the skid pad on the base



4) Remove the worn skid pad (use of a flat painting scraper may be required to separate adhesive from the sensor base).

5) Once the skid pad is removed, clean the sensor base with a clean cloth saturated with 70% isopropyl alcohol.

6) Remove the backing from the new adhesive strip on the skid pad and reinstall, referring to the location noted in step 4. Application requires significant force, to ensure flatness and adequate adhesion.

7) Once applied, refer to the shell/wheel washer orientation in step 3 and slide the shell back into place.

Reinstall the (4) screws from step 1.

13.4 Storage Cases

Equipment that is transported and stored loosely is more susceptible to damage. All equipment should be stored in its shipping case or a storage box. Sensors & Software has shipping cases available as options for all systems.

13.5 Upgrading Embedded Software on Display Unit

From time to time, Sensors & Software may release new software for the Display Unit. The instructions below describe how to update this software. Please note that this procedure will **erase all GPR data** from the system, so export any valuable data before continuing.

1 Download

the zip file provided by Sensors & Software into a folder on your PC.

2 Insert

a clean USB stick into your PC.

3 Unzip

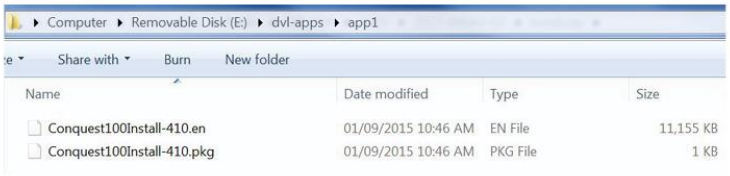
the file by double clicking the file in Windows Explorer.

4 Copy

the unzipped folder to the root of the USB key. The resulting folder structure on the USB key should be:

```
dvl-apps
    app1
        PACKAGE_NAME.en
        PACKAGE_NAME.pkg
```

where PACKAGE_NAME is the name of the item to be installed.
An example of the Conquest 100 installation files are shown below:



5 Turn off

the Display Unit. Remove the USB stick from your PC and insert it into the USB port on the side of the Display Unit.

6 Turn On

the Display Unit. You will see a list on the screen showing all software installations. The USB key may hold one or more packages which are displayed as numbered items:

```
Select app to run:
    1. PACKAGE_NAME
```

7 Select

the package to run by pressing the associated numbered key on the Display Unit. The selected software will now be installed. The process may require multiple reboot cycles initiated by the system. When complete, the system will shut down, and the red light on the front of the Display Unit will turn off.

8 Remove

the USB stick from the Display Unit.

9 Turn On

the Display Unit and access the System Info screen to verify the newly installed version number.

14 Parts List & Accessories

14.1 Spare Parts

Customers working in remote areas, or for whom downtime in the field is unacceptable, should consider buying spare parts like extra cables. The following is a list of spare parts available for purchase:

100-55-0024	AC Power Adapter
100-55-0025	Li-ion Battery Pack
100-60-0067	Conquest 100 Portable Carrying Case
100-54-0116	Mixed Disposable Grids
100-52-0116	Conquest Transducer Cable (1.75 m)
100-52-0117	Conquest Transducer Cable (3.5 m)
100-52-0074	Conquest Transducer Cable (5 m)
100-52-0077	Conquest Transducer Cable (10 m)
124-00-0014	Adhesive Back Skid pad
126-84-1090	Collapsible Handle – Fork Section
126-84-1100	Collapsible Handle – Center Section
126-84-1110	Collapsible Handle – End (top) Section

14.2 Accessories

The following accessories are available for purchase

CONQUEST® 100 Vinyl Grid (set of 5)
Available in:
100-54-0062 Imperial 24"x24"
100-54-0064 Metric 600 mm x 600 mm

CONQUEST® 100 Disposable Paper Grid
100-54-0116 (set of 2 imperial + 2 metric)

CONQUEST® Transducer Cable
Available lengths:
100-52-0117 3.5 m
100-52-0074 5 m
100-52-0077 10 m

100-54-0144 CONQUEST® 100 Deluxe Mobility Kit *

100-53-0113 Deluxe
Display Unit Carry Harness

100-52-0116
CONQUEST® 100
Transducer Cable (1.75 m)

100-53-0097
CONQUEST® 100
Collapsible Handle

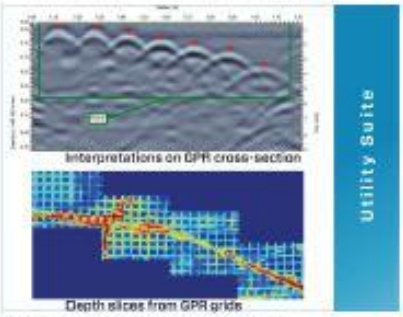
100-55-0026
CONQUEST® 100
Battery Charging Station

100-55-0025
CONQUEST® 100
Spare Battery Pack

* These items can be purchased separately

100-12-0053 CONQUEST® 100 Enhanced Upgrade Package

Software Upgrade



100-11-0118 EKKO_Project™
Utility Suite Software License
- Includes LineView, SliceView and Interpretation modules

15 Technical Specifications

Specifications	Values
Sensor head size	150 x 130 x 190 mm (5.84 x 5.00 x 7.38 in)
Sensor weight	1.00 kg (2.18 lbs)
Display Unit weight (without battery)	2.83kg (6.24 lbs)
Battery weight	0.48 kg (1.05 lbs)
Display Unit screen	8.0" high-visibility, sunlight-readable diagonal LCD display with touchscreen Adjustable backlighting 1000 NIT and 800:1 contrast ratio
Colors	24 total color palettes (8 color palettes with 3 contrast levels per palette)
Wireless	Integrated modules: Wi-Fi (IEEE 802.11 b,g,n) GPS/GLONASS
Audio	Built-in speaker - 85dBA speaker w/volume control Bluetooth connectivity
Acquisition Rate	100,000 samples/s
Battery	Lithium Battery pack Battery Life: 4-6 hours Battery Capacity: 9 Ah Built-in power management features to conserve battery power and preserve data integrity
Charger	Built-in charger with status indicator Universal AC mains charger input: 100-240V ~, 2A, 50/60Hz Output: 18V, 4.45A, 80W Max
Display Unit input	10-24V ⎓ , 4A maximum
Temperature & Environmental	Ruggedized, environmentally sealed unit and connections Ingress protection (IP) rating: DVL-500 is rated to IP65 under IEC 60529 Relative Humidity operation (non-condensing): 10 – 90% DVL-500 operating temperature range: -40 to 50°C Use battery charger/AC adapter between 0 and 35°C. Operation on battery is possible below -20°C but battery endurance will be limited. Do not use touch screen below -20°C.
Battery Storage	Recommended conditions for battery storage are -20 to 25°C. Maximum temperature range for battery storage is -20 to 60°C. Extended storage above 40°C could degrade battery performance and life.
Regulatory Specifications	EMC-FCC, CE, IC Safety-TUV, CE

Appendix A: Health & Safety Certification

Radio frequency electromagnetic fields may pose a health hazard when the fields are intense. Normal fields have been studied extensively over the past 30 years with no conclusive epidemiology relating electromagnetic fields to health problems. Detailed discussions on the subject are contained in the references and the web sites listed below.

The USA Federal Communication Commission (FCC) and Occupational Safety and Health Administration (OSHA) both specify acceptable levels for electromagnetic fields. Similar power levels are mandated by corresponding agencies in other countries. Maximum permissible exposures and time duration specified by the FCC and OSHA vary with excitation frequency. The lowest threshold plane wave equivalent power cited is 0.2 mW/cm^2 for general population over the 30 to 300 MHz frequency band. All other applications and frequencies have higher tolerances as shown in graphically in Figure B-1.

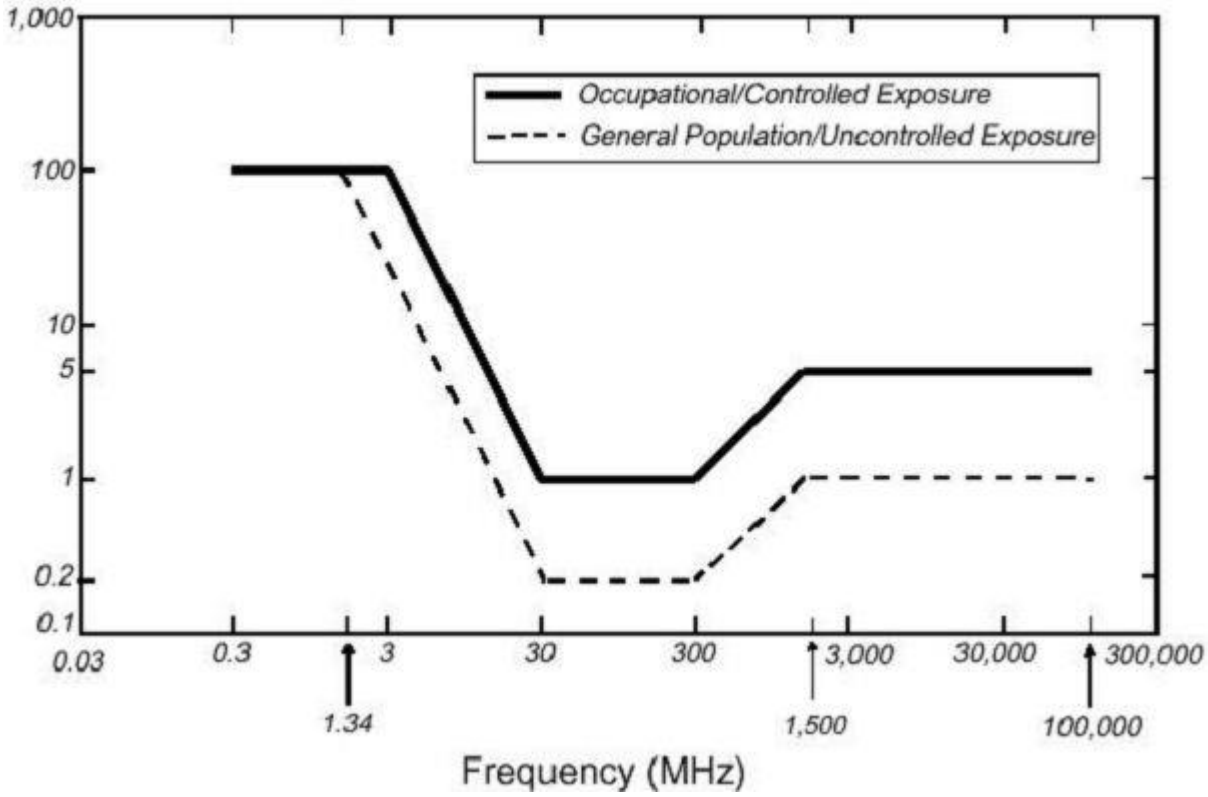


Figure B-0-1: FCC limits for maximum permissible exposure (MPE) plane-wave equivalent power density mW/cm^2.

All Sensors & Software Inc. GPR products are normally operated at least 1 m from the user and as such are classified as “mobile” devices according to the FCC. Typical power density levels at a distance of 1 m or greater from any Sensors & Software Inc. product are less than 10^{-3} mW/cm^2 which are 200 to 10,000 times lower than mandated limits. As such, Sensors & Software Inc. products pose no health and safety risk when operated in the normal manner of intended use.

Appendix B: GPR Emissions, Interference and Regulations

All governments have regulations on the level of electromagnetic emissions that an electronic apparatus can emit. The objective is to assure that one apparatus or device does not interfere with any other apparatus or device in such a way as to make the other apparatus non-functional.

The manufacturer tests their GPR products using independent professional testing houses and comply with latest regulations of the USA, Canada, European Community, and other major jurisdictions on the matter of emissions.

Electronic devices have not always been designed for proper immunity. If a GPR instrument is placed in close proximity to an electronic device, interference may occur. While there have been no substantiated reports of interference to date, if any unusual behavior is observed on nearby devices, test if the disturbance starts and stops when the GPR instrument is turned on and off. If interference is confirmed, stop using the GPR.

Where specific jurisdictions have specific GPR guidelines, these are described below.

B-1 FCC Regulations

This device complies with Part 15 of the USA Federal Communications Commission (FCC) Rules. Operation in the USA is subject to the following two conditions:

- this device may not cause harmful interference and
- this device must accept any interference received, including interference that may cause undesired operation.

Part 15 – User Information

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

WARNING

Changes or Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

Certification of this equipment has been carried out using approved cables and peripheral devices. The use of non-approved or modified cables and peripheral devices constitutes a Change or Modification outlined in the warning above.

Operating Restrictions

Operation of this device is limited to purposes associated with law enforcement, firefighting, emergency rescue, scientific research, commercial mining, or construction. Parties operating this equipment must be eligible for licensing under the provisions of Part 90 of this chapter.

FCC Interpretation of Operation Restrictions issued July 12, 2002

(FCC Order DA02-1658, paragraph 9)

The regulations contain restrictions on the parties that are eligible to operate imaging systems (See 47 C.F.R. 5.509(b), 15.511(b), and 15.513(b)). Under the new regulations, GPRs and wall imaging systems may be used only by law enforcement, fire and emergency rescue organizations, by scientific research institutes, by commercial mining companies, and by construction companies. Since the adoption of the *Order*, we have received several inquiries from the operators of GPRs and wall imaging systems noting that these devices often are not operated by the users listed in the regulations but are operated under contract by personnel specifically trained in the operation of these devices. We do not believe that the recent adoption of the UWB rules should disrupt the critical safety services that can be performed effectively only through the use of GPRs and wall imaging systems. We viewed these operating restrictions in the broadest of terms. For example, we believe that the limitation on the use of GPRs and wall imaging systems by construction companies encompasses the inspection of buildings, roadways, bridges and runways even if the inspection finds no damage to the structure and construction does not actually result from the inspection; the intended purpose of the operation of the UWB device is to determine if construction is required. We also believe that the GPRs and wall imaging systems may be operated for one of the purposes described in the regulations but need not be operated directly by one of the described parties. For example, a GPR may be operated by a private company investigating forensic evidence for a local police department.

FCC Permitted Mode of Usage

The GPR antenna must be kept on the surface to be in compliance with FCC regulations. Use of the antenna is not permitted if it is lifted off the surface. Use as a through-the-wall imaging device is prohibited.

GPR Use Coordination

FCC regulation 15.525(c) (updated in February 2007) requires users of GPR equipment to coordinate the use of their GPR equipment as described below:

TITLE 47--TELECOMMUNICATION

CHAPTER I--FEDERAL COMMUNICATIONS COMMISSION

PART 15_RADIO FREQUENCY DEVICES

Subpart F_Ultra-Wideband Operation Sec.

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

(**Sensors & Software Inc. Note**: The form given on the following page is a suggested format for performing the 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.

(d) Users of authorized, coordinated UWB systems may transfer them to other qualified users and to different locations upon coordination of change of ownership or location to the FCC and coordination with existing authorized operations.

(e) The FCC/NTIA coordination report shall identify those geographical areas within which the operation of an imaging system requires additional coordination or within which the operation of an imaging system is prohibited. If additional coordination is required for operation within specific geographical areas, a local coordination contact will be provided. Except for operation within these designated areas, once the information requested on the UWB imaging system is submitted to the FCC no additional coordination with the FCC is required provided the reported areas of operation do not change. If the area of operation changes, updated information shall be submitted to the FCC following the procedure in paragraph (b) of this section.

(f) The coordination of routine UWB operations shall not take longer than 15 business days from the receipt of the coordination request by NTIA. Special temporary operations may be handled with an expedited turn-around time when circumstances warrant. The operation of UWB systems in emergency situations involving the safety of life or property may occur without coordination provided a notification procedure, similar to that contained in Sec. 2.405(a) through (e) of this chapter, is followed by the UWB equipment user.[67 FR 34856, May 16, 2002, as amended at 68 FR 19751, Apr. 22, 2003]

Effective Date Note: At 68 FR 19751, Apr. 22, 2003, Sec. 15.525 was amended by revising [[Page 925]] paragraphs (b) and (e). This amendment contains information collection and recordkeeping requirements and will not become effective until approval has been given by the Office of Management and Budget.

FCC GROUND PENETRATING RADAR COORDINATION NOTICE

NAME:

ADDRESS:

CONTACT INFORMATION [CONTACT NAME AND PHONE NUMBER]:

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

FCC ID: QJQ-CONQ-DE1

EQUIPMENT NOMENCLATURE: CONQUEST DE

Send the information to:

Frequency Coordination Branch., OET

Federal Communications Commission

445 12th Street, SW

Washington, D.C. 20554

ATTN: UWB Coordination

Fax: 202-418-1944

INFORMATION PROVIDED IS DEEMED CONFIDENTIAL

B-2 ETSI Regulations for the EC (European Community)

In the European Community (EC), GPR instruments must conform to ETSI (European Technical Standards Institute) standard EN 302 066-1 v1.2.1. Details on individual country requirements for licensing are coordinated with this standard. For more information, contact Sensors & Software's technical staff.

All Sensors & Software ground penetrating radar (GPR) products offered for sale in European Community countries or countries adhering to ETSI standards are tested to comply with EN 302 066 v1.2.1.

For those who wish to get more detailed information, they should acquire copies of the following documents available from ETSI.

ETSI EN 302 066-1 V1.2.1 (February 2008) Electromagnetic compatibility and Radio spectrum Matters (ERM); Ground and Wall- Probing Radar applications (GPR/WPR) imaging systems; Part 1: Technical characteristics and test methods

ETSI EN 302 066-2 V1.2.1 (February 2008) Electromagnetic compatibility and Radio spectrum Matters (ERM); Ground and Wall- Probing Radar applications (GPR/WPR) imaging systems; Part 2: Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive

ETSI TR 101 994-2 V1.1.2 (March 2008) Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra Wide Band technology (UWB); Part 2: Ground- and Wall- Probing Radar applications; System Reference Document

B-3a Industry Canada Regulations - English

Industry Canada published it regulations for ground penetrating radar (GPR) on Mar 29 2009 as part of the RSS-220 titled 'Devices Using Ultra-Wideband (UWB) Technology'.

Industry Canada has made a unique exception for GPR by not requiring user licensing. The user does have to comply with the following directives:

This Ground Penetrating Radar Device shall be operated only when in contact with or within 1 m of the ground.

This Ground Penetrating Radar Device shall be operated only by law enforcement agencies, scientific research institutes, commercial mining companies, construction companies, and emergency rescue or firefighting organizations.

Should the ground penetrating radar be used in a wall-penetrating mode then the following restriction should be noted by the user:

This In-wall Radar Imaging Device shall be operated where the device is directed at the wall and in contact with or within 20 cm of the wall surface.

This In-wall Radar Imaging Device shall be operated only by law enforcement agencies, scientific research institutes, commercial mining companies, construction companies, and emergency rescue or firefighting organizations.

Since operation of GPR is on a license-exempt basis, the user must accept the following:

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

B-3b Règlement d'Industrie Canada - Français

Industrie Canada a publié des règlements pour les appareils géoradar (GPR) le 29 mars 2009, dans le cadre du RSS-220 intitulé "Dispositifs utilisant la bande ultra-large (UWB)".

Industrie Canada a faite une exception unique pour GPR en n'exigeant pas de licence par utilisateur. L'utilisateur doit se conformer aux directives suivantes:

Ce géoradar périphérique doit être utilisé que lorsqu'il est en contact avec ou moins de 1 m du sol.

Ce géoradar périphérique doit être utilisé que par les organisations d'application de la loi, les instituts de recherche scientifique, des sociétés minières commerciales, entreprises de construction et de secours d'urgence ou des organisations de lutte contre les incendies.

Si le géoradar est utilisé dans un mode de pénétration au mur, la restriction suivante est à noter par l'utilisateur:

Ce dispositif d'imagerie radar doit être utilisé lorsque l'appareil est orienté vers le mur et en contact avec ou dans les 20 cm de la surface du mur.

Ce dispositif d'imagerie radar doit être utilisé que par les organisations d'application de la loi, les instituts de recherche scientifique, des sociétés minières commerciales, entreprises de construction et de secours d'urgence ou des organisations de lutte contre les incendies.

Parce que l'exploitation de GPR est sur une base exempte de licence, l'utilisateur doit accepter le texte suivant:

La fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement du dispositive

Appendix C: Instrument Interference

Immunity regulations place the onus on instrument/apparatus/device manufacturers to assure that extraneous interference will not unduly cause an instrument/apparatus/device to stop functioning or to function in a faulty manner.

Based on independent testing house measurements, Sensors & Software Inc. systems comply with such regulations in Canada, USA, European Community and most other jurisdictions. GPR devices can sense electromagnetic fields. External sources of electromagnetic fields such as TV stations, radio stations and cell phones, can cause signals detectable by a GPR which may degrade the quality of the data that a GPR device records and displays.

Such interference is unavoidable but sensible survey practice and operation by an experienced GPR practitioner can minimize such problems. In some geographic areas emissions from external sources may be so large as to preclude useful measurements. Such conditions are readily recognized and accepted by the professional geophysical community as a fundamental limitation of geophysical survey practice. Such interference being present in the GPR recordings is not considered as an equipment fault or as a failure to comply with immunity regulations.

Appendix D: Safety Around Explosive Devices

Concerns are expressed from time to time on the hazard of GPR products being used near blasting caps and unexploded ordnance (UXO). Experience with blasting caps indicates that the power of Sensors & Software Inc.'s GPR products are not sufficient to trigger blasting caps. Based on a conservative independent testing house analysis, we recommend keeping the GPR transmitters at least 5 feet (2m) from blasting cap leads as a precaution. Some customers do experimental trials with their particular blasting devices to confirm with safety. We strongly recommend that GPR users routinely working with explosive devices develop a systematic safety methodology in their work areas.

The UXO issue is more complex and standards on fuses do not exist for obvious reasons. To date, no problems have been reported with any geophysical instrument used for UXO. Since proximity and vibration are also critical for UXO, the best advice is to be cautious and understand the risks.

Appendix E: Wi-Fi Module

FCC Notice:

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

Industry Canada Notice:

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

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