Sensors & Software

RESCUE RADAR

Manual

2018-00120-02

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Important Safety Information

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.

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

Rescue Radar is an integrated search and rescue tool used to locate survivors trapped beneath the surface. It is designed for rapid deployment in disaster situations, such as mudslides, earthquakes, avalanches and building collapses.

Using Ground Penetrating Radar (GPR) technology, the system continually transmits and receives radio waves into the subsurface. Slight movement will be detected and displayed, allowing the operator to determine the survivor's approximate location and begin rescue efforts.

The manual references embedded software version V1.2. To see which software version is installed on your system, consult the Help icon in Section 4.6.

2 Assembly

2.1 Out of the Box

Rescue Radar consists of two major components (Figure 2-1):

- Rescue Radar unit

- Tablet (currently a Winmate M700DM8)

Figure 2-1: Rescue Radar unit and Tablet

The complete system is housed in a durable transport case. The tablet, tablet charger, Rescue Radar battery charger and manual are stored in an ancillary bag which resides in the case.

The components inside the transport case are labelled in Figure 2-2.

Figure 2-2: Rescue Radar unit opened with components labelled

2.2   Powering up the System

Open the Rescue Radar case and connect the power cable from the battery to the console as shown in Figure 2-3. Each battery will power the unit for 4-6 hours. Always make sure that batteries are recharged after use and recharged monthly if the system sits idle. This will ensure that the batteries are fully charged when the system is required.

Lift the antenna so that it is pointing straight up.

Press the Power button to turn the system on.

Figure 2-3: Connecting power cable

If necessary, the battery can easily be replaced by unlatching the battery cover and connecting a new battery (Figure 2-4).

Figure 2-4: Battery cover removed showing battery

The Rescue Radar unit has fully booted up when the Console Display shows something similar to Figure 2-5. The number beside RR are the last 8 digits of the serial number.

The case can now be closed for operation.

Figure 2-5: Console display

2.3 Connecting the tablet

Turn on the tablet by pressing the button shown in Figure 2-6.
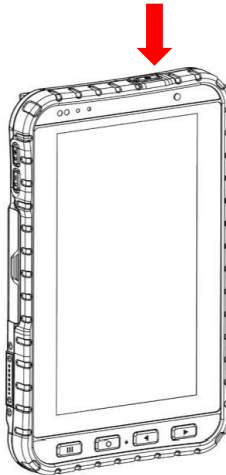
Figure 2-6: Power on/off button for tablet

Once the tablet is on, then touch the Rescue Radar icon. You will see the image in Figure 2-7. For more details on navigating the tablet, or if you are having trouble connecting to Rescue Radar, see Section 3.
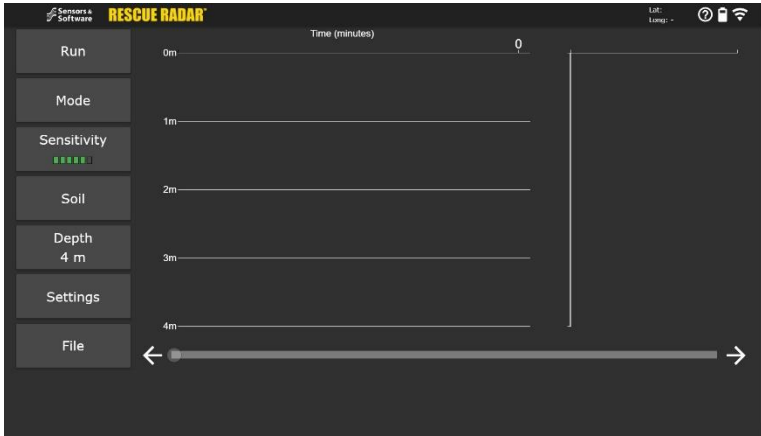
Figure 2-7: Rescue Radar screen

2.4 Shutting down

The system can be shut down from the software (Section 4.3.4), or by pressing the Power button on the Rescue Radar console (Figure 2-2). When the power button is pressed, there will be a 10 second countdown on the tablet (Figure 2-8) before Rescue Radar completely shuts down.
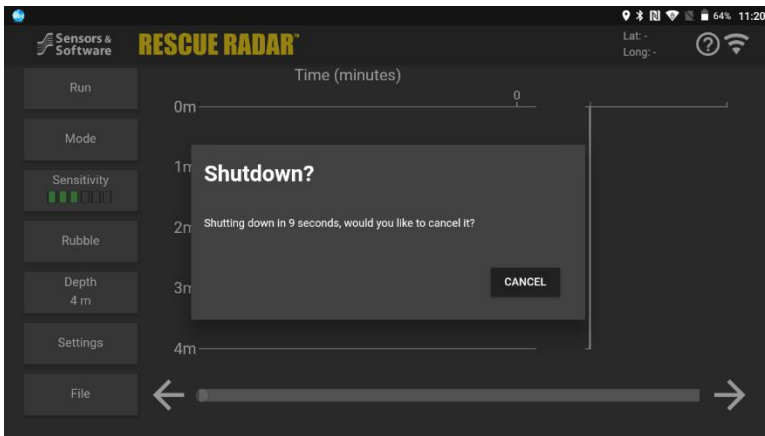
Figure 2-8: Shutdown timer

To turn off the tablet, press and hold the power button shown in Figure 2-6. You will then see the confirmation message (Figure 2-9), then press Power Off to turn off the tablet.
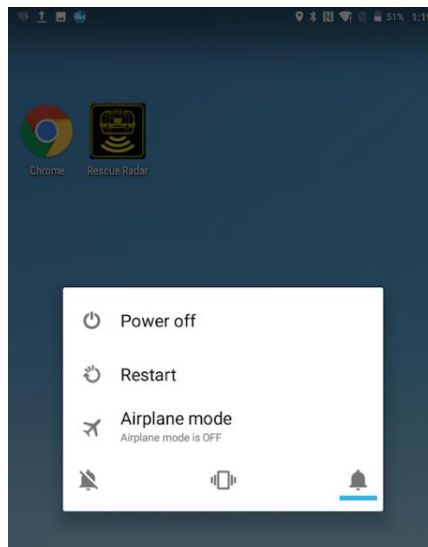

Figure 2-9: Power off window on tablet

2.5 Charging the Rescue Radar battery

To charge the Rescue Radar battery, unplug the power cable from the console (opposite to what is shown in Figure 2-3), and plug the power cable into the Rescue Radar battery charger.

2.6 Deployment

Once the system and tablet are powered up and connected, you are ready to start using it.

Place the Rescue Radar unit in a central position in the area being scanned (Figure 2-10).

Figure 2-10: Placement of Rescue Radar at a collapsed building

The operator and other people should move at least 15 meters away from the Rescue Radar unit (Figure 2-11).

Figure 2-11: Minimum distance between operator and Rescue Radar

See Section 6 for guidelines on systematic surveying for covering an area in a disaster zone.

The following section explains how to run the system and the various options available.

3 Navigating the Tablet

The tablet that is included with Rescue Radar is a Winmate M700DM8, running an Android operating system.

This tablet will be setup and configured to connect to Rescue Radar prior to shipment. Press and hold the power button (Figure 3-1) for a few seconds until the display activates to turn on the tablet.
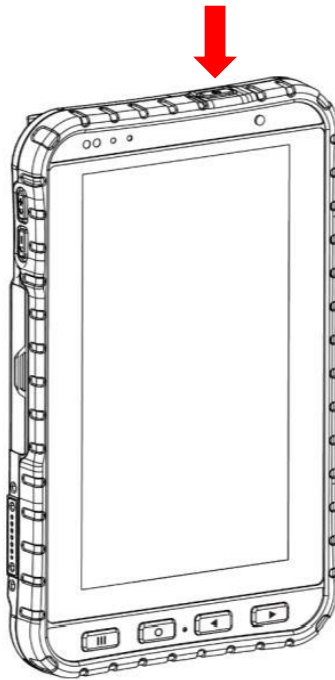

Figure 3-1: Turning on Tablet

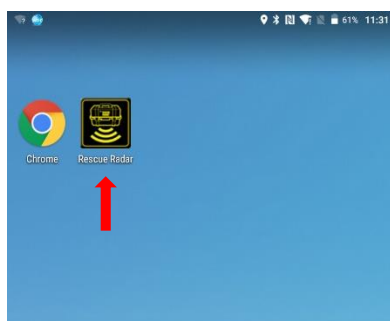Once the tablet has booted up, you will see the main screen as shown in Figure 3-2.

Figure 3-2: Main screen on Tablet

Touch the icon labelled Rescue Radar to launch the Rescue Radar software. You will then see the screen shown in Figure 3-3.
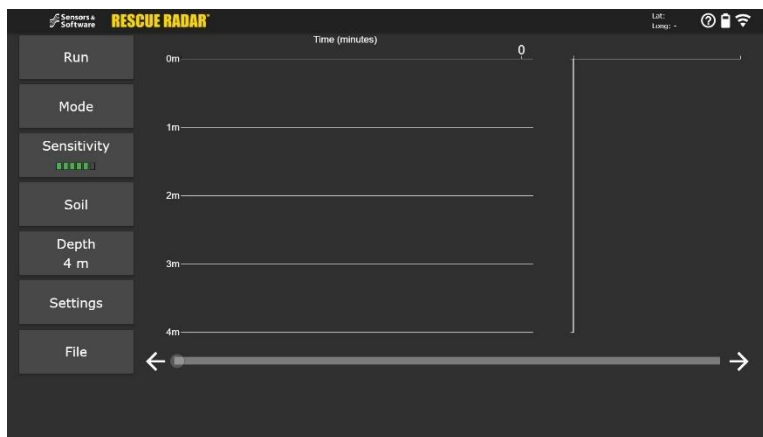

Figure 3-3: Rescue Radar home screen

3.1   Wi-Fi Connectivity

If you believe the tablet is not connecting to Rescue Radar, check the status bar on the tablet. The Wi-Fi icon should be as shown in Figure 3-4 (red arrow); if it's greyed out then it's not connected.

Figure 3-4: Zooming in on Tablet status bar

Swipe down from the top to the middle and then from the middle to the bottom to see the image in Figure 3-5.
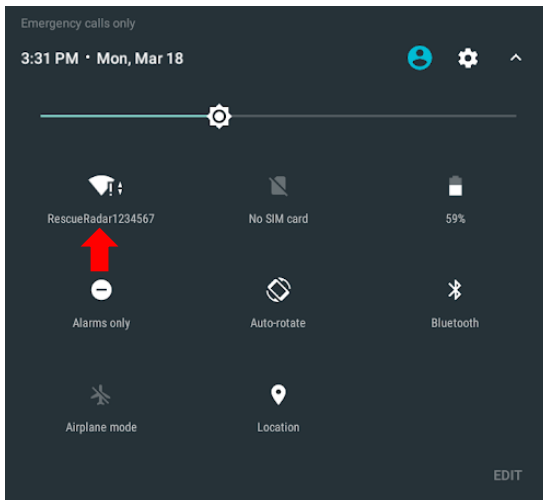

Figure 3-5: Tablet menu showing access to Wi-Fi network

Touch the Wi-Fi icon (indicated by the red arrow in Figure 3-5) to get a list of Wi-Fi networks within range (Figure 3-6). Ensure that you are connected to Rescue Radar.
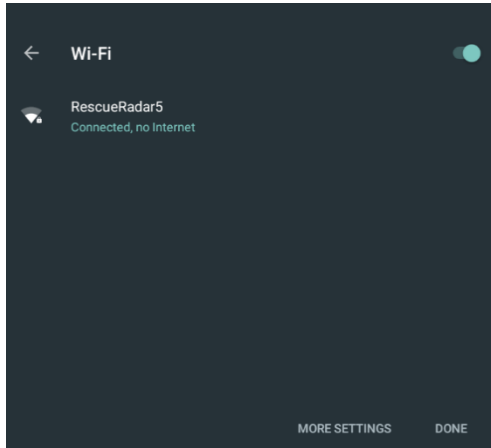

Figure 3-6: List of available Wi-Fi networks

If you do not see the Rescue Radar wi-fi network, make sure Rescue Radar is turned on and try moving closer to it. See Troubleshooting in Section 8 if any issues still persist.

3.2   Brightness

Since Rescue Radar will usually be used outdoors, ensure the brightness is set for comfortable viewing. From the top of the tablet swipe down twice. The brightness can be adjusted by moving the sun icon as shown (red circle in Figure 3-7.
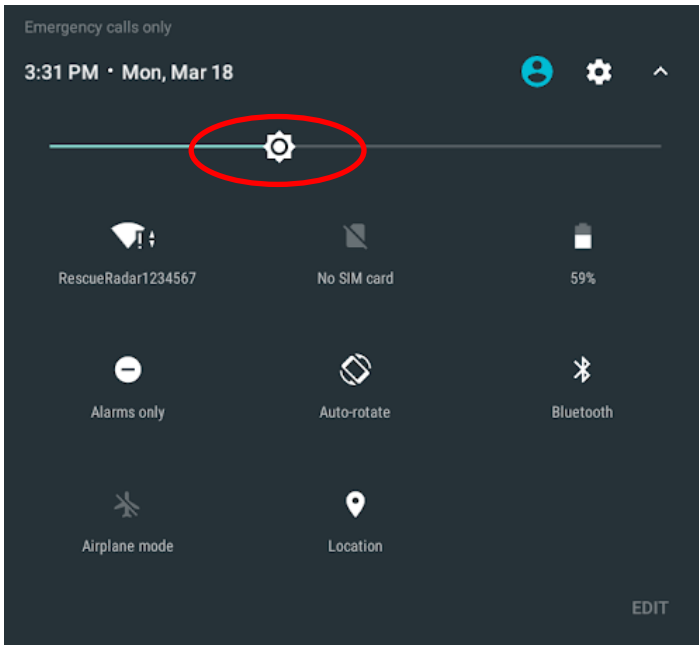
Figure 3-7: Adjusting brightness

3.3 Status indicator

There is an LED indicator on the front of tablet, as shown in Figure 3-8. The colour of the LED indicates the status of the tablet as explained below:

- **Red**: The device is charging
- **Continuously Flashing Red**: Indicates low battery status (below 15%)
- **Flashes Red twice**: Not enough power for the device to turn on
- **Green**: Indicates the device has finished charging and has 100% Battery
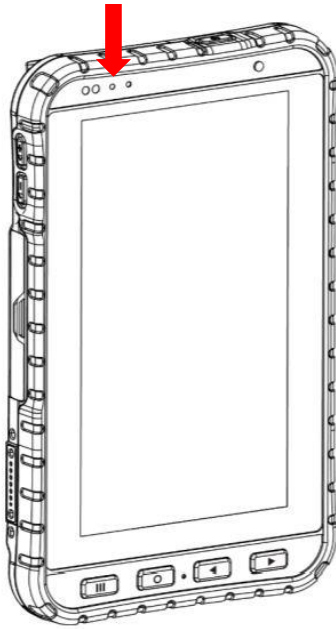- **Blue**: The LED will display as blue when the device is being turned on.

Figure 3-8: Arrow is pointing to LED status indicator

4 Configuration

4.1 Movement Indicators

Movement Indicators give an indication of the type of movement that is picked up by Rescue Radar. These are shown in Figure 4-1. This Legend can also be accessed from the Help menu.

Figure 4-1: Movement Indicators

- The yellow box indicates a strong movement,
- The yellow triangle indicates the second strongest movement if there is more than one movement
- The red circle indicates a person breathing.

You can have overlapping yellow and red symbols. There can also be multiple movement targets in a single cycle.

For a given cycle, there will never be more than the above 3 indicators.

4.2   Data collection options

The main screen is shown in Figure 4-2. The data collection options on the left side are explained below:
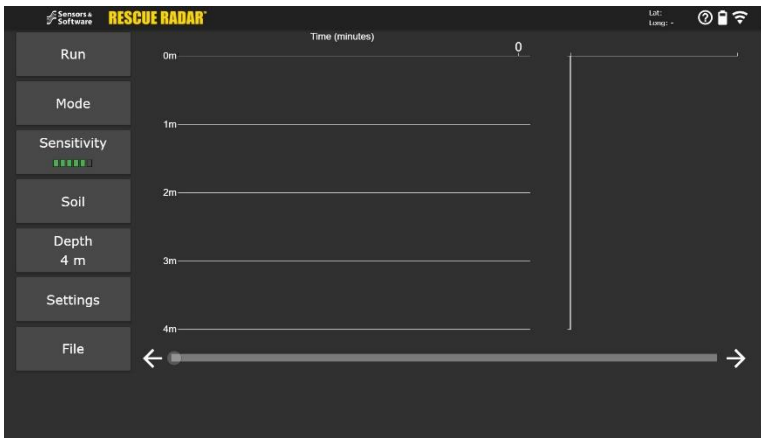

Figure 4-2: Home screen

Run / Stop – pressing this button will start data acquisition. The button will then change to Stop; press it again to stop data acquisition.

Mode – toggles between Basic Mode and Time Lapse Mode.

> **Basic mode** (Figure 4-3) shows a simple display of Movement Indicators on a distance scale. This mode only displays the results of the most recent cycle. The cumulative cycle time is displayed at the top of the screen in minutes, and will increment by each cycle length (Section 4.3.2).
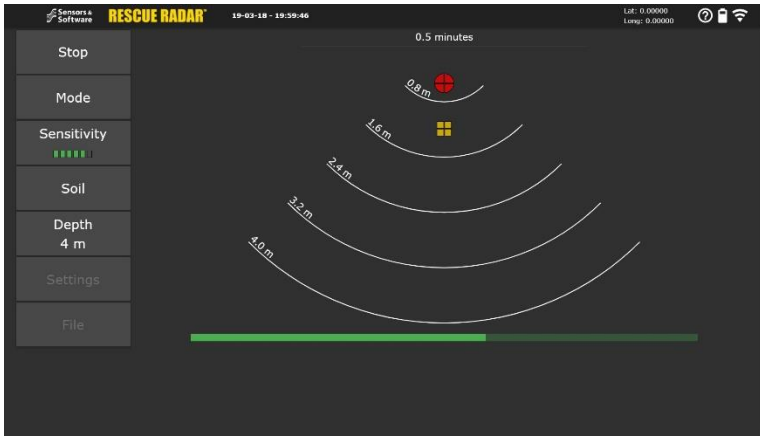
Figure 4-3: Basic Mode data acquisition

Time Lapse Mode (Figure 4-4) displays the history of movement indicators for the last several cycles. This allows the operator to look for consistency over a time period, which will help reduce false positives. In addition, the raw signal response is shown the right, as a plot of amplitude (horizontal axis) versus depth (vertical axis). This provides a real-time indication of movement while the cycle is in progress, however the final results will be calculated and displayed at the end of each cycle.

Figure 4-4: Time Lapse acquisition mode

After 10 cycles are displayed, the older ones will move off the screen. Once the Stop button is pressed, a slider bar will be displayed at the bottom (Figure 4-5). Move the green dot to the left to view older cycles. Alternatively, you can just swipe the main part of the screen to the right to view the older cycles at any time, even during collection.

The maximum number of cycles that can be collected before the system stops is 100.
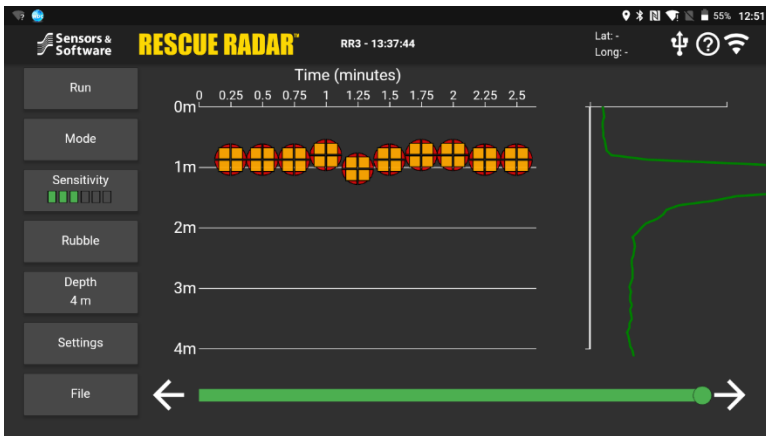
Figure 4-5: Time lapse mode with scrolling option at bottom

Sensitivity – this controls how sensitive the unit is for movement detection. The current level is indicated by the number of green bars on the button icon; this can be changed during data collection or playback.

Level 1 (or one bar) requires the most movement for it to show up on the screen.

Level 6 requires the least amount of movement. Note that Level 5 and Level 6 are more susceptible to false alarms.

Usually Levels 2 to 4 are recommended in most situations. Increasing Sensitivity may cause targets to appear on the detection screen while reducing the Sensitivity Level may cause targets to disappear.

Some examples of changing sensitivity are shown in Figure 4-6 and Figure 4-7.
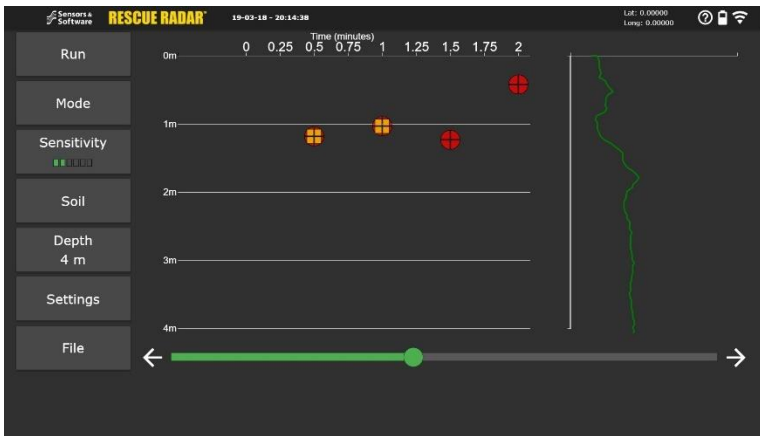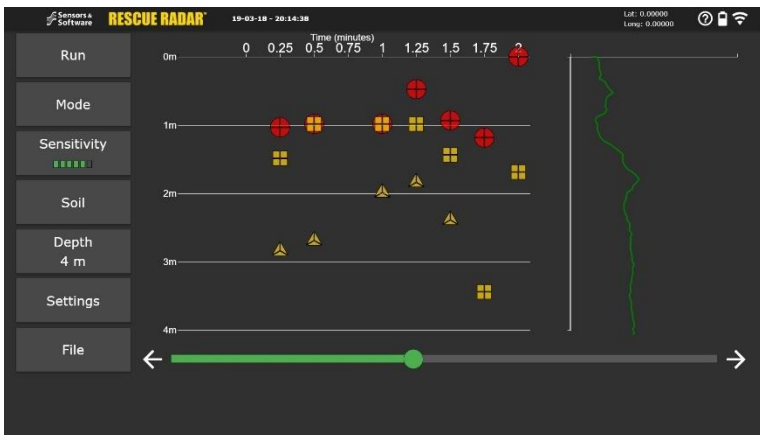
Figure 4-6: Sensitivity set to 2 bars

Figure 4-7: Sensitivity set to 5 bars

Material – this button cycles between the various materials being scanned: Soil, Air, Snow, or Rubble. Set this button accordingly, as it's used to get an accurate distance to the target, since the radar signals travel at different speeds in different materials. For example, a target that appears at

15m when Material is set to Air will appear at 5m when the Material is set to Soil. Rubble is assumed to be roughly 50% air and 50% concrete / soil. The Material can be changed during data collection or playback.

Depth – this button cycles between depth ranges that are displayed on the screen. The maximum depth for the Material is always collected but the operator can display a smaller depth range if desired. The depth ranges available depend on the material selected. Values available for all materials are 2, 4, 6 and 10m. Additionally, snow allows a depth setting of 20m, and air allows depth settings of 20m and 30m.   The Depth can be changed during data collection or playback.

4.3   System Settings

Pressing the Settings button on the main screen will display a pop-up window where system settings can be changed and other levels monitored (Figure 4-8). The Settings button is greyed out and not available during data collection.
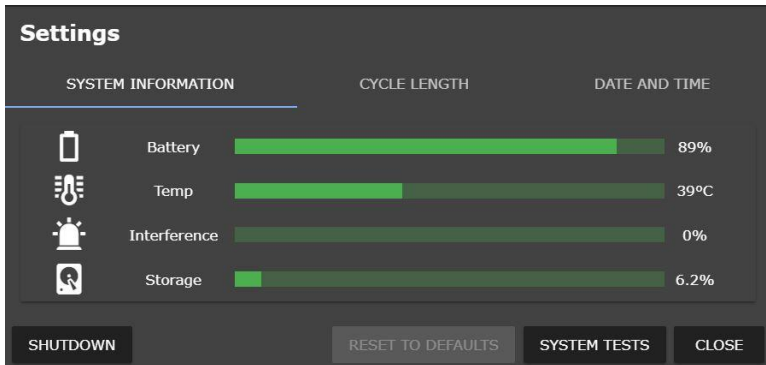

Figure 4-8: Settings pop-up window

There are three tabs, along with some common buttons at the bottom of this window. Touch the name of the tab to access its

functions. The active tab is always underlined in blue. The functionality of the tabs are described below.

4.3.1 System Information

The System Information tab displays:

- Battery Level – the Rescue Radar battery level is indicated by the length of the bar, and by a percentage. When the level is low, the bar turns red to indicate that the battery should be recharged.

- Temperature – The internal temperature of the Rescue Radar unit is indicated. If the temperature gets too high, the bar will turn red. Open the lid to allow the Rescue Radar unit to cool. Note: Data can still be collected with the lid open.

- Interference - The level of Interference from external radio frequencies sources is indicated by the length of the bar. If interference is high, the bar will turn red. Try turning off possible sources of radio frequency interference (e.g. two-way radios). Increasing the Cycle Time can also help reduce the negative effects of interference.

- Storage - amount of hard drive space used on the RR system, expressed as a percentage.

4.3.2 Cycle Length

The Cycle Length can be set under this tab (Figure 4-9).

Figure 4-9: Setting cycle length under Processing Settings

Data is collected continuously for a set time interval (called a Cycle), at which point results are then calculated and displayed. The cycle time can be set to 15, 30, 60 or 180 seconds. Consistent targets that show up over multiple cycle times increase confidence. The recommended cycle time is 30 seconds.

4.3.3 Date and Time

The current date and time can be set under this tab (Figure 4-10). Press the date field to change the date, and the time field to change the time.
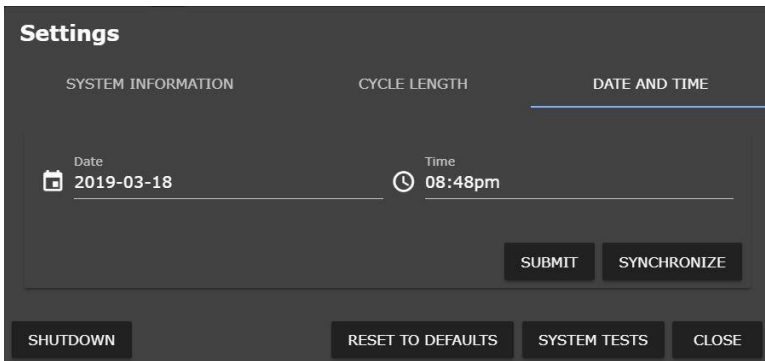
Figure 4-10: Setting date and time

Touch **Submit** to send the updated time to the Rescue Radar unit.

Press the **Synchronize** button to sync the time of the tablet to the time on the Rescue Radar unit. This may be required if the system is not used for several months.

4.3.4 Buttons at the bottom of window

Figure 4-11: Buttons at the bottom of the Settings window

At the bottom of the Settings window (Figure 4-11), the following buttons are always displayed:

- **Shutdown** – pressing this button will shutdown the Rescue Radar unit; this is the recommended way to power down the system. Alternatively, the system can also be shutdown by pressing the Power button on the console (Figure 2-2).

- **Reset to Defaults** – this restores the system to the default data collection options: Basic mode with cycle time of 30 seconds, sensitivity of 3 bars, rubble material and a depth of 4m.

- **System Test** – explained in <u>Section</u> 4.5.

4.4 Languages

Touching the globe icon will display a pop-up menu where the language can be changed (Figure 4-12). The currently selected language is indicated by the blue radio button.
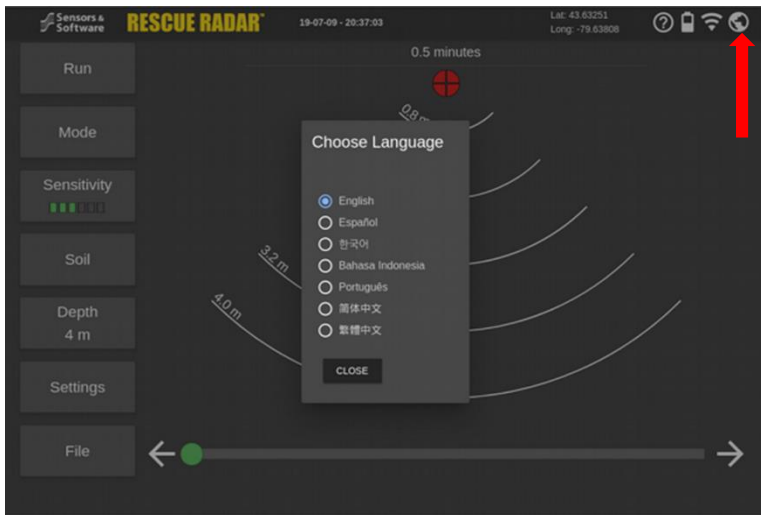
Figure 4-12: Changing languages. Red arrow points to globe icon

To change languages, touch the radio button associated with each option. The language will be updated immediately after selecting it and doesn't require the user to close the menu to take effect. All menus and options will now be displayed in the selected language. This language will be remembered for all future use, even after power down.
To exit the menu touch the close button at the bottom of the menu.

4.5 System Tests

Pressing this button displays a pop-up window where diagnostic tests can check the performance of specific components (Figure 4-13).
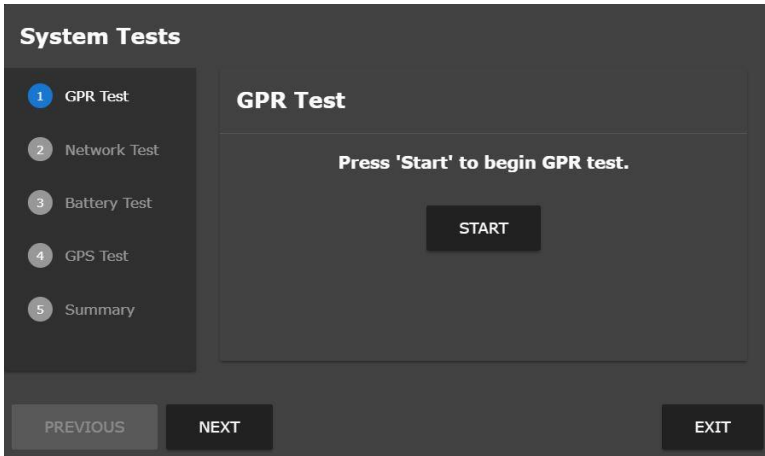

Figure 4-13: System Tests

Select one of the tests from the left side of the window by pressing the **Previous** and **Next** buttons, and follow the instructions in the main part of the window. You can also touch the specific test directly. Press the **Start** button to begin the test.

4.5.1 GPR Test

This test checks the GPR signal emitted from the Rescue Radar system. Tilt the Rescue Radar unit on its side and make sure no one is standing in a 2m radius from the unit. Select **START** to run the GPR Test. A passing result is shown in Figure 4-14.
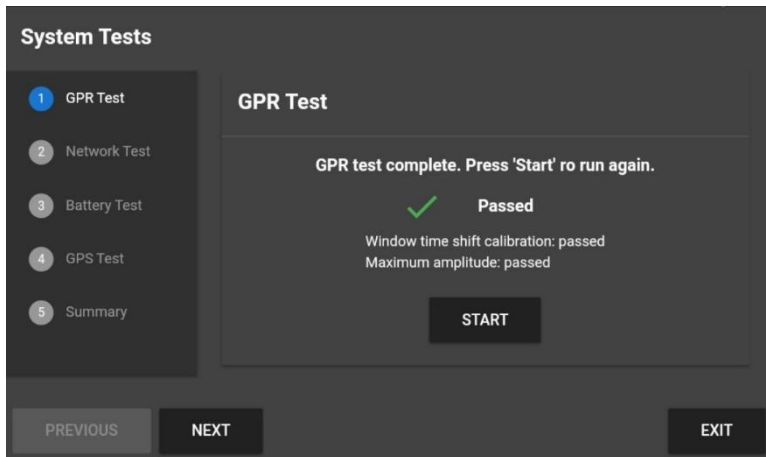

Figure 4-14: Results of GPR Test

4.5.2 Network Test

The test confirms the connectivity between the tablet and the Rescue Radar unit. The closer the tablet is to the unit, the higher the connection speed. An example of a passing test is shown in Figure 4-15.
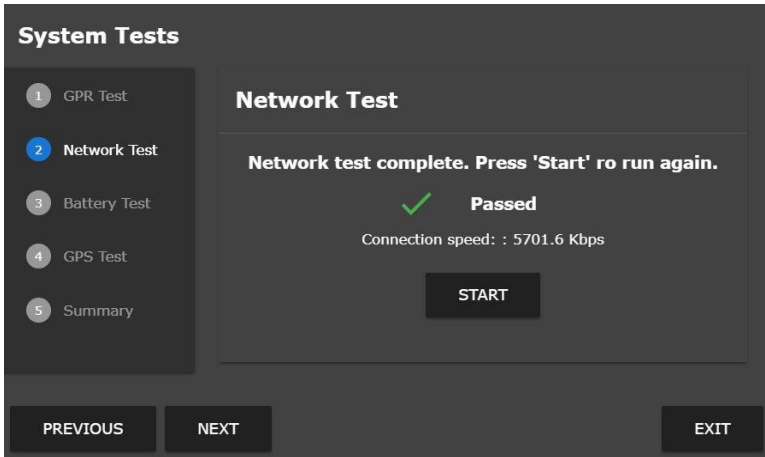

Figure 4-15: Results of Network Test

4.5.3 Battery Test

This simply checks the voltage of the battery. Anything above 10.5V is considered a pass. (Figure 4-16)
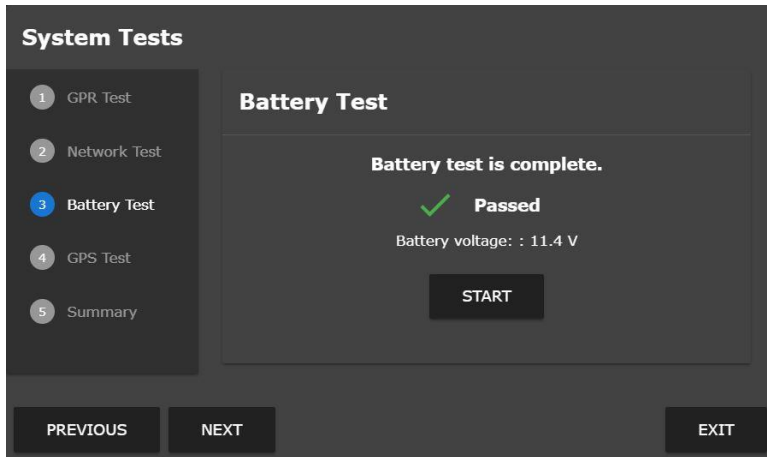
Figure 4-16: Results of Battery Test

If the test fails, try recharging the battery overnight and run the test again. If it continues to fail, the battery needs to be replaced. See Troubleshooting in Section 8.

4.5.4 GPS Test

The GPS test confirms that the GPS is communicating with the Rescue Radar unit. It waits for 30 GPS strings to be received by the system, whether or not it's detecting satellites.
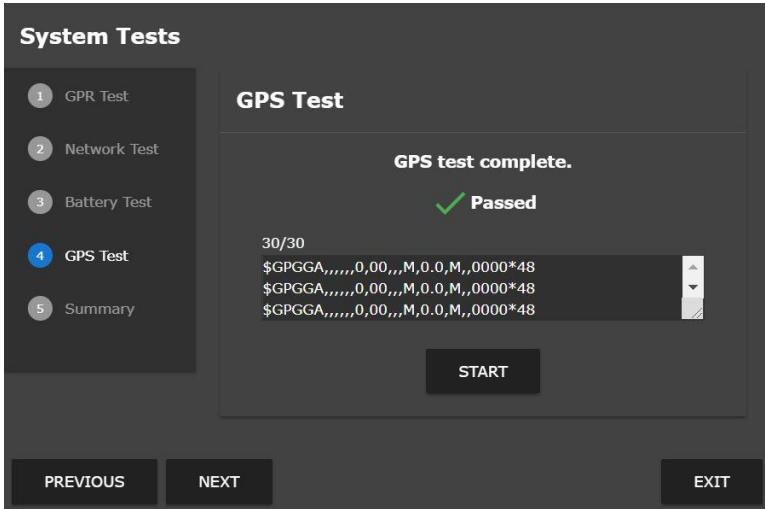

Figure 4-17: Results of GPS Test

4.5.5 Summary

Pressing Summary displays the results of all the tests (right column) as well as serial and version numbers for the hardware and software (left column) (Figure 4-18).
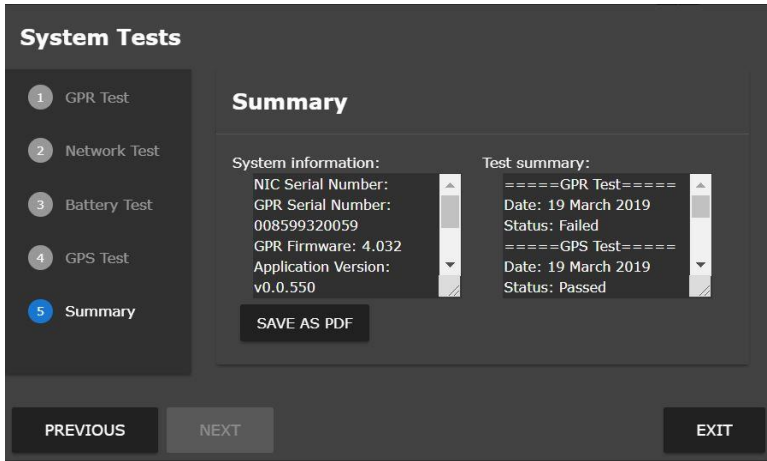
Figure 4-18: System Summary information

Press **Save as PDF** to export this information as a System Summary Report. It will confirm if you want to download the system_summary.pdf file to the tablet. Press Download to confirm.

If there are any operational issues, this file may be requested by the manufacturer as part of the troubleshooting process. An example of a Summary Report is shown in Figure 4-19.

Figure 4-19: System Report Summary

4.6   Other Icons & Settings

There are several other icons in the top right corner (Figure 4-20) which are labelled and explained here:
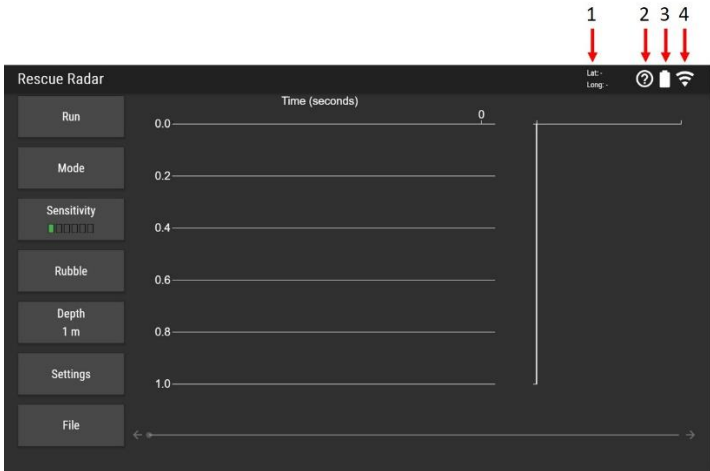
Figure 4-20: Icons in the top right corner

1 - Lat/Long: As the system has an embedded GPS receiver, the Latitude and Longitude of the currently displayed data will be shown here.

2 - Help: Touching the question mark icon will launch a pop-up Help window (Figure 4-21)
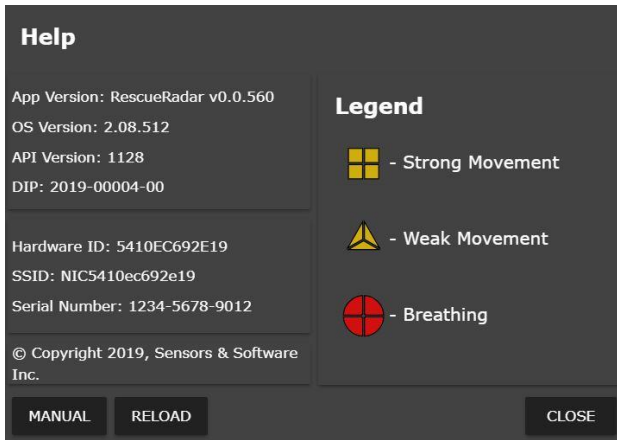
Figure 4-21: Help window

This window shows the meaning of the movement indicator symbols. If the user presses the **Manual** button, this manual will be launched as a .PDF file.

Pressing the **Reload** button will refresh the Rescue Radar screen. This may be required if you move out of range and then back into range.

3 – Battery Level: This icon shows battery power for the Rescue Radar at a quick glance. The icon will turn red when the power is low. The precise battery level reading can be obtained from the System Information window (Section 4.3.1)

4 – Wi-Fi: if connected, you will see the Wi-Fi symbol. If not, there will be a slash through it.

5 Data collection

Once you have configured all settings, press Run to start acquiring data. You will see the screen displayed in Figure 5-1, which shows the basic mode.
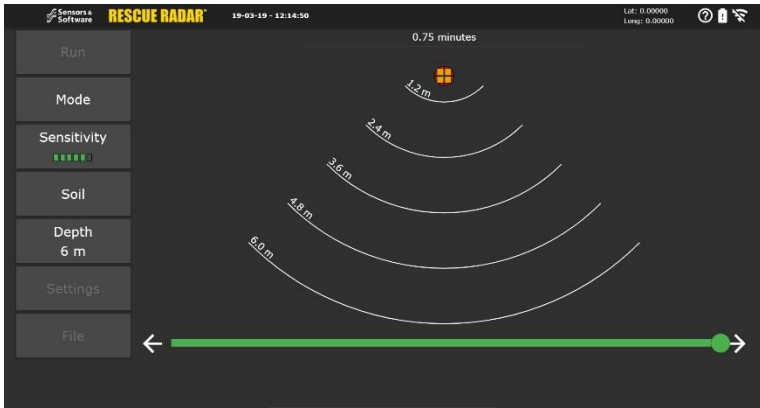
Figure 5-1: Collecting data in basic mode

Data will be collected for the length of a cycle. The cycle time is displayed as a progress bar. Once a cycle is complete, there may be movement indicators. Movement indicators are explained in [Section](#) 4.1. The cumulative cycle time is displayed at the top, in minutes.

At any time, the user can press the **Mode** button on the left to toggle back and forth between Basic Mode and Time Lapse mode (Figure 5-2). Time Lapse mode displays the results for every cycle, as well as the ability to scroll back and review data that has moved off the screen. Remember that consistent targets (similar movement, same depth) over multiple cycles increases confidence and reduces false positives.

The maximum number of cycles that can be collected before the system stops is 100.
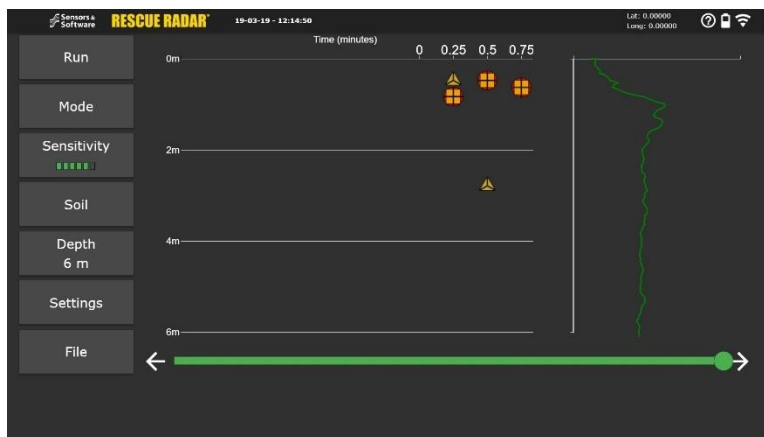
Figure 5-2: Collecting data in Time Lapse mode

Movement indicators will be shown at the approximate depth, based on the material selected. In many cases, breathing will be accompanied by movement, hence two symbols will be overlapped.

Here are some observations about the image in Figure 5-2:

- The cycle length is 15 seconds (0.25 minutes)

- 3 cycles are being displayed

- In the first cycle, strong movement with breathing is detected around 1m deep, with weaker movement around 0.5m deep

- In the second cycle, strong movement with breathing is detected around 0.5m deep, with weaker movement just below 3.0m deep

- The third cycle again shows strong movement with breathing is detected around 0.5m deep

See Section 6 for tips on proper data collection.

6 Systematic Surveying

Rescue Radar detects movement within a cone under it.
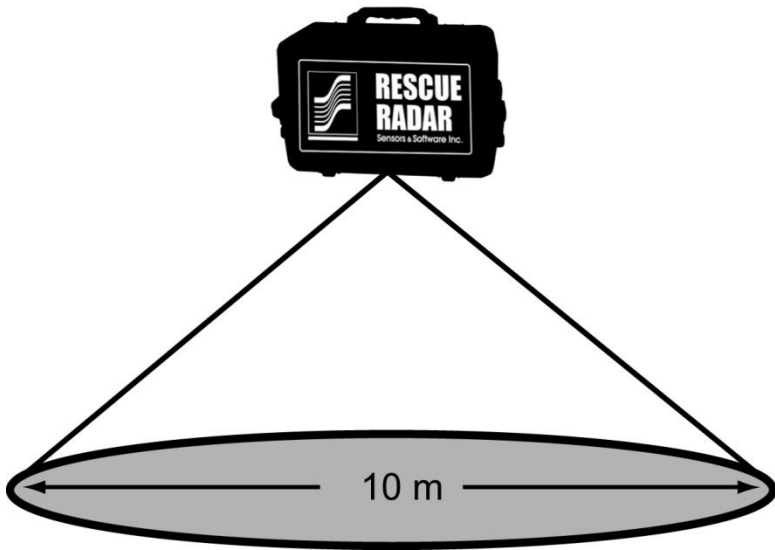
The diameter of the area of coverage (or footprint) varies slightly with the actual material being scanned and the orientation of the Rescue Radar box but a value of 10 meters is a good, conservative approximation.

To cover an area, the Rescue Radar measurements should be collected on a regular grid pattern at a maximum separation of 5 meters so there is overlap between each Run.
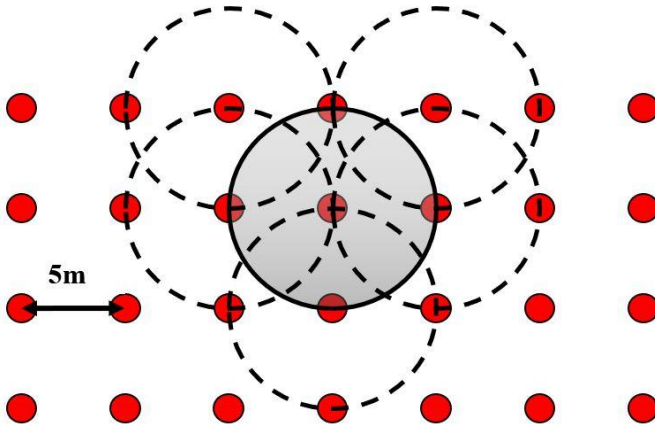
The volume of material scanned varies with penetration of the signal.
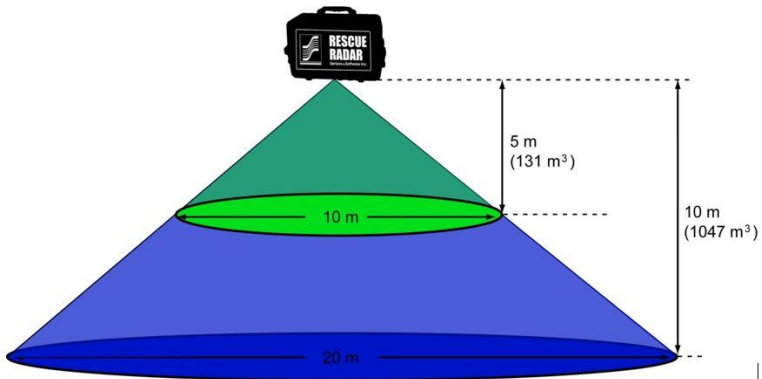
If penetration is 10 meters in rubble or soil the volume investigated with Rescue Radar is approximately 1047 m³. If penetration is 5 meters in rubble or soil the volume investigated with Rescue Radar is approximately 131 m³.

Ensure that the operators remain at least 15m away from the Rescue Radar system, so that their movement is not detected.

Some additional tips for surveying:

- Remember that Rescue Radar cannot penetrate metal, so it will not detect movement below a metal sheet for example. If there is a metal sheet in the debris, it should be removed if you suspect there could be someone beneath it.

- Limit 2-way radio use as much as possible to minimize interference between the tablet and rescue radar

7 File Management

Data is always saved to the Rescue Radar console during collection. Saved files are named by the date, then by the time of the collection. The file naming convention is detailed in Section 7.6.

Collected data can be exported to a USB drive or the tablet. Previously collected data can also be reloaded and viewed, either from a USB drive or the tablet. The following sections explain these operations in more detail.

Pressing File from the main screen will display a pop-up menu as shown in Figure 7-1
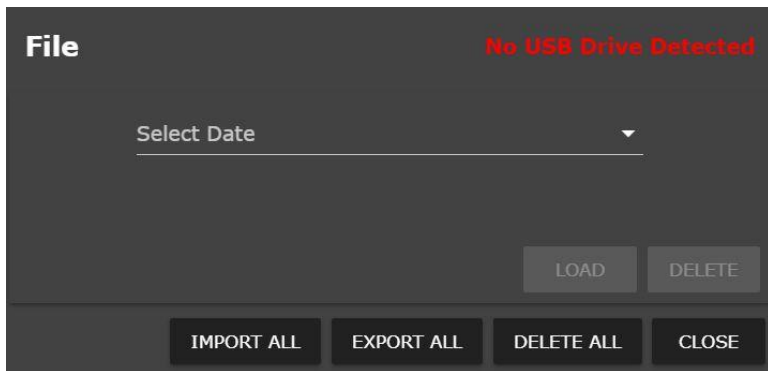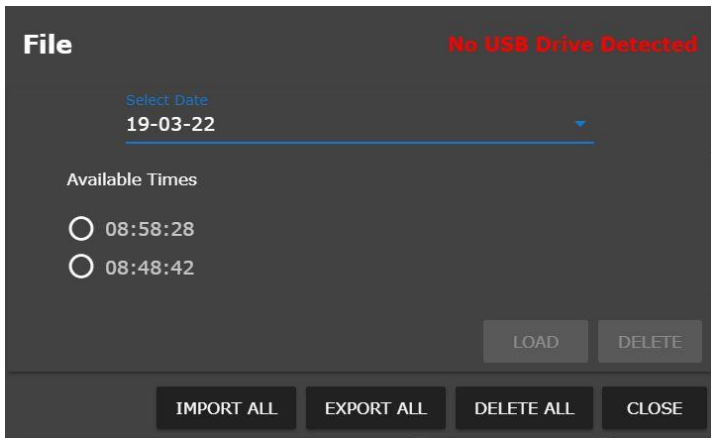
Figure 7-1: Pressing the file button

7.1 Loading or Deleting Data from Rescue Radar console
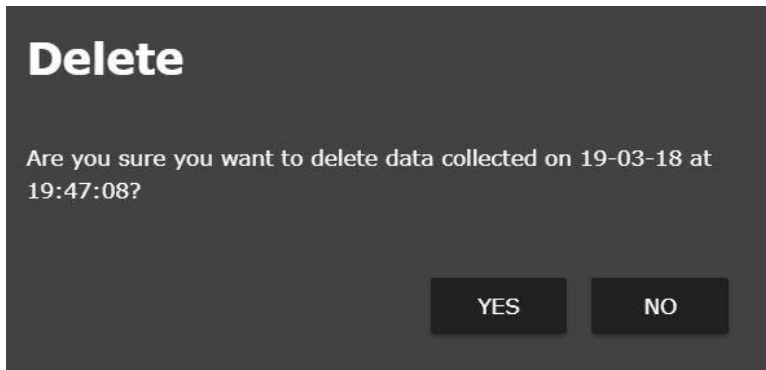
Touch the screen where is says "Select Date" to list dates where data was collected and saved. The date format is listed at year-month-day. Once a date is selected, available times are now shown (Figure 7-2). The times correspond to the start time of data acquisition.

Figure 7-2: Selecting file based on date and time of collection

Selecting a time will now make the Load and Delete buttons visible. Press Load to import the data for viewing, or press Delete to permanently delete this file. You will get a delete confirmation window, press **Yes** to proceed with the file deletion (Figure 7-3).

Figure 7-3: Confirming file delete

7.2 Importing Data

Data that was archived or collected with another Rescue Radar unit can be imported into the current one.

Touch the File button on the left side of the main menu, then press the **Import All** button.

<u>From USB</u>

If a USB stick is inserted, it will be shown in Green on the pop-up window. This will take precedence over the tablet and all files will be imported from the USB to the Rescue Radar. These files will remain on the Rescue Radar unit, even when the USB stick is removed. Once a date is selected, available times are now shown. Select a file then touch **Load** (Figure 7-4).

Figure 7-4: Importing files from USB

From tablet

If there is no USB inserted and the user presses **Import All**, it will attempt to load data from the tablet onto Rescue Radar. When you the see image in Figure 7-5, press **Documents**.
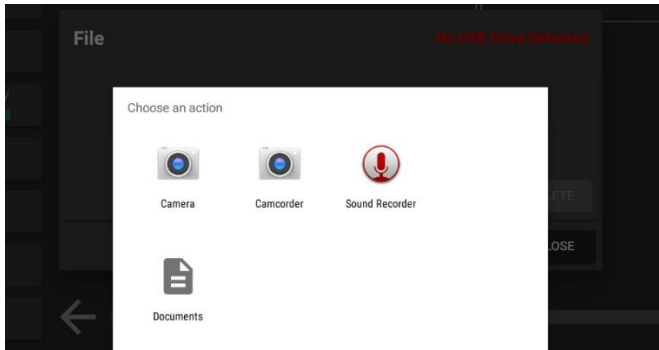
Figure 7-5: Importing data from the tablet

Any data that was previously exported to the tablet is saved in a compressed .zip file. Press the hold the desired .zip file until there is a green checkmark to the left of it (Figure 7-6), then press Open in the top right of that window.
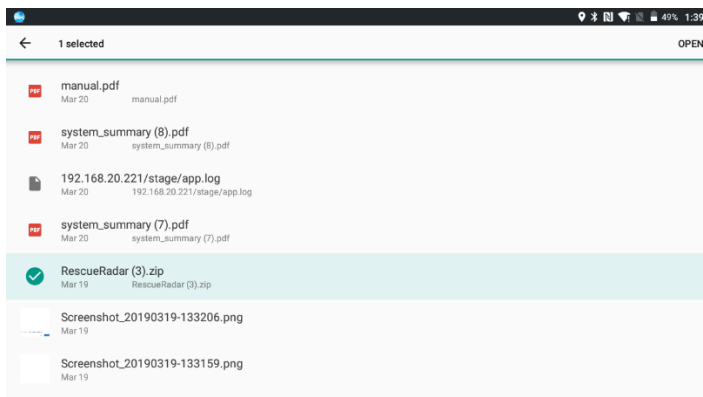
Figure 7-6: Selecting the .zip file

It will then begin to import the data to the unit (Figure 7-7). When completed, there will be a message indicating the import was successful. These files will remain on the Rescue Radar unit, even when the USB stick is removed. Once a date is selected, available times are shown. Select a file then touch **Load.**
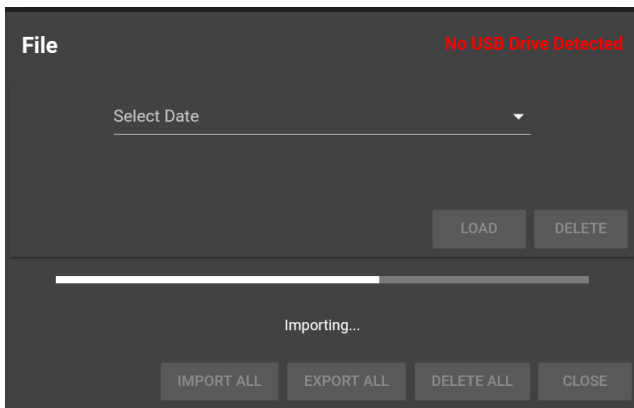
Figure 7-7: Importing a selected .zip file

Regardless of how the data is imported to Rescue Radar (USB or tablet), the data will be loaded into the main window for viewing. Sensitivity, depth and material values can be changed. Going into Time Lapse mode can show multiple cycles of collected data.

7.3 Exporting Data

Data can be exported from Rescue Radar for archiving purposes. Pressing the **Export All** button will download all the data on Rescue Radar.

If a USB is inserted, the data is downloaded to the USB and not onto the tablet. If there is no USB present, the data is downloaded to the tablet. The data still remains on the Rescue Radar unit itself until deleted.

7.4   Formatting USB Sticks

There may be times when a USB stick is not recognized by Rescue Radar. 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.

7.5   Deleting All data

Touching the **Delete All** button will delete all saved data from the Rescue Radar unit. As always, there will be a confirmation window that pops up asking if you would like to proceed.

7.6 File Structure

Rescue radar data consists of two files:

- .HD - header file

- .RR3 – actual data file

The directory structure when viewed on the USB Stick would look like the following

- Rescue Radar
  - YY-MM-DD
    - Lineset
      - HH-MM-SS.rr3
      - HH-MM-SS.hd

The directory is based on the date the file is created, where
    YY is the 2-digit for the year
    MM is the 2-digit for the month
    DD is the 2-digit for the day

The filename is based on when the data collection started, where
    HH is the hour in a 24-hour format
    MM is the minute
    SS is the second

8 Troubleshooting

Rescue Radar is designed to minimize user problems; however, all electronic devices are subject to possible failure. The following are troubleshooting hints which can be referred to if the system fails to operate.

8.1 Power Supply

The most common problem that can occur while trying to run the system is insufficient power. The battery may be dead or have a low voltage. Always make sure that batteries are recharged after use and recharged monthly if the system sits idle. This will ensure that the batteries are ready when the system is required.

If the battery does not charge up to 12 Volts or more, it should be replaced. Open the battery compartment, disconnect and remove the battery to replace.

If the battery seems OK but the system still does not power up, check the battery cable connections and inspect the battery cable for damage.

8.2 Wi-Fi Connection

The tablet is configured to connect to the Rescue Radar unit at the factory, prior to shipment. Occasionally, it is possible that it might have trouble establishing or maintaining this connection.

If the tablet loses the wi-fi connection with the Rescue Radar unit during data collection, collection continues. However, it's important to re-establish connection as soon as possible. Try moving closer to the unit, but no closer than 15m.

Make sure the network name is displayed on the console. The password for the Wi-Fi network is the same as the network name. Then make sure the tablet is connected to that network. See Section 3.1 if there are issues with Wi-Fi connectivity.

8.3 System Overheating

The internal system temperature of the Rescue Radar unit can be checked by touching the Settings button on the left and then making sure System Information is underlined in the pop-up window (Figure 8-1)

Figure 8-1: System Temperature

If the temperature exceeds 75° C, the bar colour will change from green to red. If that happens, turn off the system, and open the lid allowing it to cool.

8.4 Shutdown

If Rescue Radar cannot be shut down from the software, then press and hold the power button (Figure 2-2) for a few seconds.

9 Technical Specs

Specifications	Values
Dimensions – Rescue Radar case	530 x 325x 325 mm
Weight - Rescue Radar	7.7 kg (with tablet)
Dimensions – Tablet	212 x 133 x 19 mm
Weight – tablet	0.55 kg
Center frequency	500 MHz
Battery	Sealed lead acid gel cell Battery Life: 4-6 hours Battery Capacity:9.0 Ah
Battery charger	AC mains charger input: 110-240V, 1.5A, 50/60Hz. Use between 0 - 30°C.
Power	1.25A @ 12V
Environmental	Rescue Radar Electronics: -40 to 50°C Tablet: -10 to 50°C
Maximum Wi-Fi distance	75m
Tablet OS	Android
Wireless	IEEE 802.11 b,g,n
Regulatory Specifications	EMC-FCC, CE, IC, ACA, RSM, 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 at the end of this Appendix.

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 the general population over the 30 to 300 MHz frequency band. All other applications and frequencies have higher tolerances as shown in graphically in Figure A-1.

*Figure A-1: FCC limits for maximum permissible exposure
(MPE) plane-wave equivalent power density mW/cm².*

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. products are less than 10^{-3} mW/cm² which is 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.

References

1. Questions and answers about biological effects
    and potential hazards of radio-frequency
    electromagnetic field.

    USA Federal Communications

    Commission, Office of Engineering &

    Technology OET Bulletin 56
    (Contains many references and web sites)

2. Evaluation Compliance with FCC Guidelines for
    Human Exposure to Radio Frequency
    Electromagnetic Fields.

    USA Federal Communications

    Commission, Office of Engineering &

    Technology OET Bulletin 56
    (Contains many references and web sites)

USA Occupational Safety and Health Administration
regulations paragraph 1910.67 and 1910.263

Appendix B: GPR Emissions, Interference and Regulations

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 test 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

Appendix B: GPR Emissions, Interference and Regulations

This equipment has been tested and found to comply with the limits for a Class A digital device, where applicable, and for an ultra-wide 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 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/her 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

Appendix B: GPR Emissions, Interference and Regulations

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.

Appendix B: GPR Emissions, Interference and Regulations

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-NG250
EQUIPMENT NOMENCLATURE: NG250

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 B: GPR Emissions, Interference and Regulations

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 is 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/her 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.

Appendix F: Calibration

This Ground Penetrating Radar (GPR) system has been manufactured according to Sensors & Software's strict quality standards. All components used in the manufacture of this product are obtained from qualified vendors.

This product has been through a stringent set of tests to ensure all quality requirements are met which includes final system calibration and configuration.

This system is equipped with built-in diagnostic tests. By running the tests and getting a passing result, you can be confident that the system is operating within specification. No further user calibration is required.