200 HS ANTENNA MANUAL

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Geophysical Survey Systems, Inc.
40 Simon Street • Nashua, NH 03060-3075 USA • www.geophysical.com

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Regulatory Information

The use of GSSI antennas is governed by different regulatory agencies around the world. Specific antenna models must be certified for legal operation in your country. Please read and understand the following regulatory passages that pertain to your antenna. A listing of certified antennas by region can be found www.geophysical.com/regulatoryinformation.htm.

Notice

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.

Survey Wheels

All of GSSI’s antennas are designed to operate with survey wheels. Some antennas have built-in survey wheels, including the 62000 Palm Antenna and the Mini-SIR. The series of concrete antennas, including the 5100, 5101 and 52600, have survey wheels built in to their special carts, the 614 and 615. The larger antennas, including the 3101D, 5103, 50400 and 5104 are used in the larger carts, the 623 and 643, which have survey wheels built in to them. Various sizes of survey wheels can also be attached directly to these antennas. This includes the 611, 620 and 622. For highway surveys we use the 630 Distance measuring Instrument (DMI).

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Introduction

Thank you for purchasing one of GSSI's GS (Geophysical Survey) Series low frequency antennas. The GS antennas represent the state-of-the-art for GPR applications that require the deepest possible penetration while maintaining the fine resolution you've come to expect from GSSI mid and high frequency systems. GS antennas incorporate GSSI's HyperStacking® (HS) technology for blazingly fast collection speed and high levels of noise immunity. The GS has been designed with real-life field conditions in mind. This is a system that you can confidently take to the ends of the Earth and use in the harshest environments. Here at GSSI we're very proud of what we've created and even prouder that you've decided to place your trust in us.

What Comes in the Box

- 200 HS Antenna
- HS Module
- Lithium-ion Batteries (2)
- Dual Bay Battery Charger
- Tow Handle
- GS Series Manual
- Panasonic G2 Tablet (optional)
- SIR 4000 WiFi Module (optional)

A Note about HyperStacking Technology

The GPR data you see on the screen start as received pulses of electromagnetic energy that have reflected off objects or interfaces in the ground. The reflected signals generate electrical charges in the receive antenna element that are digitized by the antenna's onboard sampler. They are then converted into digital values and displayed as a colorized linescan profile or an oscilloscope trace. Traditional GPR systems send out one pulse at a time and record one small piece of reflected information (a sample) from that one pulse. It takes many samples to make a single scan and many scans to make a profile.

HyperStacking (HS for short) technology represents a generational leap in GPR. HS antennas record many samples from a single pulse. This allows an HS antenna to record data at speeds up to an order of magnitude faster than conventional systems. In practice, the HS antennas use that extra data to average, or stack, individual samples. This helps to reduce the random noise present in the signal and results in cleaner and deeper data.

An added benefit is that we randomize the timing of the transmit pulse. This is called "dithering" and means that we automatically average out manmade noise from nearby radio transmitters. This patented technique enables you to work more confidently in high-noise environments like urban areas or airports.

About this Manual

This document provides important information for operating the GS Series antenna and collecting, reviewing, and transferring GPR data to a PC. It is available for free download at www.geophysical.com. This manual is not necessarily a substitute for a full training class. Purchase of a GS Series system includes complimentary access to GSSI's regularly scheduled curriculum of professionally led training classes. We encourage you to take advantage of the opportunities for instruction and networking with other professionals. Please visit www.geophysical.com or contact training@geophysical.com for more details.

Hardware Assembly

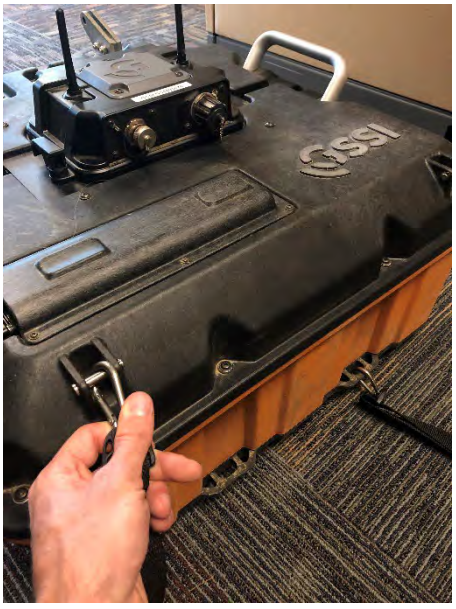
This section describes how to assemble your GS Series Antenna to prepare for a survey. Here we are assuming a distance-based survey; if you are instead performing a time or point-based survey disregard Steps 3-5.

Unpack and prepare:

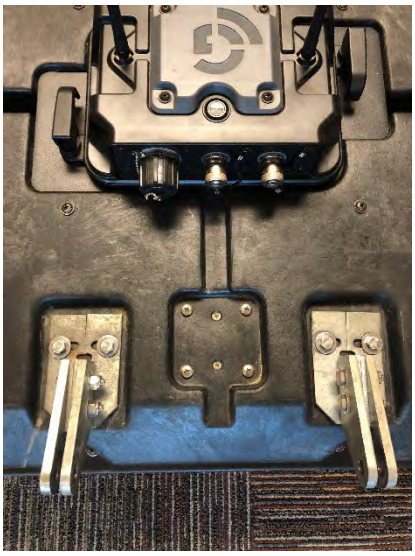
- 200 HS
- Tow Handle
- HS Module
- 1 Lithium-ion battery
- Model 620 SW (for distance-based only)
- A wrench (for distance-based only)

1 Attach the HS Module to the top of your 200 HS antenna. Snap the two levers (one on each side) to secure it.

2 Clip the Tow Handle to the front of the device. The front is also where the battery port sits. There are four areas to clip to – pick an orientation that works best for your site to keep the antenna on the ground.



3 Attach the Model 620 SW brackets to the back of the 200 HS. You will need a wrench to secure the bolts properly.



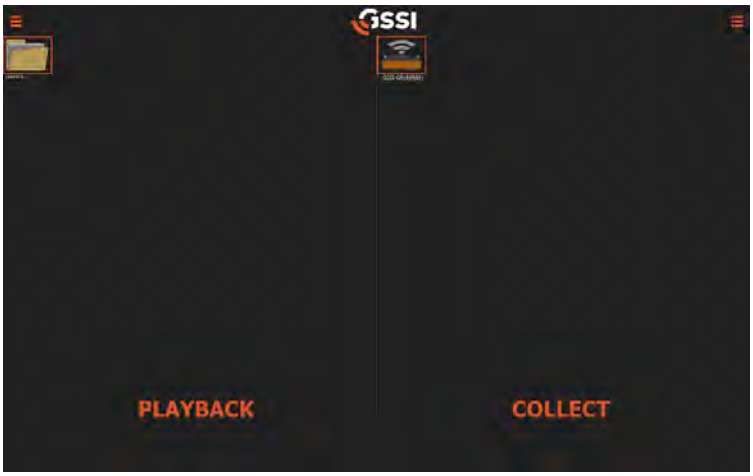
4. Secure the 620SW to the brackets using the attached pins.
5. Attach the 620SW cable to the 4-pin connection on the HS Module.
6. Insert a battery into the battery port on the antenna.
7. Press the power button on the HS Module.
8. Wait for the power light to blink continuously before attempting to connect on the Panasonic G2 Tablet or before powering on your SIR 4000.

Setting Up Your System for the First Time

This section describes how to configure typical one-time settings such as language and units of measurement, connect to the antenna via WiFi, and navigate the control software. For this section we are assuming the use of a tablet computer. For use with the SIR 4000, please refer to the appropriate section of the SIR 4000 manual.

1. To begin, **double tap the GS Software shortcut from the Windows desktop.** You will briefly see the application loading image before landing on the Playback/Collect screen.

- The right side of the window will show a list of detected antennas which are transmitting a WiFi signal. Note that you are not yet connected to your antenna, the system is just displaying available connections.
- The left side of the window will show Project folders.
- If this is the first time you are using the system, the only folder shown will be the factory default one: COMMON.



Playback/Collect Navigating the Menu Items

Playback/Collect & Navigating the Menu Interface

There are three groupings of control items that you will interact with: the **Global Stack** at the left, the **File Stack** at the right, and the **Control Bar** at the bottom.

- In order to maximize the visible data image, these are collapsed into the sides of the screen and opened when needed.
- The Global Stack and the File Stack can be accessed by tapping the collapsed menu icon in the top left and top right corners respectively.
- In Playback or Collect mode, the Control Bar is always present. Control Bar functions will vary depending on which mode you are in. See the Control Bar section of this manual for an explanation of each function.

Interface with all menus open

Configuring One-Time and Global Settings

It is important to configure one-time settings such as language and units of measurement, as well as global settings like designating the correct project folder to save individual profiles to, prior to connecting to your antenna.

1 If you have already clicked through to Collect or Playback, tap the Back arrow ( ) in the lower left corner to return to the Playback/Collect screen. Tap the Global/Project stack button at the top left. This will expand the portion of the menu pertaining to settings which do not vary from file to file in a single project.

2 Scroll to the Project section of the stack.

3 Tap the current Project folder name (this will be called "COMMON" if using the system for the first time) next to Project to select or create a new project folder. This will designate the folder in which your data files will be saved.

- You can create a new folder by tapping the **New Project Name** field and typing the desired name of your new folder. Press the **Enter** key ( ) on the keyboard to save the new folder. Each data file you collect while in that project will take the new project name as its root name.
- When playing back data remember that you are only viewing files stored in the currently selected Project folder.
- To select an existing project, simply tap it from the list of saved folders. You many need to swipe left/right if you have more projects folders than can be displayed on the screen at once.

Add a new project

4 Navigate to the **GPS** option in the Project menu. To change your GPS setting click **None** then scroll and select the name of the GPS you would like to use.

a) If you do not plan to use GPS, leave this set to **None**.

b) If you plan to use the Panasonic G2 internal GPS, select **G2-GPS**.

c) If you plan to use the HS Module integrated GPS, select **Internal**.

d) For an external GPS connection, follow the GPS connection instructions in Appendix A, then reopen the GS Software application to have your GPS appear as an option on the list.

5 Next, navigate to the **GPS Offset** option. This is the distance that your GPS is offset from the threading on the top portion of the antenna near the handle attachments.

a) If yours GPS is mounted on a pole using the threading on the antenna, your GPS Offset value will be **zero**.

b) If you are using the Panasonic G2 internal GPS, measure the horizontal distance from the threads on the antenna to the center of the tablet. If you are behind the antenna the offset value will be negative, if you are in front of the antenna the offset value will be positive. If you use the Panasonic G2 internal GPS, take care to maintain the input offset distance from the antenna throughout collection.

c) If you are using the HS Module integrated GPS, measure the horizontal distance from the threads on the antenna to the center of the module. The offset value will be positive.

d) If you are not using GPS, this value can be **zero**.

6 If you plan to collect data with GPS and would like a KMZ file to be exported, toggle the **Export to KMZ** option **On**. For more information on exporting KMZ files see Appendix B.

7 If you plan to collect data using an external survey wheel, toggle the **External SW** option **On**.

8 Navigate to the System menu to **Units** and **Language** options.

9 Tap the selected parameter to change. For example, if you wish to change the Units from Imperial to Metric, tap the word **Imperial**. These settings will remain from session to session unless changed.

Connecting to the Antenna

The Panasonic G2 tablet communicates with the antenna via a WiFi network. To ensure a successful connection, turn on the antenna and wait for a flashing blue light before proceeding with the pairing process. Turn on the tablet and confirm that WiFi is turned on and that the tablet is not in Airplane mode. The tablet should automatically connect to the WiFi network broadcasted by the antenna, but if you have recently connected to another WiFi network you should use the Windows WiFi manager to “Forget Network” before following the connection instructions below

1 Tap on the icon of the antenna that you want to connect with. An antenna broadcasting animation will be shown while the antenna is attempting to connect. A successful connection will bring you to the Setup/Preview screen.

2 If your tablet network settings have changed and you are having connection issues, you can restore them to connect to your 200HS. To do so, close the GS Software application and tap the Windows icon (⊞) in the bottom left of the Windows control bar. Select the application icon (▤) and navigate

to the GSSI folder. Click on the folder to expand and select GS Network Defaults. Your network settings are now configured to be compatible with connecting to the antenna and you can connect normally.

Setting Up for Data Collection

This section will get you set up to collect data with a GS Series antenna in either distance, time, or point-based mode.

For more information about individual menu items and settings, see the "Overview of Menu Items and their Functions" below.

To begin, you will need to insert a battery into the antenna's battery port and press the power button on the antenna. **Wait for the power light to flash before starting the GS Software**.

1 Once in the GS Software, connect to your antenna using the instructions provided in the "Connecting to the Antenna" section above.

2 After connecting to your antenna, the setup/preview screen will load. Data will scroll continuously as you make adjustments, but the system will not begin collecting a data file until you press the **red Record icon (●)**.. After two minutes the data on the preview screen will stop scrolling to save tablet battery. It is important to spend some time making adjustments in the setup screen to reach your desired collection parameters prior to collecting a data file.

3 Tap on the Global/Project Menu Stack to check your Project parameters.

- Check the Project Folder and adjust the title if needed.
- Check the Save Prompt and GPS and adjust if needed.

4 Next, tap on the File Parameters Menu Stack. In the Scan area, we are most concerned with:

Collect Mode

- **Time:** No survey wheel, emitting scans/second continuously
- **Distance:** Using a survey wheel, transmitter triggered by wheel movement
- **Point:** Collecting one scan at a time when prompted, able to stack many scans together to reduce noise.

Vertical Scale – Depth or Time

- When the vertical scale is displayed as Depth, you will set the depth of signal penetration. Note that the depth displayed is calculated by converting time (in nanoseconds) to depth using the dielectric value you have set. The accuracy of your depth scale is dependent on how accurate your dielectric value is. For more information on dielectric, see Appendix C.
- When the vertical scale is displayed as Time, you will set the time range (in nanoseconds) for which the system will "listen" for returns. The time value input will impact the depth of penetration as the subsurface material will depend how quickly or how slowly the radar energy can travel through it. If the energy travels slowly, the depth of penetration will be shallower as the system will only record returns within the specified time range. Conversely,

if the radar energy travels quickly through the subsurface material, the depth of penetration will be greater.

Regardless of the method you use to set penetration depth, you'll want to look at the scan to set it properly. Observe the scan trace displayed in the O-Scope window (O-Scope can be toggled on and off by pressing the  icon in the control bar).

- When the scan trace gets to a depth/time where there is more noise/interference than signal strength, you'll see the scan trace jump from negative to positive and appear craggy. To setup the system so that you're collecting the maximum range of data possible you'll want to see some of that noise in the scan trace.
- If no noise is apparent, then you should increase your depth or time range until about 10-25% of the scan trace consists of noise. The noise to signal ratio will change as you move across your survey area. Keeping some noise on the screen will help ensure that you always collect the full range of quality signal.

Dielectric: This value is used to convert the RADAR two-way-travel-time into a depth on the screen. It is crucial to set this accurately to obtain accurate depths to features. If your vertical scale is set to Depth, you can use the Soil Types to help get you within range of an appropriate dielectric for your subsurface conditions. There are ways to calibrate it further in the field with focus and set depth.

Depth/Time Range: See Vertical Scale above for details.

Samples/Scan: Multiply your Time Range by 10 and divide by 2.5. Use a Samples/Scan set higher than this value. If your Vertical Scale is set to Depth, toggle it to Time to see this value. Feel free to switch it back after.

Scans/Second

- For **Collect Mode – Time:** This is your data collection speed. Calculate this value by considering how many scans/ft or scans/m traveled are required to resolve your targets, as well as your movement speed. A good default is 50 scans/second.
- For **Collect Mode – Distance and Point:** Set this as high as possible. The higher this number is, the faster you can survey.

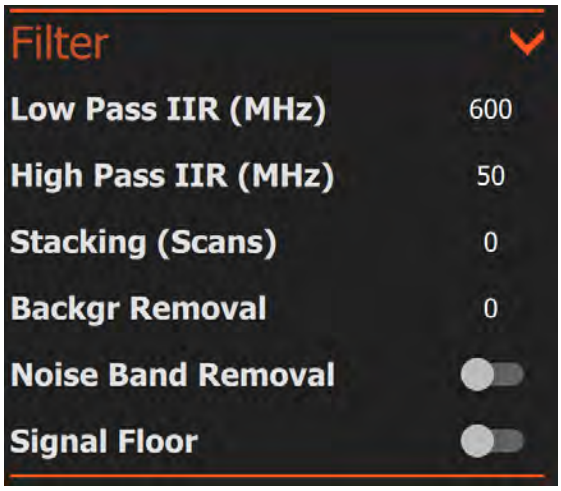
Scan Density

- For **Collect Mode – Distance:** This is your horizontal data density. A good starting value is 12 scans/ft or 50 scans/m.
- For **Collect Mode – Point:** This will control your horizontal scale display. It's not required but if you are aware of how far you will move the antenna during each file collection you can set this to display the horizontal scale accurately.

Scans/Point

- For **Collect Mode – Point** only. The higher this value is, the cleaner your data will be. However, note that higher values will slow down your data collection speed. A good starting point is 512 samples/point.

In the Filters Area



Low Pass/High Pass Filters: These filters are crucial to reducing external signal interference in the field. Without any filtering, the antenna's receiver will record anything in the frequency range of radiation that it encounters. By applying an IIR frequency filter, you can filter out any frequencies **outside the** range specified. For the 200MHz antenna, the frequency range of interest is around 50 – 600MHz. The High Pass allows anything *higher* than the entered frequency to stay in the data, and the Low Pass allows anything *lower* than the entered frequency to remain in the data.

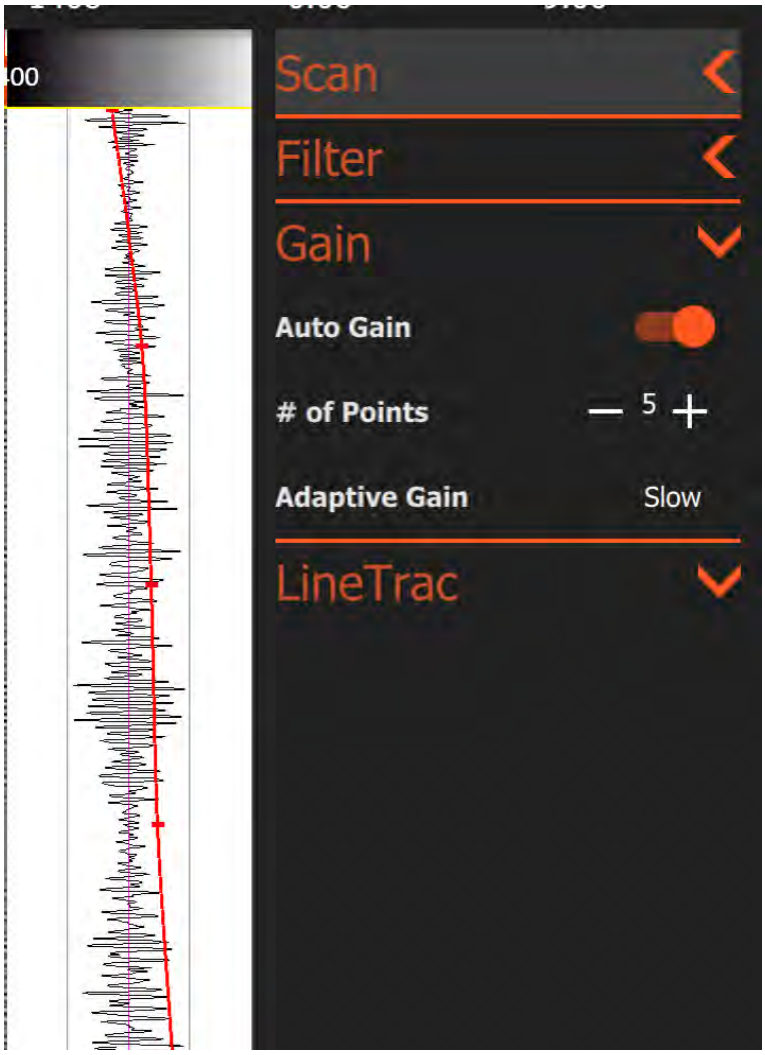
Stacking (Scans): This is optional. It can help reduce the amount of noise visible in data. If you decide to use it, smaller values are crucial. Large stacking values will cause scans to average to the point of erasing targets of interest. GSSI recommends a stacking value between 3-11 if you choose to use the stacking function.

Background Removal: This is an optional filter that can help to remove external low-frequency noise and may improve target visibility in high dielectric, wet, and/or conductive materials. The background removal filter removes any reflector that appears for **more** than the input scan value at the same time, depth, and amplitude across scans. External low-frequency noise often manifests as horizontal banding, and conductive materials can produce a fair amount of ringing or horizontal banding. This filter removes horizontal banding that may be overprinting features of interest. GSSI recommends a scan value of at least 100-200 scans to prevent erasing features of interest. A good rule of thumb is to set this filter to a value greater than your target length times your scans/ft or meter. Using very large values may cause a lag in data population on the screen, as the system must record the number of scans input before displaying the filtered data.

Noise Band Removal: This is also an optional filter. Enabling Noise Band Removal applies a smart background removal that is weighted to remove horizontal banding while minimally impacting hyperbolic targets.

Signal Floor: This is also an optional setting. When Signal Floor is turned on a green field is overlaid on the Linescan display. This green field is an estimate of the effective depth of each scan based on an analysis of the noise to signal loss (attenuation).

In the Gain Area



Auto Gain: Auto Gain causes the system to re-initialize and adjust the time-variable gain curve based on the current scan and the selected number of gain points. This is useful if you find that your data is clipped (over-gained) or too weak to see (under-gained) over a particular section of your survey area. Just place the antenna on the area where the data is clipped or weak and turn Auto Gain off and then back on again. This will cause the system to reset the gains to a lower level to prevent clipping or a higher level to strengthen weak reflections. If Adaptive Gain is off and then you turn Auto Gain off, you can manually adjust the gain curve. Use the # of Points setting to add or delete points along the gain curve. Modify the Gain Value (in dB) applied to each point by increasing or decreasing the value. Toggle between points to adjust by using the Current Point # setting. Point 1 will be at the top of the scan, and points will be counted consecutively down the scan. It is recommended to have your O-Scope view open while adjusting gains so you can see how the waveform is impacted by increasing or decreasing gain values.

Adaptive Gain: If adaptive gain is toggled on, a gain compensation algorithm designed to counteract attenuation will be applied. The algorithm factors in ground conductivity and the dielectric constant to edit the gain curve and accentuate targets. No adjustments can be made to adaptive gain.

Control Bar

Once you enter Collect mode or open a previously recorded file in Playback mode, the Control Bar will appear along the bottom of the screen. It contains functions that you will access while collecting or reviewing data.

The Back Arrow ( ): Tapping this will return you to the collect/playback screen. This is not available while you are actively collecting data.

Contrast ( ): Tapping this will show the display gain and color table controls. Shallow, level, and deep will manipulate the display gain while color table, stretch, and slide adjust the distribution of colors within a particular color table. You can hide this menu by tapping Contrast again while open.

- **Level:** This control will increase (brighten) or decrease (dim) the display gain in increments of 3 dB. Changes here will apply to the entire vertical scale. Changes to the display gain level are not saved with the DZX file and are for display purposes only.
- **Shallow/Deep:** These control the display gain for the top or bottom 50% of the time range only. They are useful if you want to brighten/dim only the top or bottom half of your data.
- **Color Table:** Use the carousel wheel or +/- buttons to select from 31 different color tables. The color distribution is shown in the color bar above the numerical selector. Positive amplitudes will be assigned the color on the right, negative on the left, and zero amplitude will be at the center.
- **Stretch:** This control allows you to use a single-color palette to accentuate different portions of the amplitude scale. Setting this to 1 will compress more colors near to zero amplitude which will accentuate weaker reflections. A setting of -1 will compress color values at the positive and negative extremes and show more differentiation for higher amplitude reflections.
- **Slide:** Shifts the center of the color table associated with zero amplitude in either the positive or negative direction. This can help to accentuate either the positive or the negative values.

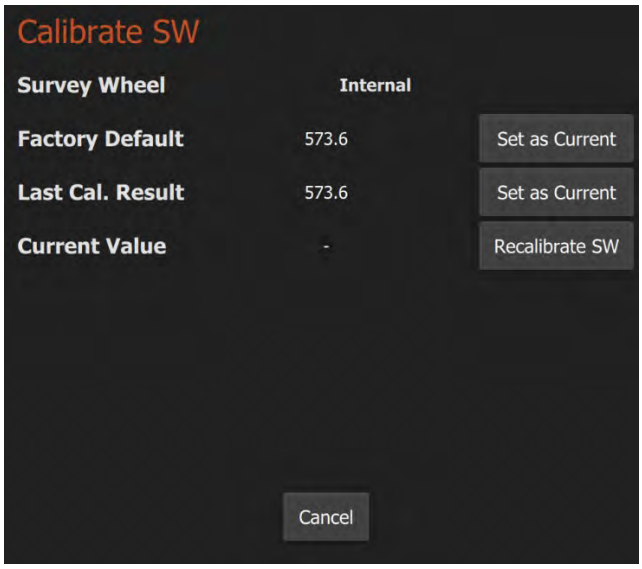
Calibrate SW( ): The calibrate survey wheel icon will only be visible when you pause the data preview in collect mode or pause while actively collecting a data file. Once selected you will have the option to use the factory default survey wheel value, use the last calibration value, or recalibrate the survey wheel. There is no need to calibrate the survey wheel if you are collecting data in time or point mode.

To recalibrate the survey wheel:

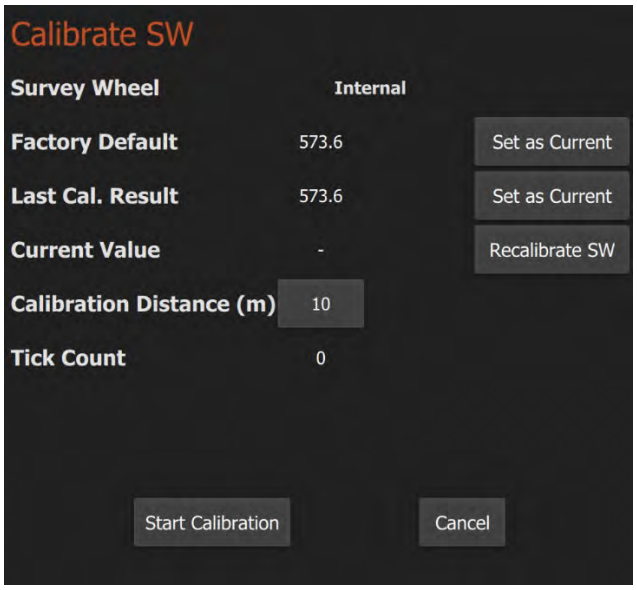
1. Select **Recalibrate SW**.
2. Set the desired calibration distance.
3. For Imperial units the distance options are 5, 10, 15, 30, or 100 feet.
4. For metric units they distance options are 1, 5, 10, 15, 20, or 30 meters.
5. Press **Start Calibration**.
6. Move the system the desired distance (it is helpful to mark out the distance on the ground, or to walk alongside a measuring tape).
7. Press **Stop Calibration**.
8. Press **Accept**.

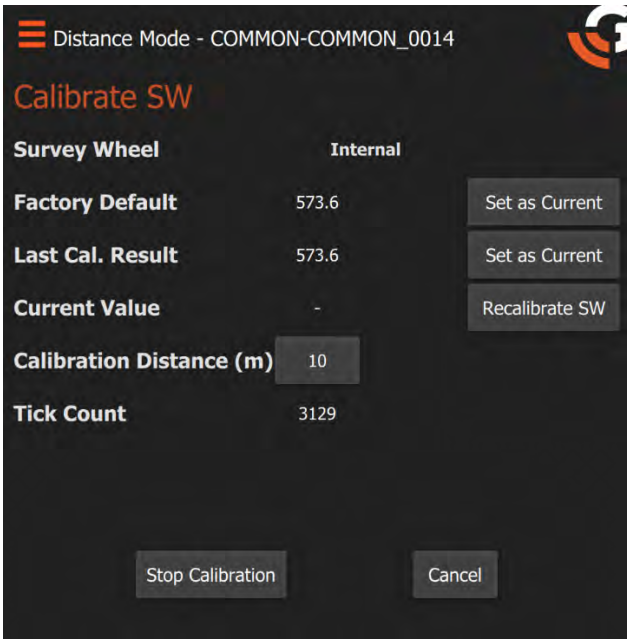
You can check the accuracy of your survey wheel calibration by collecting a data file and walking the length of your calibration distance, then looking at the distance readout in the top right of the collection screen. If the distance is the same as your calibration distance, you have successfully recalibrated. If the distance is drastically different than your calibration distance, it is recommended that you recalibrate the survey wheel again.

1

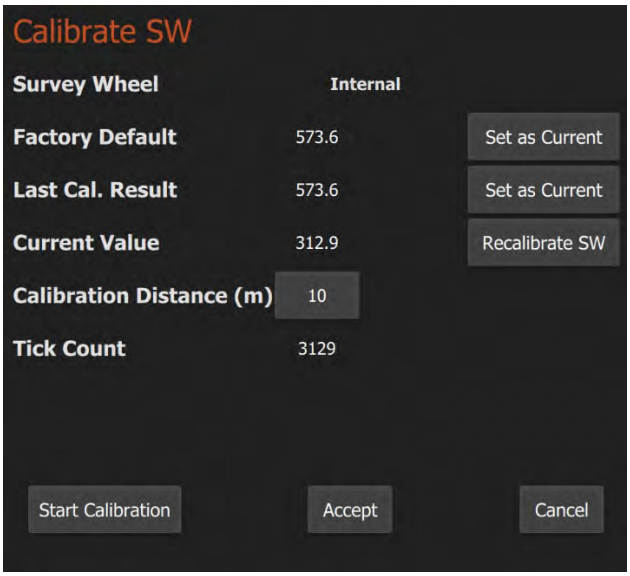

Calibrate SW
Survey Wheel
Internal
Factory Default
573.6
Set as Current
Last Cal. Result
573.6
Set as Current
Current Value
-
Recalibrate SW
Cancel

2


Calibrate SW
Survey Wheel
Internal
Factory Default
573.6
Set as Current
Last Cal. Result
573.6
Set as Current
Current Value
-
Recalibrate SW
Calibration Distance (m)
10
Tick Count
0
Start Calibration
Cancel



3

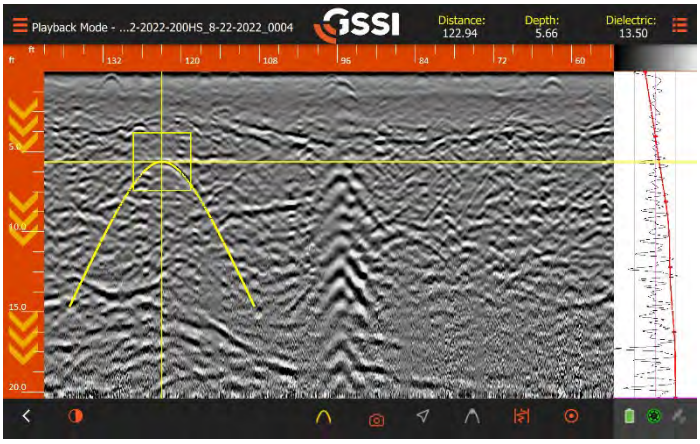


4

Set Depth ( ): This feature is used to calibrate your dielectric value and vertical depth scale when you have a target of a known depth. This is also known as “ground truthing” and can result in very accurate depth calculations in homogenous ground conditions. You must first collect data crossing the object of known depth. Then back the system up or move it forward so the vertical cursor scrolls horizontally through your data until it is bisecting the target of a known depth. Drag the crosshairs down until they are centered on the target. Press the ( ) icon and adjust the depth scale until the horizontal bar intersects it at the correct depth value of the target. The dielectric value will automatically adjust as the depth scale is changed.

3D Grid Collection ( ): The 3D Grid Collection icon will only be visible when you pause the data preview in collect mode. Selecting the 3D icon will display the 3D collection module. Here you will enter your 3D collection parameters, including grid dimensions, line spacing, and collection direction. The 3D grid image will tell you where to begin collection and what line you are collecting.
Once the antenna is centered over the starting coordinate press the red record button. This initiates data collection of Line 1. Data will start collecting when the survey wheel starts moving in a forward direction (or whichever direction was used during SW calibration), and you will see the line progress across the screen. After traveling the distance that you specified in 3D Setup, the system will automatically stop collecting data. The file will save, and the system will automatically increment to the next line.

- The X spacing can be different from the Y spacing, but the spacing must be regular.
- You cannot start your grid and change your line spacing interval part way through the grid to a different interval.
- If you need to recollect a line, use the previous line and next line buttons (/)to navigate to the correct line to recollect.
- Use the View icon ( ) to toggle between different views during 3D collection.
- You can view your grid in Playback mode after it has been collected. For more information on viewing a 3D grid in Playback mode, see “Playing Back Data” section below.
- **Set Dielectric ( ):** This feature allows you to calibrate the dielectric value and depth scale using hyperbola fitting. Hyperbola fitting measures the geometry of visible hyperbolas in the data to generate an estimated dielectric constant using a process called migration. Different dielectric values cause different dispersion angles, which impact the width of hyperbolas displayed in data. Using hyperbola fitting to measure the shape of a hyperbola in your data allows the GS Software to back calculate velocity of the radar energy and the resulting dielectric value. Having an accurate dielectric value also results in a calibrated depth scale and more accurate depth read-outs.



- To use Set Dielectric, align your vertical cursor so it bisects a hyperbola in your data and pull the horizontal cursor down to the apex of the hyperbola. Tap the Set Dielectric icon, which will cause a yellow hyperbola to appear at the intersection of the vertical and horizontal cursor. Use your finger to drag the depth scale up and down to change the width of the yellow hyperbola until it fits perfectly around the hyperbola in the data. Press the Set Dielectric icon again to save the resulting dielectric value and close the hyperbola fitting tool.

Take Screenshot ( ): Tapping this control will save a screenshot of the current display. Screenshots are attached to the file that was being collected when they were taken. They are stored in the project folder with the file.

Open Map View ( ): This control displays the current location from a series of pre-loaded map files. If you are collecting data using GPS, the map will display your collection path and any user marks or

target picks in real time. Tapping the map view icon multiple times toggles through the three available map screen display sizes. Instructions for pre-loading map files can be found in Appendix D.

Focus Mode ( ): Focus mode is a display filter that will perform a migration process on your data. The migration will collapse any hyperbolas present in the data, including all the +/- amplitude bands of the reflection. This is intended to assist in calibrating the dielectric constant. Once the button is tapped, you'll be able to pinch the screen to increase/decrease the dielectric constant to better "focus" your targets. A successful migration will result in the hyperbolic features being focused into dots.

O-Scope Display ( ): Toggling this control will display the oscilloscope view at the right edge of the data screen. The O-Scope scale matches the vertical scale of the linescan profile and displays the data one scan at a time. The center vertical line denotes zero amplitude. Positive amplitude values are to the right and negative are to the left. The red line superimposed on the scan is a representation of the time variable gain curve. Gain point locations are noted with red dots.

Mark ( ): Tapping this icon places a vertical dashed line (user mark) at the antenna's current position. This can be useful for noting a target's location, areas of interest, or to distance normalize a file collected in time-mode. Double tapping the mark icon will open a target marking tool. You can select the color and size of the mark applied to your target. Ensure that the vertical cursor is bisecting the feature of interest by backing the system up or moving it forward so it scrolls horizontally through your data, then drag the crosshairs down until they are centered on the feature. The target mark will be placed in the center of the crosshairs. Turning Multiple Targets to ON in the target menu will keep the menu on the screen during data collection for easier target marking. If using a GPS, all user marks and targets will be reflected on the collection path in Map Mode.

Status Bar

The three icons at the lower right corner are status indicators. They are for display only and tapping them will not open any control items.

Battery Status: Indicates remaining battery life of the antenna battery. The level will progress from green to yellow to red as the battery drains.

Overspeed Indicator: This is active when you are collecting in distance mode with a survey wheel. There is a maximum rate at which the system can collect data with respect to certain parameters. If you move the antenna too fast, the system will not have time to collect and store the required scans, and data loss will result. Any rate up to the maximum will produce valid data. The speed indicator will change from grey, to green, to yellow, to orange, to red as you approach the maximum speed possible.

GPS Data Validity: The color of this indicator reports the GPS signal quality and is based on HDOP (Horizontal Dilution of Precision). Green is the highest with the GPS reporting a high-quality fix on many satellites. Yellow shows that the data is still adequate for positioning but that the accuracy has suffered. Red means that there are not enough satellites for a proper fix and that the GPS data is invalid.

Collecting Data

This section will describe how to begin collecting data, how to adjust settings while collecting. It will also describe how to save a file and collect a new one.

1 To start data collection, press the Record icon ( ) on the bottom center of the screen. Your file name and number will be displayed at the top of the screen. When you hear a beep, the system is ready to collect.

2 Data will begin to scroll right away if in Time Mode. If in Distance Mode, data will appear when the survey wheel starts to spin.

- If you encounter a feature of interest while collecting, you can reverse the system until the yellow vertical cursor is bisecting the feature. You can then use your finger or the stylus to drag the yellow box until the crosshairs are centered on the feature of interest to get a depth readout in the upper right corner of the collection screen. If you would like to apply a user mark or a target pick to the feature, use the Mark button ( ) on the bottom Control Bar (more information in the Control Bar section above). Note that no additional data will be collected until you push the system forward so that the vertical cursor is at the edge of the collection screen.
- If you are collecting data with GPS, you can see your collection path in real time by selecting the Map Mode icon ( ) from the control bar (more information in the Control Bar section above, instructions on connecting to an external GPS can be found in Appendix A, and instructions on pre-loading base maps can be found in Appendix D).
- If you are collecting a 3D Grid ( ), more information can be found in the Control Bar section above.

3 While collecting data, the Record icon ( ) will become a Stop icon ( ). Pressing this button will stop the file and ether save it automatically (Save Prompt = OFF) or ask you to save or delete (Save Prompt = ON). After you have stopped collecting a file, simply select the Record icon ( ) again to begin another file.

4 The icon next to Record/Stop is the Pause/Resume button. Pressing this will allow you to pause data collection and move the antenna to a location where you intend to resume data collection. When you are in position, press Resume ( ).

5 To return to the scan preview screen, press Stop ( ), then press the Resume button.

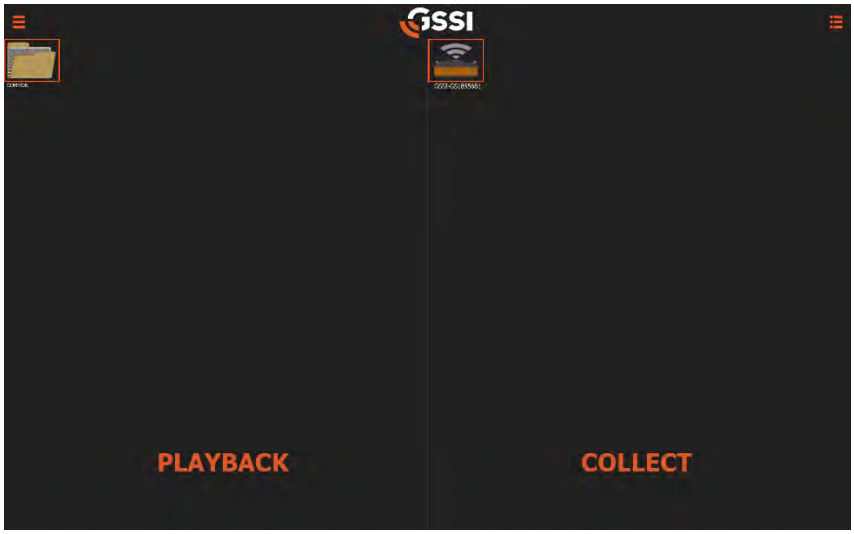
6 The Control Bar at the bottom has all the same functionality as it does during setup. For more information, please refer to the Control Bar section above.

7 Pressing the right File Stack icon will allow you to adjust the vertical scale by changing the dielectric constant. Please note that changing the dielectric will result in the depth scale adjusting, but your signal penetration will not go any deeper or shallower. To collect deeper data, you will need to stop data collection and adjust depth/time range in the Setup screen.

You also have full access to filters and gain adjustments during data collection. Please refer to the Setting Up for Data Collection section (above) for more details.

Playing Back Data

This section will describe how to play back data that have already been collected.



1 Playback is available when the application is opened, or by selecting the white back arrow in the bottom left of the collection screen.

- On the Playback/Collect screen, you will see all the project folders containing data on the left side.
- Tapping **once** on a folder will open a file browser. Your files will be organized in three areas:
  - Data collected Today
  - Data collected in the last two weeks
  - Older files
  - In each section they will be further organized from left to right, where left is the newest data in that section.

2 Tap the file(s) you would like to see and press the Play button ( ) to playback the data.

- The 2D data will scroll along the screen. If multiple files are selected, one file will be displayed at a time. To display the next file, you will need to press the Stop icon, then the Play button to playback the next file.
- To play back a 3D file, select the appropriate grid file from its folder and press Play. Once loaded, you can slice up and down the grid's z-axis to display data at different depths by using the slider on the left side of the screen. You can use the + / - on the slider to make slices thicker or thinner. Use the Contrast setting on the control bar to change your 3D grid's color table.
- While the file is playing back, you have full access to dielectric adjustments and gain/filters. This will allow you to perform basic processes on your data for reports and target detection in

the field. You can also utilize functions found on the Control Bar, including changing the Contrast settings, applying user marks and target picks, taking screenshots, and Map Mode.

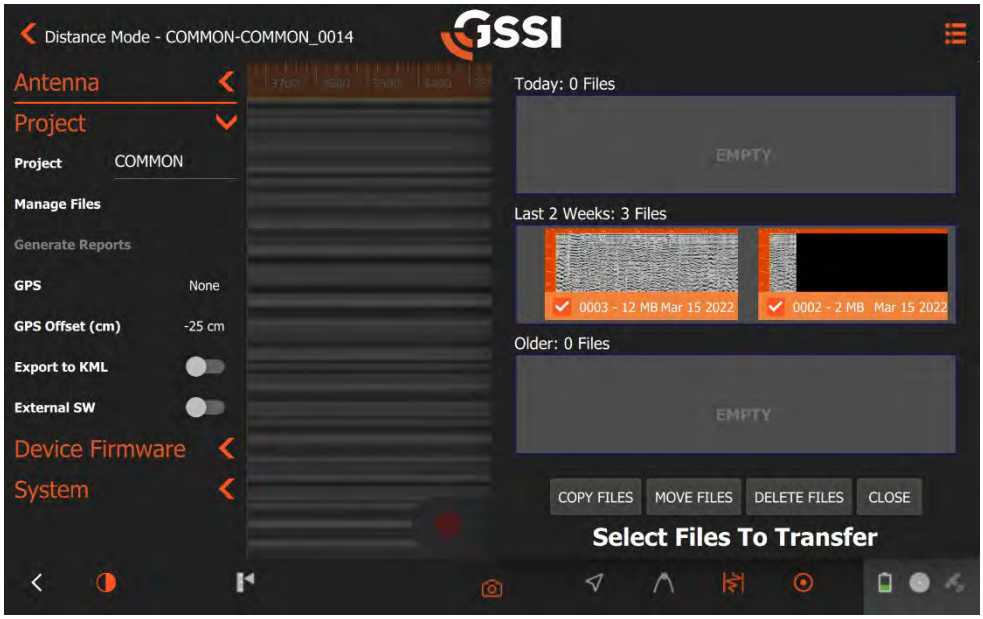
- For more advanced processes, the data will need to be transferred to a PC with GSSI's RADAN software. Please refer to our website or your direct GSSI sales associate for more information on RADAN.

File Maintenance and Data Transfer

This section describes the transfer of data from the tablet to a PC for processing and interpretation, and also how to clear unwanted data from the system's memory. These functions are accomplished under the Global Menu Stack using Manage Files.

1 To transfer data, open the menu stack and tap **Manage Files**.

2 The Manage Files section will open on the righthand side. Select the folder you would like to transfer from and select your files. You can also transfer an entire folder by adding a check next to the desired folder.



- **Copy Files** will copy selected files to a USB while keeping them on the device. (Recommended)
- **Move Files** will move selected files to a USB and delete them from the device.
- **Delete Files** will delete the selected files.
- **Close** will bring you back to the project folder select screen.

3 Make sure to insert a USB before selecting Copy/Move Files. Any screenshots taken of your file will transfer with the GPR data.

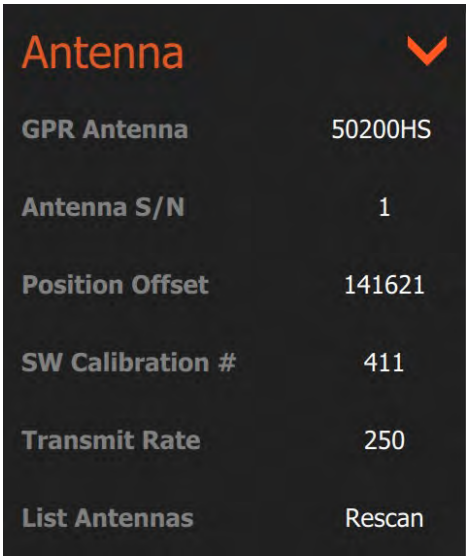
Overview of Menu Items and their Functions

This section assumes that you have either connected to an antenna and are in Collect mode or have opened a previously recorded file in Playback mode. Any menu items that cannot be accessed in the current mode will be grayed out.

The Global/Project Menu Stack 

Tapping the collapsed menu icon in the top left will open the Global Stack. This grouping of items provides general system information as well as parameters which generally do not change during a single survey or job. This menu also contains collapsed submenus. Expand these by tapping the left-pointed arrow next to each section heading.

Antenna



This section contains information specific to the individual antenna that is connected. Much of this information is read from the antenna and cannot be changed.

GPR Antenna: The antenna model currently connected or used to collect the played back data. This can only be changed by connecting to a different antenna in the Collect/Playback screen.

Antenna S/N: The serial number of the antenna currently connected or used to collect the played back data.

Position Offset (pS): The internal antenna time delay (in picoseconds) from the system's absolute time zero to the generation of the trigger pulse in the transmitter. This is an internal system parameter that is a factory setting and cannot be edited.

SW Calibration #: The survey wheel calibration value is displayed here if using an internal survey wheel to measure distance. This is not an editable field; it only displays the calibration value input for the survey wheel. You will calibrate your survey wheel while in Collect Mode using the Calibrate SW option located on the Control Bar (see Control Bar section above for survey wheel calibration instructions).

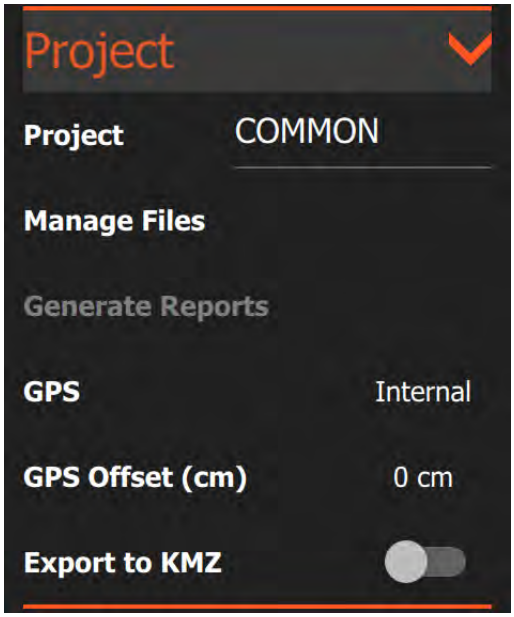
Ext SW Cal #.: The survey wheel calibration value is displayed here if using an external survey wheel. This is not an editable field; it only displays the calibration value input for the survey wheel. You will calibrate your survey wheel while in Collect Mode using the Calibrate SW option on the Control Bar (see Control Bar section above for survey wheel calibration instructions).

Transmit Rate: GPR operates by sending out pulses of energy. The transmit rate is the number of thousand pulses per second (kHz) that the antenna is emitting. This value is set at the factory to the maximum transmit rate allowable according to the regulations of the destination country specified at the time of order.

List Antennas: Tapping Rescan will cause the software to display the list of currently transmitting and detected antennas.

Project

This section allows you to manage reporting outputs, transfer/delete data, and load base maps to use with GPS.



Project: Tapping the current project name will open a browser which enables you to create a new project or switch to an existing one. New data files will be saved into that project folder and the root name of those files will be the same as the project name.

Manage Files: Tapping this option will bring up a list of project folders containing data files. You can browse these to select files for copying or deletion. See the section of this guide on data transfer and file maintenance for more details.

Generate Reports: Tapping this option will create a survey report of data already collected. To access this feature, you will need to be in Playback Mode. You will also need to tap the pause button when you have the image you want in your report on the screen even if the file is completely displayed already. Tapping Generate Reports will create a preset report including an image and your RADAR parameters. This report is placed in your Project folder under Reports as an .html file.

GPS: Toggles your choice of GPS between None, 'G2-GPS' for the Panasonic G2's internal GPS, 'Internal' for the HS Module's integrated GPS, and any external GPS units that have been previously connected via Bluetooth. See Appendix A for details on connecting a third-party GPS to the system.

GPS Offset (cm/in): This is the distance that your GPS is offset from the GPS threading on the top of the antenna. See Configuring One-Time and Global Settings section above for GPS Offset information.

Export to KMZ: If collecting data with a GPS attached, you can toggle the **Export to KMZ** option on to have a KMZ file of your collection path saved along with your data file. The KMZ file will display the location of your collection path as well as location and depth information for any target picks or user marks applied during data collection. For more information about using the **Export to KMZ** function, see Appendix B.

External SW: Toggle External SW on if you are using an external survey wheel to collect data in Distance Mode. Be sure to calibrate your survey wheel if connecting an external survey wheel to the system for the first time to ensure that distance is recorded accurately (see Control Bar section above for survey wheel calibration instructions).

Device Firmware

Items in this menu section list important details about your system's hardware.

Device Configuration: This option allows you to run several subapplications. Tapping Open will bring up a browser to access several different connectivity options.

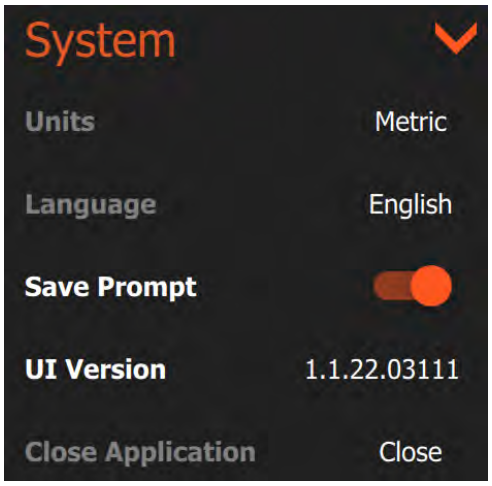
Firmware Update: This pushes a firmware update to the antenna. Firmware is the name for a series of programs which control the various components on the HS Module attached to the antenna. Firmware is different from the UI (user interface) version which is the software that runs on the tablet. The current firmware version is displayed in the "Firmware" section of the Device Firmware menu.

Model: This lists the model number for the HS module.

Serial Number: This lists the HS Module's serial number.

Version: The firmware version number. GSSI publishes occasional updates. Please see Appendix E for instructions on updating firmware.

System



Units: Set the units as either Imperial (Feet) or Metric. This option is only available when accessed from the Collect/Playback screen.

Language: Choose your desired display language from the available options. This option is only available when accessed from the Collect/Playback screen and may require the software to restart.

Save Prompt: Enables the save prompt when you close a data file. If this is off, the software will save your data file by default when you close it. If turned on, you will be asked if you want to save the data after collecting a file.

UI Version: UI stands for User Interface. This is the software that runs on the tablet. GSSI publishes occasional updates to this software. The currently loaded UI version is displayed. Please see Appendix E for instructions on updating your tablet's UI.

Close Application: Tapping **Close** will exit the software and return you to the Windows desktop. Note that when you are in Collect preview mode or are actively collecting a file you will not be able to close the application. To do so, select the back arrow in the bottom left to return to the Playback/Collect screen and then close the application.

The File Parameters Menu Stack 

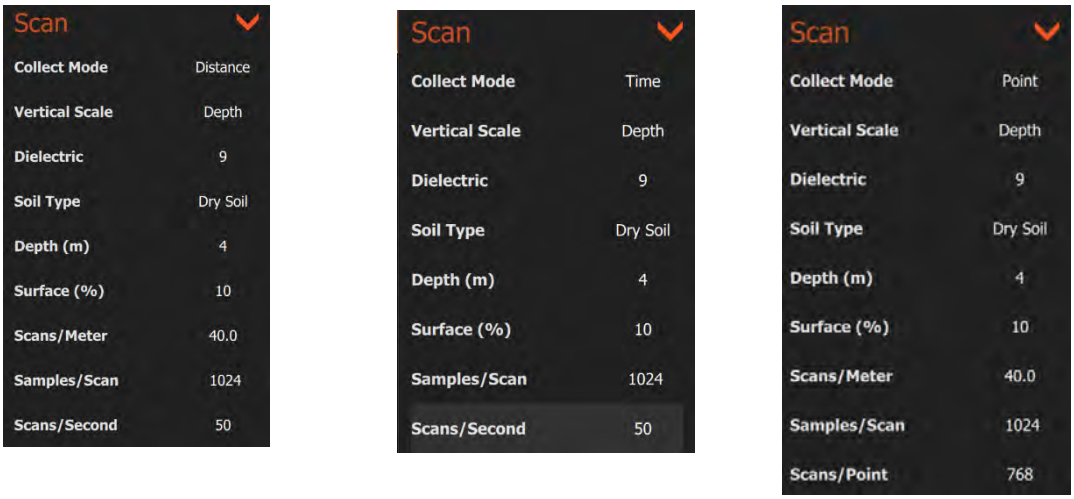
Tapping the collapsed menu icon in the top right will expand the file parameters (hereafter just called "file") menu stack. The items in this menu change settings which affect individual files during collection and playback. These items can also be changed between file collection during a single survey. This menu stack contains four submenus: Scan, Filter, Gain, and LineTrac (Note: LineTrac is not an available feature for the 200HS antenna). You can expand the menu stack by tapping the right arrow next to each of the three items.

Scan

The Scan menu controls collection mode, time/depth settings, and data density. These settings are "hard coded" into your data file and cannot be changed in post-processing, apart from dielectric and scans/unit.

Collect Mode: The available options in the scan menu will change depending on whether you are collecting in Time, Distance, or Point collect mode.

- **Time:** For collection without a survey wheel encoder. In time mode, enter the desired scans/second. The GPR will record data at this rate regardless of how fast the antenna is physically moved over the ground surface. Moving the antenna slowly results in more dense data collection. Data collected in time mode may need to be distance normalized in post-processing software such as RADAN. GSSI recommends that you place a user mark at constant distance intervals since these marks will be required for the distance normalization process. Please refer to the section on data collection for more information about marks.
- **Distance:** For collection with a survey wheel encoder. The important variable here is scan density (scans/unit). Scan density controls the number of scans per foot or meter that you collect as you move the antenna. The speed with which you move the antenna is not a factor. Generally, you will want dense data collection as you can always stack or remove data in RADAN post-processing.
- **Point:** For collecting single scans with a stationary antenna. This mode is best for very uneven terrain or for situations where you want to maximize depth penetration by collecting multiple scans and averaging (stacking) them at a single location. You will notice that the data display view changes from Linescan profiles to Wiggle trace where the waveform of each individual scan is shown. The important variable is scans/point. This controls the number of averaged scans at each given location to create a single recorded scan. The higher the scans/point value, the more averaging will take place and the potential for depth penetration will increase since the signal to noise ratio may improve. Note that a high scans/point value may slow down data collection speed.



Scan menu showing different options by Collection mode

Vertical Scale: Toggles the option from Time to Depth. When set to time, the vertical scale is displayed in nanoseconds (ns). This represents the two-way travel time from antenna transmission to recording of the reflected energy. When set to depth, the vertical scale is displayed in the desired depth units and the GPR software will perform a conversion calculation from time to depth using the input dielectric value. The accuracy of this calculation depends on your inputting an accurate dielectric.

Time Range: This option is only visible if the vertical scale is set to time. This parameter is expressed in nanoseconds (ns) and controls the time the GPR will "listen" for reflections from the subsurface. This represents two-way travel time (TWTT). Increasing this value allows for deeper penetration if soil conditions permit. Tapping on the value allows you to change in steps from 50 to 500 ns if collecting 512 Samples/Scan, or 50 – 1000 ns if collecting 1024 Samples/Scan.

Dielectric: This value represents the ratio of the velocity with which GPR energy travels through a given material when compared to a vacuum. The lower the value of a material's dielectric, the faster GPR energy will move through it. The dielectric value is only used to convert two-way travel time to depth. Although the vertical scale (when set to depth) will appear to change when you change the dielectric, GPR energy is still penetrating to the same time-depth regardless of what value is entered. Changing this to match the assumed dielectric of the actual ground will result in a more accurate time to depth calculation. This value can be modified when playing back data or in the RADAN post-processing software. Please see Appendix C for a detailed discussion of dielectric.

Soil Type: This option is only visible if the vertical scale is set to depth. Soil type allows you to rapidly change the dielectric to a preset value based on the published dielectric constant associated with that material type. Choose the one which most closely matches your survey conditions.

Depth: This option is only visible if the vertical scale is set to depth. Changing depth will change your depth of investigation by changing the time range (hidden). Depth accuracy is dependent on correctly setting the dielectric value.

Surface (%): Surface (%) refers to the position of the viewable scan with respect to the antenna's direct wave. The direct wave is the first instance of the receiver seeing the transmitted signal and corresponds to the ground surface. There may be situations when you want to view a portion of the scan before the direct wave. Shifting the surface % in the negative direction will move the direct wave farther down the window. The Surface (%) value entered represents a percentage of the full-time range. For example, entering a value of -10 while collecting with a time range of 100ns will shift the direct wave down by 10 ns.

Scan Density (Scans/Meter or Scans/Ft): This refers to the number of scans collected within a unit of distance. This option is only visible if the collect mode is set to distance. Increasing your scan density will result in more scans being stacked next to one another and therefore causes the data to be exaggerated on the horizontal scale. A lower scan density will cause the data to appear more horizontally condensed.

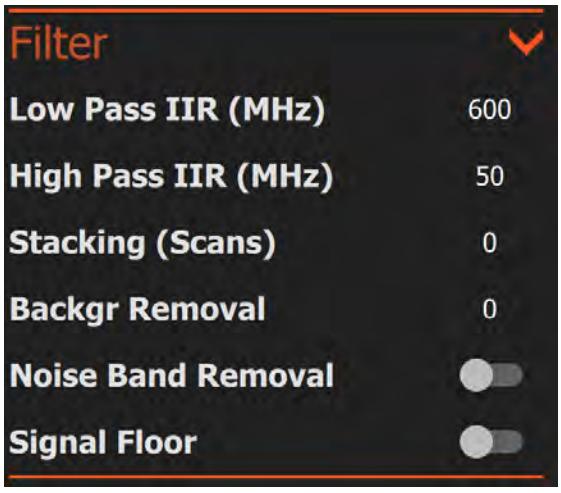
Samples/Scan: Each scan trace is made up of individual samples. You can think of samples as the "dots" that make up a "line." Samples are collected along each scan recorded by the antenna's receiver. The amount of samples/scan can affect your vertical resolution, as the number of samples essentially represents the number of datapoints collected along each scan. Inputting a Samples/Scan value that is too low risks recording a signal with poor resolution. Inputting a Samples/Scan value that is too high will result in slower collection and larger files sizes for no practical benefit. For a 200 MHz antenna a good rule of thumb is to multiply your time range by 10 and then divide by 2.5. Set your sample density to the next step higher than the result.

Scans/Second: Refers to the maximum number of scans each second that are available to record. This value is the functional limit of your collection speed and should be set as high as possible. It will vary according to the interplay of your samples/scan and transmit rate.

Scans/Point: This option is only visible if the collect mode is set to point. This parameter controls the number of scans collected and averaged into a single recorded scan at each given shot location. The higher the number, the more averaging that takes place. More averaging, if subsurface conditions permit, may result in deeper penetration.

Filter

This section contains controls for different horizontal and vertical filters used to remove noise from your data. These filters impact display only and their use does not permanently alter your collected data. The filter parameters are saved to a DZX file, which is parsed by RADAN when you open your data file in the software. RADAN will apply the settings you have input during collection to the open file but will also retain a raw data file that you can manually process with different settings.



Low Pass / High Pass IIR (MHz): IIR(Infinite Impulse Response) frequency filters are designed to help remove external noise from your data. The 200MHz antenna's HyperStacking technology is already very effective at removing noise, but these filters can assist in additional noise reduction. The low pass (LP) and high pass (HP) serve as the effective cutoff values of the frequencies displayed in your data. The low pass (LP) is the higher of the two values and allows all frequencies *lower* than the entered value to be displayed in the data. The high pass (HP) is the lower of the two values and allows all frequencies *higher* than the entered value to be displayed. IIR filtering can be used to isolate areas of the recorded frequency spectrum. It is not recommended to set your IIR LP or HP so that it cuts off the antenna's center frequency while collecting data, since the center frequency contains most of the antenna's signal strength. Conservative IIR inputs are typically a low pass of 2-3 times the antenna's center frequency and a high pass of ¼ - 1/3 the center frequency.

Stacking (Scans): Stacking is a high-frequency noise reduction filter that operates in the horizontal direction. The Stacking filter input is in number of scans. Each new scan has a 1/n influence in the data (with n representing the number of scans entered as your stacking value), so this filter tends to smooth high frequency targets and accentuate low frequency horizontal features, like layers. As the number of stacked scans (n) increases, the influence of each new scan drops.

- High frequency noise generally has a 'snowy' appearance.
- The larger the stacking value, the smoother the data will be. It is possible to over smooth and 'smudge' out real data. It is recommended to use a stacking value between 3-11. Using a stacking value that is too large (>15 scans) can cause data to become washed out and obscure targets.
- A larger stacking value also means that the system is performing a great deal of extra calculations and data collection speed may be reduced.

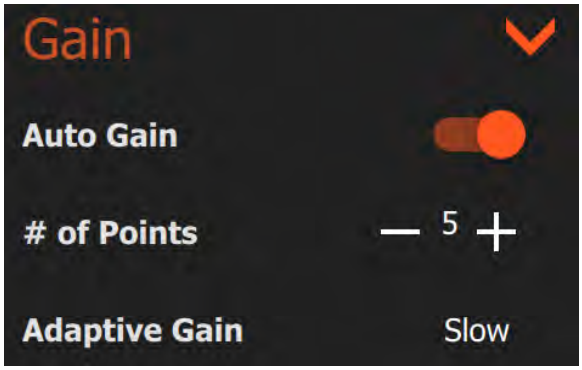
Background Removal: Background Removal is a filter which removes horizontal bands of noise. Sometimes these bands are caused by 'real' horizontal reflectors, but they can also be caused by low frequency noise such as antenna ringing or by poor soil conditions. These layers can obscure other 'real' horizontal or point source reflectors. Filter length should be set to the number of scans equal to the feature length to be removed. Any continuous feature within the data, such as a water table reflector or a stratigraphic boundary between two soil types, may also be filtered out by performing Background Removal. Be careful; it is easy to filter out desired reflectors. The Background Removal filter input is in number of scans.

- Determine the length in scans of the feature or noise that you want to remove from the data and input that number. Features, or horizontal reflections, of this size or larger will be removed.
- The Background Removal filter maximum value is 1023 scans.
- It is recommended that this filter be set last. When Background Removal is turned on, the previewed linescan data will gradually be averaged out by the filter and only noise will be visible. This makes it impossible to preview the effects of other filters prior to collecting a file.

Noise Band Removal: Toggles On/Off a horizontal band filter. This filter is designed to downplay horizontal noise artifacts resulting from wet or clayey conditions and is weighted to not impact hyperbolic features as much. This filter will also remove the direct wave from the top of the screen.

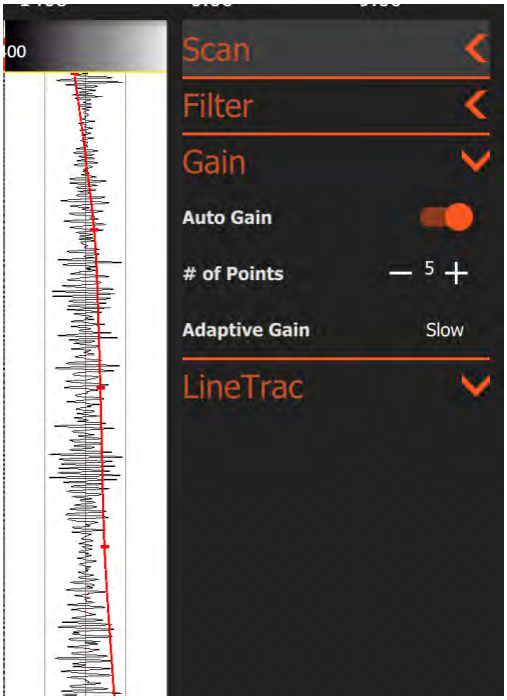
Signal Floor: When Signal Floor is turned on a green field is overlaid on the Linescan display. This green field is an estimate of the effective depth of each scan based on an analysis of the noise to signal loss (attenuation). Note: strong, real reflectors may still be located beneath the Signal Floor. This process does not affect the data being collected. It is a visual indication only.

Gain



Gain is the artificial addition of signal in order to counteract the natural effects of attenuation. As a radar scan travels into the ground, some of the scan is reflected, some of it is absorbed, and the remaining signal continues penetrating until it is completely absorbed in the medium. Therefore, as the scan gets deeper it also becomes weaker, causing signal attenuation. Gain counters the effects of attenuation by adding more amplification at different depths. No additional energy is sent from the antenna; gain works strictly with the received signal.

Gain operates on a number of points that are evenly distributed along the time scale. Deeper (later) areas will require more gain than shallower (earlier) ones. Since the amount of gain added varies with the point's position on the time scale, this process is often called "time variable gain" or TVG. Furthermore, the software only changes the gain amount at the gain points, so it is important to set an adequate number of points. In an area with complex stratigraphy, you may want more points than in an area with homogenous conditions. Opening the O-scope display will show the gain curve as a red line superimposed on the scan trace. The location of each point is represented by a small dot along the curve. Each successive gain point should be equal to or greater than the previous point.



Auto Gain: With auto gain turned on, the software will configure the necessary gain values automatically based on where the antenna is placed. You will want to make sure that the system is setting gains in an area of representative conditions, but not sitting directly on top of a feature of interest. If Adaptive Gain and Auto Gain are toggled off, you will be in Manual Gain mode.

# of Points: You can set any number of gain points from 1-8. These will be evenly distributed along the time scale. If 1 gain point is specified, it will be located at the top of the scan trace.

Current Point #: This option is only visible if adaptive gain and auto gain are turned off. If you wish to manually change the gain value associated with a single point, select that point using this control.

Gain Value: This option is only visible if adaptive gain and auto gain are turned off. Changing this will change the amount of gain applied at the currently selected point. A higher value will increase gain and brighten the region around that gain point.

Adaptive Gain: GSSI has developed a gain compensation algorithm that is designed to more accurately counteract attenuation. This is done by taking the conductivity and dielectric of the subsurface material into account. This helps accentuate targets with contrasting attributes from the surrounding material. For example, a clay lens in sand may be much easier to detect with this gaining method. For best results, specify a reasonably accurate dielectric in the scan menu for the material.

LineTrac: The LineTrac menu allows you to turn the LineTrac accessory on or off. The LineTrac accessory is not available for 200HS antennas.

Appendix A: GPS

The HS Module atop your GS Series antenna is equipped with an onboard GPS to make data collection with GPS coordinates even easier. The system is also capable of using an external Bluetooth GPS. An external GPS can be mounted directly to the antenna using the GPS mount accessory.

A.1: HS Module Onboard GPS Specifications

The onboard GPS uses the Neo-7 chip made by u-blox. The full specifications on this chip can be reviewed here:
https://www.u-blox.com/sites/default/files/products/documents/NEO-7_DataSheet_%28UBX-13003830%29.pdf

A.2: Connecting an External GPS

To connect to an external GPS, you will need to utilize the Windows Bluetooth & devices menu outside of the GS Software app.

1. If you have already launched the GS Software application, hold down the Windows key in the center of the bottom buttons on the Panasonic G2 tablet and navigate to the Windows icon in the bottom left corner of the screen. If you have not yet launched the application, you can simply tap the windows icon in the bottom left corner of the screen.
2. Navigate to the Settings menu (Gear icon), then select Devices (Bluetooth, printers, mouse)
3. Ensure that the tablet Bluetooth is toggled to **On** and that your GPS device is turned on and Bluetooth enabled.
4. If you have never paired your GPS with the tablet, select **Add Bluetooth or other device** and then select **Bluetooth**. This will search for devices available to pair and your GPS should be visible on the list. Select your GPS device in the list to pair it with your tablet.
5. If you have previously paired your GPS with the tablet, it will appear in the Paired Devices field. If you have multiple devices paired, select the appropriate one from the dropdown before continuing. Please note, you can only have a maximum of 5 devices paired.
6. Open the GS Software application on the tablet
7. Navigate to the Project menu to the GPS setting and select the correct GPS device.
8. Ensure that the GPS offset value is set correctly in the Project menu. Note that the GPS position offset is based off the threads that a GPS pole would be connected to on the antenna. If you are utilizing a GPS mounted on a pole using these threads, your offset will be zero. From this point, any GPS mounted closer to the front of the antenna will have a positive offset value, and anything toward the back of the antenna will have a negative offset value.
9. Connect to the appropriate antenna to access Collect mode.
10. Once in Collect mode, open the menu stack to ensure that the correct GPS unit is displayed in the GPS section of the Project menu.

You are now fully connected to the external GPS.
Please note that our system will only read the NMEA GPGGA or GNGGA strings from your external GPS. You may need to toggle these on manually within your external GPS settings.

Appendix B: Export to KMZ Function

KMZ files contain the location and attribute information for your collected data. These files can be opened in Google Earth, which will display the collection path and the location of any target picks or user marks applied while collecting or playing back the data. The KMZ file format will also store attribute information for each target pick and user mark, which is accessible by clicking on the target icons when opened in Google Earth:

For user marks, the KMZ will record:

- Scan number
- Latitude
- Longitude
- Distance along the collection profile
- A screenshot of the linescan data where the user mark was applied

For target picks, the KMZ will record:

- Type (color)
- Scan number
- Latitude
- Longitude
- Distance along the collection profile
- Depth
- Time Range
- A screenshot of the linescan data where the target pick was applied

Creating a KMZ File

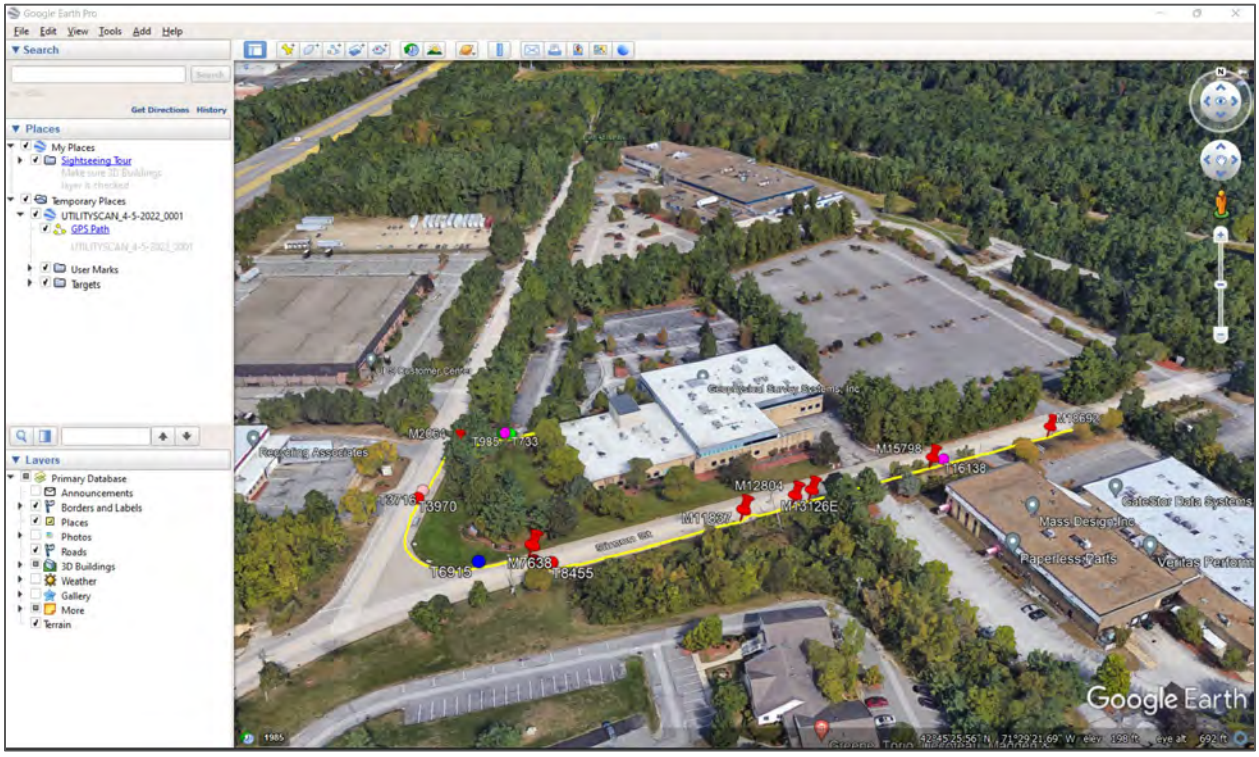
If the Export to KMZ setting is toggled on in the Project menu prior to collecting data, a KMZ will be automatically created for each file collected when you press the red stop icon to stop data collection. Note that the KMZ file will only contain location information if you are collecting data with GPS on.

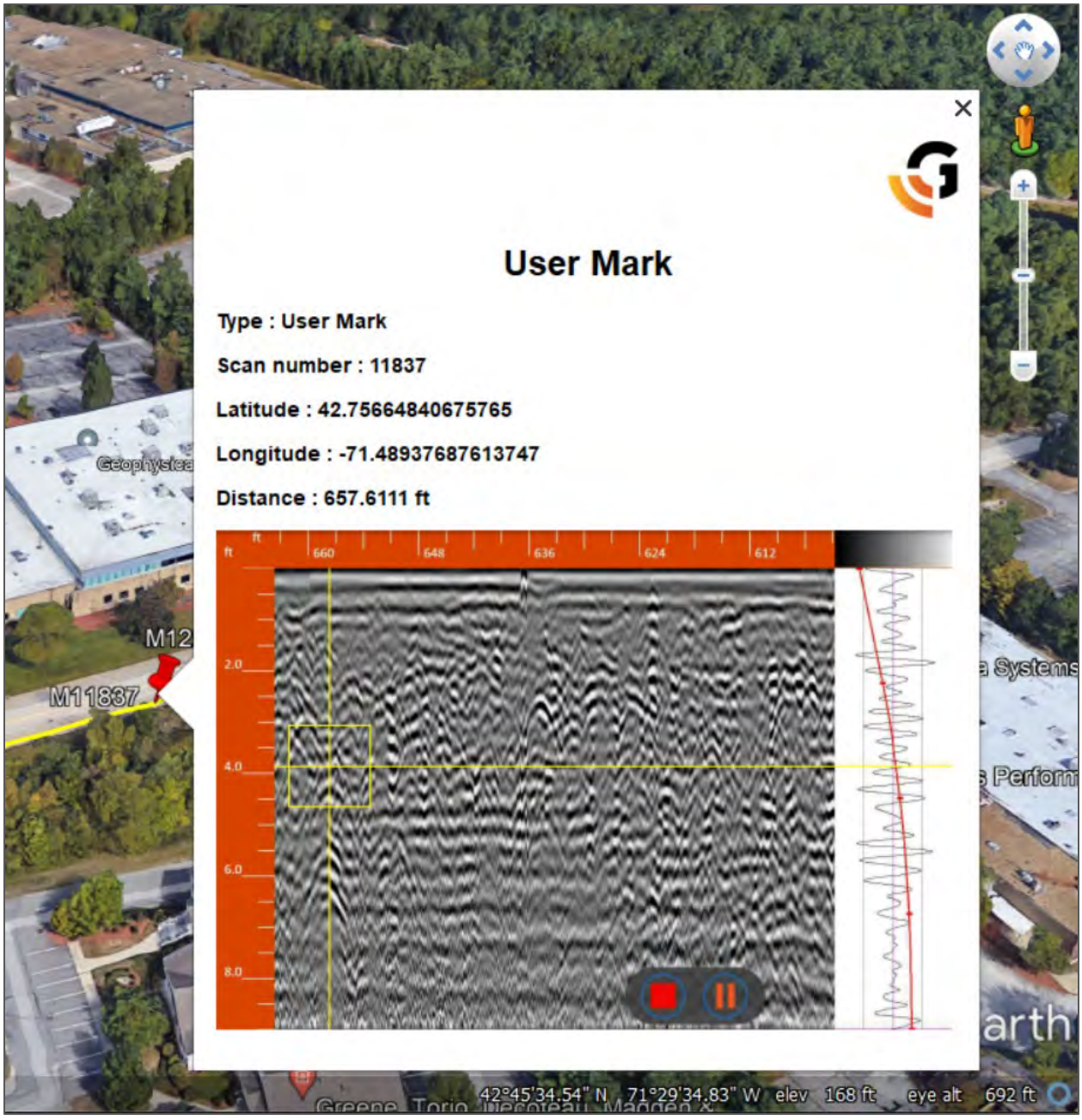
If the Export to KMZ setting is toggled on in the Project menu prior to playing back data, a KMZ will be automatically created for the portion of the file that was displayed up to the point of pressing the red stop icon to stop data scrolling. Note that the KMZ file will only contain location information if your data was collected with GPS on.

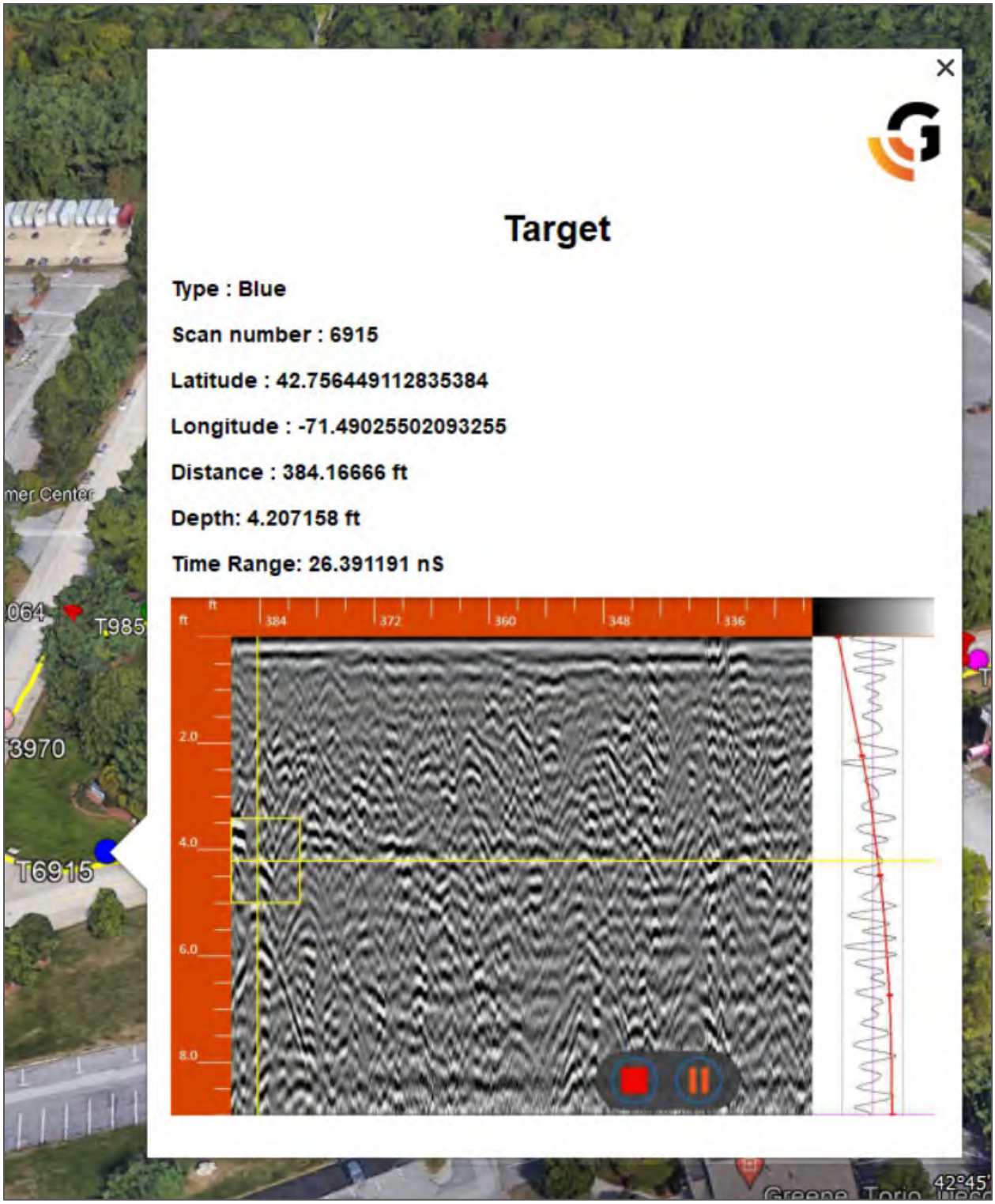
Opening and Viewing a KMZ File

Opening a KMZ file on your laptop or PC: Transfer your data files from the Panasonic G2 tablet to a USB drive using the instructions provided in the File Maintenance and Data Transfer section of this manual. Note that you will not see the .KMZ files displayed in your list of files in the project folder, they are nested in the parent linescan data file. Once data is transferred to a USB, insert the USB in your laptop or PC. Open the file explorer to view all files and save them to a safe location on your computer. Ensure that Google Earth is installed on your device and that you are connected to a WiFi network. Navigate to the folder containing your files and double-click on the appropriate .KMZ file. This will prompt Google Earth to open the file for viewing. Once opened in Google Earth, you can click each target pick or user mark icon to display attribute information.

Opening a KMZ file on the Panasonic G2 tablet: Close the GS Software application, then connect the tablet to a WiFi network. Select the Windows icon ( ) in the bottom left corner, then select the Documents icon ( ). Open the RADARDATA folder, then navigate to the appropriate project folder. Double-click on the .KMZ file you would like to open. This will prompt Google Earth to open the .KMZ (Note: The Panasonic G2 tablet should have Google Earth pre-installed when received from GSSI, but if Google Earth is not installed for some reason you will have to download it.). Once opened in Google Earth, you can click each target pick or user mark icon to display attribute information.




User Mark
Type : User Mark
Scan number : 11837
Latitude : 42.75664840675765
Longitude : -71.48937687613747
Distance : 657.6111 ft
ft
660
648
636
624
612
2.0
4.0
6.0
8.0
M12
M11837
42°45'34.54" N 71°29'34.83" W elev 168 ft eye alt 692 ft


Target
Type : Blue
Scan number : 6915
Latitude : 42.756449112835384
Longitude : -71.49025502093255
Distance : 384.16666 ft
Depth: 4.207158 ft
Time Range: 26.391191 nS
ft
384
372
360
348
336
2.0
4.0
6.0
8.0
T985
3970
T6915

Appendix C: Dielectric Constant

The dielectric constant is a descriptive number that indicates, among other things, how fast RADAR energy travels through a material. RADAR energy will always move as quickly as possible through a material, but certain materials slow the energy more than others. If we know the dielectric of the ground, we can figure out how deep something is because the dielectric tells us how fast the GPR energy is moving. The RADAR system is measuring how long it took to get the reflection, so if you know the speed of the energy, you can multiply the two-way travel time and speed to get depth. The higher the dielectric, the slower the RADAR wave moves through the medium, and vice versa. The range of values goes from 1 (air) to 81 (water). GPR energy moves through air at almost the speed of light. It moves though water at about 1/9 the speed of light. A dielectric of 5 to 20, typical for most utility surveys, corresponds to RADAR velocities from 5.3 to 2.6 inches per nanosecond (or 13.5 to 6.6 cm per nanosecond), respectively. Wet materials will slow down the signal because the presence of the water will raise the overall dielectric of the material.

A reflection will only be produced if there is a contrast in the dielectric value of the material that the signal is going through and the dielectric of the target. In other words, a reflection is produced at a boundary between two different materials, where the dielectric (and the signal velocity) suddenly changes. A higher dielectric contrast, or difference in dielectric between the two materials, results in a stronger reflection. The strength (brightness) of a reflection is proportional to the dielectric contrast between the two materials. The greater the contrast, the brighter the reflection:

Material	Dielectric Constant	Material	Dielectric Constant
Air	1	Wet Granite	6.5
Snow Firn	1.5	Travertine	8
Dry Loamy/Clayey Soils	2.5	Wet Limestone	8
Dry Clay	4	Wet Basalt	8.5
Dry Sands	4	Tills	11
Ice	4	Wet Concrete	12.5
Coal	4.5	Volcanic Ash	13
Asphalt	5	Wet Sands	15
Dry Granite	5	Wet Sandy Soils	23.5
Frozen Sand & Gravel	5	Dry Bauxite	25
Dry Concrete	5.5	Saturated Sands	25
Dry Limestone	5.5	Wet Clay	27
Dry Sand & Gravel	5.5	Peats (saturated)	61.5
Potash Ore	5.5	Organic Soils (saturated)	64
Dry Mineral/Sandy Soils	6	Sea Water	81
Dry Salt	6	Water	81
Frozen Soil/Permafrost	6		
Syenite Porphyry	6		
Wet Sandstone	6		

Appendix D: Pre-Loading Maps to Use in Map Mode

1. Ensure that your tablet is connected to the internet via ethernet or WiFi. Check your connection by opening Microsoft Edge and navigating to any website.

2. Open the GS Software application.

3. Open a playback folder – from here you can:

   - Select a file collected with GPS and press the green playback arrow. Once the file is playing back hit the location icon on the control bar. This will load a street view map corresponding to the location the file was collected in. You can add targets and user marks while in playback that will be reflected in the map display.

   - Do not select any files (this is the best option if you want to pre-load a basemap for a site you have not yet collected data at) and press the white **Back** arrow in the bottom left corner of the screen. This will bring you to a blank playback screen. You can select the location button to open Map View, which will display your current location. You can then use the zoom and navigate with your fingers until the location you wish to pre-load is displayed.

4. Once the imagery for the area you are interested in loads and is visible, it will be automatically cached on the system for future use. Now when you collect data with a GPS connected in your location of interest, the base map will automatically load in your map view.

Appendix E: Updating Software Version and System Firmware

The GS Software Panasonic G2 application will periodically be updated, check our website (www.geophysical.com) for new versions. You can either download the update installer on the tablet or an external computer.

Software Update Requirements

Download the update installer: Check our website for periodic software updates, www.geophysical.com in the Support > Download Resources section.

Updating the GS Software Application on the Panasonic G2

1. Close GS Software application (if open).
2. Double-click the update file to run.
3. Follow Installer prompt.
4. When prompted to update Files select **OK**.
5. Wait for while program installs.
6. Once Installer finish select **Finished**.
7. GS Series Update is complete!

Appendix F: File Formats

F.1: DZT

The DZT file will usually be the largest file. This is your raw, unprocessed GPR data and the most important to keep track of.

F.2: DZX

The DZX file contains any adjustments made to the raw file. This includes gain, filters, and user marks. When you open a file in GSSI's post-processing software, RADAN 7, the file will first open as just the DZT. It will then open a second time with the DZX info applied. This gives you the option to continue with a partially processed file or go back to the raw DZT file to start over in RADAN 7.

F.3: DZG

The GPS file collected with the tablet is identified by the extension .DZG and consists of multiple two-sentence blocks. First sentence (line) starting with $GSSIS contains the DZT file scan (trace number) associated with the GPS location. Second sentence (line) starting with $GPGGA contains the GPS-NMEA coordinate information.

Format:

$GSSIS,x,x

$GPGGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh

Example:

$GSSIS,0,-1

$GPGGA,112921.00,4343.9993927,N,00148.7984187,E,2,12,0.8,192.470,M,49.746,M,6.0,0136*46

$GSSIS Sentence Structure

Name	Example	Description
Message ID	$GSSIS	Fixed text identifier
File Scan #	0	File scan (trace) number, >=0
Scan Count*	-1	When Pulse Per Second (PPS) is used on the GPS unit, this number is the scan count at the specified scan rate from when the system was started, >=0 (missing value = -1)

*The value in field 2 is convertible into seconds by subtracting the number from the value associated with the $GSSIS record at Scan 0, then dividing by the scans/sec in the DZT file header.

Appendix G: Loading the App on a Windows Tablet PC

The GS Series application is not recommended for download to any Windows tablet PC except for models sold with our GS Series antennas. The main reasons for this are application scaling issues and hardware variations in different tablets. The buttons and window may appear distorted on a different tablet, or functionality/performance will be impaired on tablets with inadequate specifications.

However, if you have your own Windows tablet and would like to download it, do so at your own risk. The executable can be found on our website:
www.geophysical.com in the Support > Download Resources section.

Select the Software Updates tab and click on the GS Software to download the file onto your PC. Once the files are loaded onto your tablet PC, double click on the executable to download the software.

GSSI assumes no responsibility for any damage to unsupported devices and will not offer technical support for issues with software installed on unsupported devices.

Appendix H: System Specifications

H.1: 200 HS Antenna

Center Frequency: 200 MHz

Max Depth: 21m (70ft) under ideal soil conditions

Battery Life: 4 hours

Environmental Rating: IP65

Vibration: Mil-STD-810G Method 514.6C Category 9

Operating Temperature: -10C to 40C external (14F to 104F)

Weight: 17.9kg (39.6 lbs)

Dimensions: 64.8 x 64.8 x 34.3 cm (25.5 x 25.5 x 13.5 in)

Model Number: 50200 HS

H.2: Tablet

Please refer to the tablet manual for the most up-to-date specifications.

H.3: Data Acquisition and Software

Data Format: RADAN® (.dzt)

Output Data Format: 32 bit

Scan Rate: Maximum 400 scans/sec at 512 samples/scan

Scan Interval: User-selectable

Number of Samples Per Scan: 512, 1024, 2048, 4096, 8192

Operating Modes: Time- (Continuous), Distance- (Survey Wheel), or Point-Based Collection

Time Range: 1-16,000 nanoseconds full scale, user selectable

Gain: Manual or automatic gain, 1-8 points, (-40 to +120 dB)

Standard Real-Time Filters:

- **Vertical:** IIR Low-Pass, and IIR High-Pass
- **Horizontal:** IIR Stacking, and IIR Background Removal

Advanced Real-Time Filters: Migration, Surface Position Tracking, Signal Noise Floor Tracking, Noise Band Removal, and Hilbert Transform.

Geophysical Survey Systems, Inc.
www.geophysical.com • sales@geophysical.com

40 Simon Street
Nashua, NH 03060-3075 USA