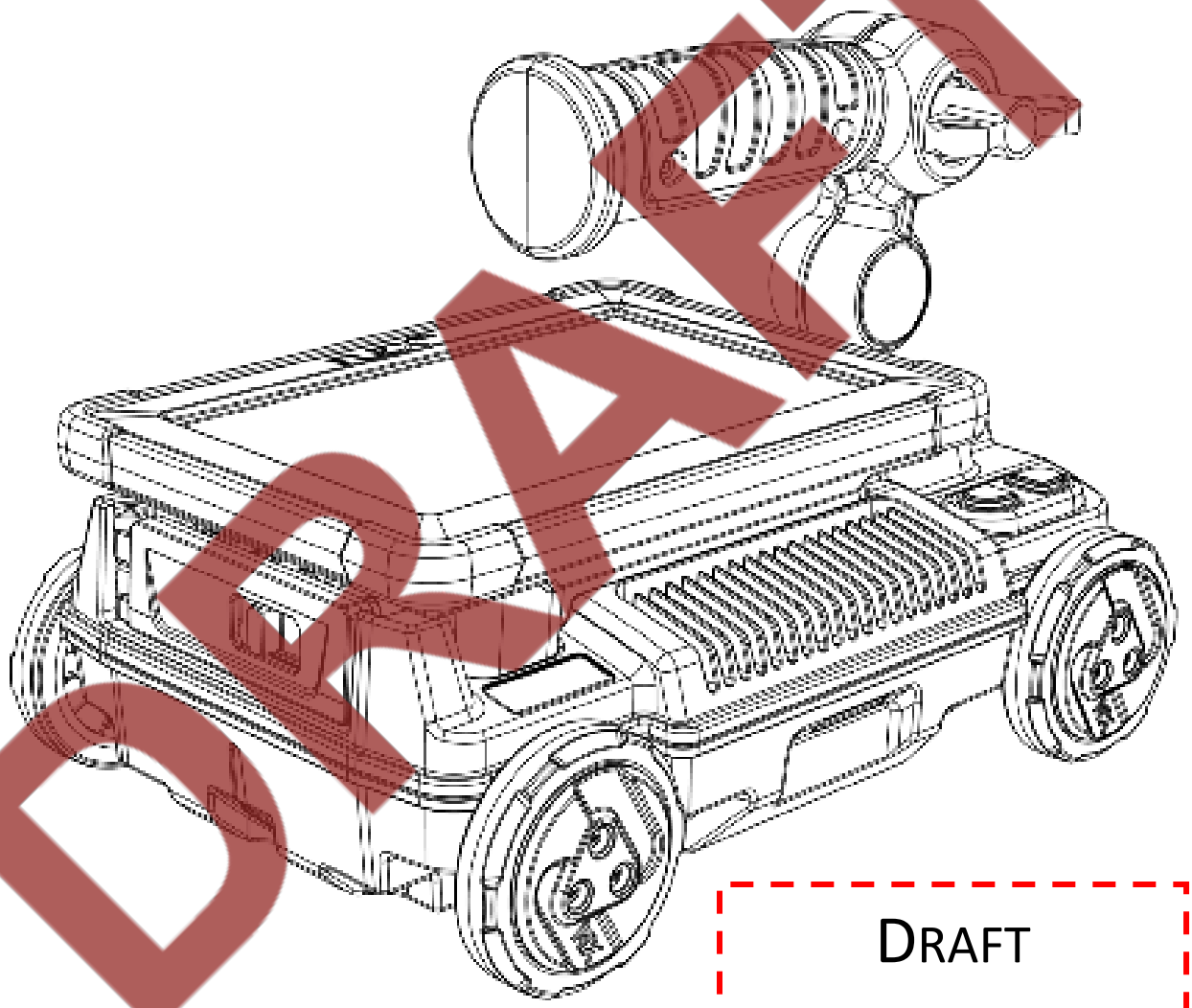
FLEX NX™

User Guide



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Limited Warranty, and Limitations of Liability and Restrictions

Geophysical Survey Systems, Inc. hereinafter referred to as GSSI, warrants that for a period of 24 months from the delivery date to the original purchaser this product will be free from defects in materials and workmanship. EXCEPT FOR THE FOREGOING LIMITED WARRANTY, GSSI DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. GSSI's obligation is limited to repairing or replacing parts or equipment which are returned to GSSI, transportation and insurance pre-paid, without alteration or further damage, and which in GSSI's judgment, were defective or became defective during normal use.

GSSI ASSUMES NO LIABILITY FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR INJURIES CAUSED BY PROPER OR IMPROPER OPERATION OF ITS EQUIPMENT, WHETHER OR NOT DEFECTIVE.

GPR UWB Compliance Notice

The FCC has granted Geophysical Survey Systems, Inc a waiver of sections 15.503(d), 15.31(c) and 15.521(d) rules so that the Flex NX system and its accessories are now certified for GPR UWB transmission. This action was adopted and released by the Chief of the Office of Engineering and Technology (OET) on 31July 2023 and is described in DA 23-650.

FCC Class A Compliance

This device complies with Part 15 Subpart B of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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 or residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the introduction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. Shielded cables must be used with this unit to ensure compliance with the Class A FCC limits.

Canadian Emissions Requirements

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numerique de la classe A est conforme a la norme NMB-003 du Canada.

Table Of Contents

Introduction

Thank you for purchasing the Flex NX™ system by Geophysical Survey Systems, Inc. This manual covers the entire suite of current product features and offers many of useful tips on data collection and interpretation.

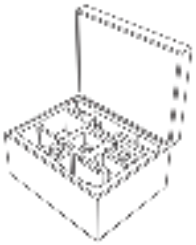
Our promise to you is to provide comprehensive training, unrivaled customer support and world-class expertise. That's why your Flex NX includes our industry-leading two-year warranty and complimentary training and technical support access. For more information, visit us at www.geophysical.com.

Our team of dedicated technical trainers is ready to work with users of all experience levels. GSSI Academy classes are offered on a revolving annual schedule. Check out the GSSI Academy offerings at www.geophysical.com/gssi-academy or use the accompanying QR code.

What's in the Box

The standard Flex NX system ships with the following:

Flex NX Controller
Part #: **FGFLEX NX**

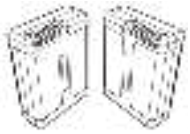


Flex NX Transit Case
Part #: **F-73-176**

Wrist Lanyard
Part #: **F-73-159**

Quick Start Guide
Part #: **MN73-190**

Extra RAM® Mount
Part #: **RAM-238U**



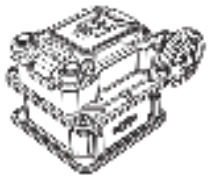
2x Lithium-Ion Batteries
Part #: **FGNX-BAT-3 CELL**

2-Bay Battery Charger
Part #: **FGMODBC-NX**

Optional Accessories

The following accessories are available for Flex NX and are sold separately:

Telescoping Pole with RAM Grip for use with Flex NX and NX25
Part #: **FGNX-POLE**



NX25 Satellite Antenna
Part #: **FGNX25**

System Specifications

Feature	Description
Unit Type	Self-contained all-in-one GPR system
Measuring Type	Ground Penetrating Radar (GPR)
Operational Modes	Single or dual channel (stacked) LineScan, Focus Mode
Max Depth	Flex NX and NX25*: 0-75 cm (0-30 in)
Gain Mode	Configurable automatic gain
Dielectric Settings	Configured though concrete cure, manual entry, matching, set depth
Languages	English, Spanish, Japanese, Korean, Chinese, French
Display	178 mm (7 in) LED backlit LCD touchscreen display
Storage	200 GB
Operating Temperature	-20°C to +50°C (-4°F to +122°F)
Storage Temperature	-40°C to +60°C (-40°F to +140°F)
IP Rating	IP65 (fully sealed against dust, low-pressure omnidirectional water)
Battery Performance	Flex NX up to 3.5 hours; NX25* up to 6 hours
Dimensions	Flex NX: 25.3 x 13.2 x 18.9 cm (9.9 x 5.2 x 7.4 in) NX25: 11.2 x 11.2 x 10.4 cm (4.4 x 4.4 x 4.1 in)
Weight	Flex NX: 2.2 kg (4.9 lbs) with battery; 2.45 kg (5.3 lbs) with battery and handle; NX25*: 0.83kg (1.8lbs) with battery
Hardware Warranty	2 years from date of purchase

*NX25 satellite antenna sold separately

Comparison of Flex NX and its Predecessors

If you have experience with other GSSI products you might wonder what new features Flex NX brings to the table. A comparison of Flex NX's closest sibling, the StructureScan MiniXT, will demonstrate the key differences between Flex NX and its predecessors.

The Flex NX retains many popular features of GSSI's previous generations of concrete scanners, while incorporating new technology and a completely redesigned user experience. Here's an overview of notable similarities and differences.

Operation	MiniXT	Flex NX
Locates metallic and non-metallic objects in concrete	X	X
High frequency, high resolution performance	X	X
2D scanning and data imaging	X	X
USB port	X	X
GSSI Fusion® compatible	X	X
Safety wrist strap	X	X
Quick start guide	X	X
Rugged transit case	X	X
Powered by Nexus™		X
Adjustable handle		X
Remote display		X
Wireless project transfer		X
One-pass cross polarization data collection		X
Tap-to-Connect accessories		X
Flex Positioning Vision System		X
Warranty	2 years	2 years
Subscription required	No	No

Configuration Options	MiniXT	Flex NX
Standalone or in a kit	X	X
Wired accessory antennas	Palm XT	
Wireless accessory antennas		NX 25
Extension pole	X	X
LineTrac®	X	

Flex NX is designed to be more customizable, mobile, and convenient than the Mini XT due to software and hardware improvements. The Flex NX is what you've come to expect from GSSI – a cutting-edge product that is simple, flexible, and trusted. Flex NX is built on GSSI's newly completed Nexus platform, and the first in a series of industry-defining and transformative GPR systems.

What is NEXUS?

NEXUS is GSSI's newest and most advanced technology platform, and it is the engine that will drive our future industry-defining innovations. A technological triumph, the core elements of Nexus will facilitate a profound leap forward in GPR performance, data stream integration, and user experience. Nexus is the tangible representation of GSSI's Simple, Flexible, and Trusted mission, and its continual evolution will lead to vast improvements in system design, application relevancy, and interoperability of Nexus-cored technologies. We invite you to learn more about Nexus, and its capabilities, by contacting your GSSI sales representative.

Flex NX and Fusion

Flex NX was, from the start, designed with GSSI's Fusion platform at the forefront. Our vision was to create a Simple, Flexible, and Trusted reporting platform that seamlessly integrated with our field devices. Fusion is the culmination of that effort. As a quick and easy reporting tool, Fusion acts as an efficient organizational system for uploading Flex NX data, adding results and descriptions, integrating field photos, and submitting a professional report branded with your company logo.

GSSI's mission is to make your scanning life as painless as possible. Therefore, our ultimate goal is the seamless interoperability of our hardware and software designs. We understand that, in most cases, a report is a procedural bottleneck that must be submitted before you leave the jobsite. To this end, Flex NX's project structure mirrors GSSI Fusion's project management environment. Create new projects on Flex NX, create areas of interest and capture results, then transfer your project to a mobile device or USB drive. Next, simply upload your projects to Fusion and your project will be set up just like you left it. Enter some notes, add field photos, and generate a report. Then move on to your next job knowing that your polished and branded report will be digitally available to your client.

We invite you to learn more about GSSI Fusion, and how it can streamline your project reports, by contacting your GSSI sales representative.

GPR Theory Overview

Ground Penetrating Radar (GPR) is a geophysical method that uses radar waves to image subsurface materials. It is commonly employed in construction, geology, archaeology, civil engineering, and environmental studies. Nearly all GPR applications share a common goal: rapid and non-destructive assessment of subsurface targets for mapping, avoidance, or physical inspection. All GPR technology acts as a true remote sensing method, whereby imaging occurs before buried targets are visually inspected. In other words, we cannot know precisely what we are imaging until it is directly observed. However, experience with GPR will improve your interpretation of the resulting data, and knowledge of concrete construction techniques will provide greater insight.

GPR operates on the principles of electromagnetic wave travel and reflection. Basic GPR theory involves an antenna transmitting short waves of electromagnetic energy into the ground, concrete, or other

material. The waves travel through different subsurface materials, partially reflecting at boundaries with contrasting physical and chemical properties. The remaining waves travel deeper, reflecting from other boundaries until the waves dissipate. A receiving antenna records the reflections and plots them for display and analysis. The majority of modern commercial GPR systems use antennas containing both transmitter and receiver.

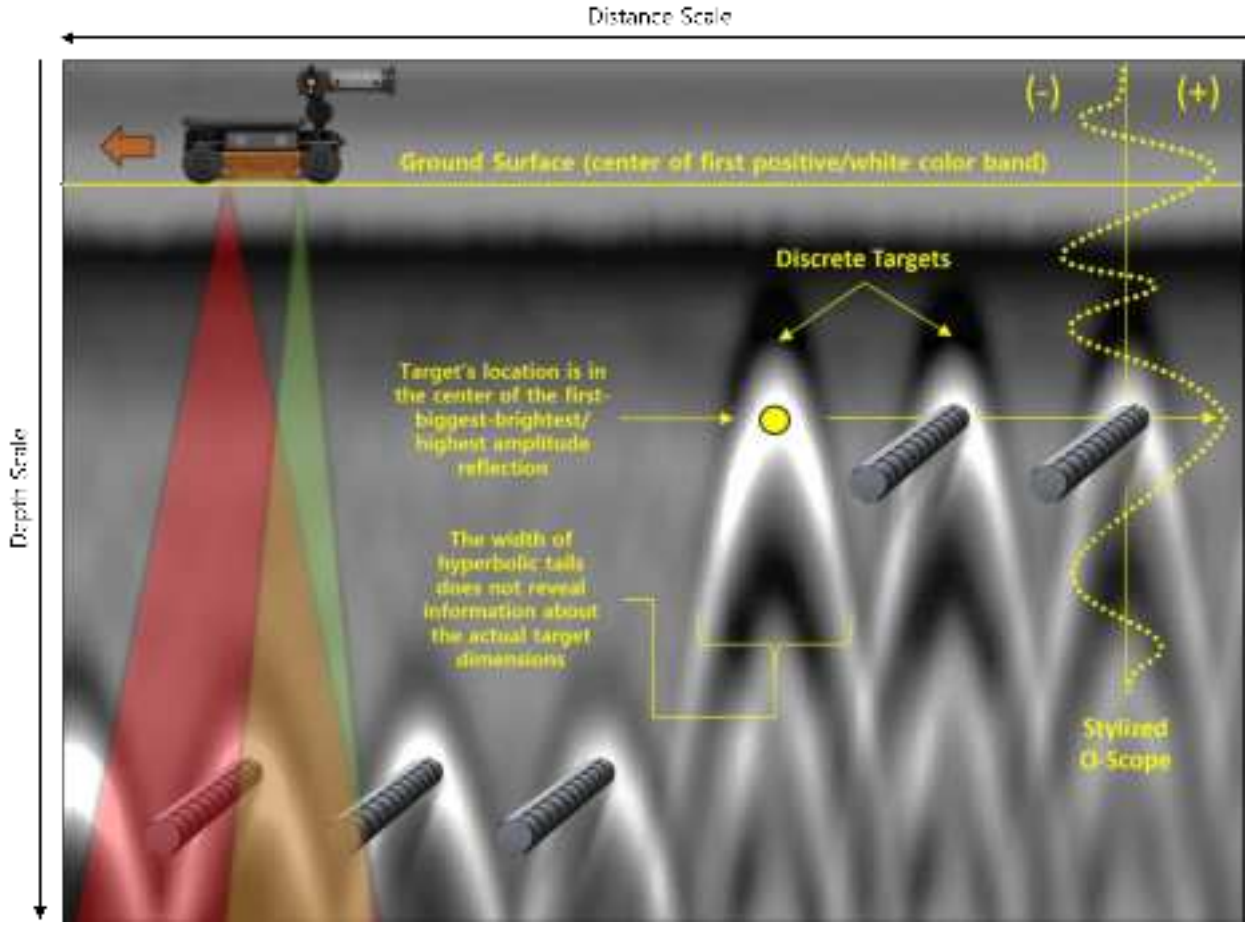
The depth penetration and resolution of GPR depend on several factors, including the frequency of the radar waves and the electromagnetic properties of a solid medium. Higher-frequency waves provide better resolution but have reduced penetration depth, while lower-frequency waves have greater penetration depth but lower resolution. Materials with high electrical resistance allow deeper penetration, such as air, concrete, and dry sand. Materials with high electrical conductivity, such as wet concrete and wet clay, dissipate the radar waves and vastly reduce penetration depth.

GPR measures the time elapsed between transmission and the return of reflections. The depth of targets or layers is based on the travel time and the speed of the radar waves. As an example, consider airplane detection using ground-based radar. The radar operator must determine the distance to an incoming airplane. To do this, they must use a distance, speed, and time calculation. To solve the problem, only two of the three variables are needed. The radar system records the time elapsed between the transmitted and received signals. Radar waves travel at a constant speed in air. The operator can then determine the distance using the time and speed to solve for distance. A GPR system works in a similar fashion, though the depth calculation is a bit more complicated. The GPR system precisely records transmit and receive times, so we can easily constrain the time variable. In most cases, the depth of targets is unknown. We must therefore determine the speed of the radar waves to solve for depth. Here's the tricky part: GPR waves travel at different speeds depending on the material they pass through.

To calculate a precise target depth we must determine the speed of the radar waves using a dielectric constant value. Multiple methods are available, and in order of least to greatest accuracy these include tables of dielectric values for different materials, hyperbola matching using software, or setting a precise target depth from physical measurements. In most cases, hyperbola matching is the method of choice; picking a number from a table just isn't accurate, and knowing the true depth of a target is not common. Once the dielectric constant is determined, the system calibrates the depth scale accordingly.

The Anatomy of a GPR Profile

GPR data are displayed as vertical profiles, much like observing the side of a saw cut, displaying depth below surface and distance traveled. As discussed above, the depth scale is only as accurate as the current dielectric value. On the other hand, the distance scale is very precise because it is measured with integrated distance encoders. This distance precision ensures accurate markouts, whether collecting data in forward movement or using backup cursors when traveling in reverse.



As reflections return to the receiving antenna, they are plotted against travel time and assigned a range of colors based on their phase/polarity and amplitude. The result is a single scan that is represented by the O-Scope. Additional scans are collected as the Flex NX moves forward, resulting in a continuous GPR profile. All GPR profiles exhibit a series of flat, high amplitude bands that appear at and around the ground surface. These reflections are the direct wave, and they are created when GPR energy travels from transmitter to receiver before it leaves the antenna. The center of the first positive (white) band is the position of the ground surface.

A typical GPR profile contains two categories of reflections: targets and layers. Targets are expressed as hyperbolas representing discrete objects, such as rebar and conduit. These hyperbolas can vary in amplitude based on the material of the object. Metallic objects produce high amplitudes, while air-filled PVC and other synthetic materials generate weaker hyperbolas. Target hyperbolas will widen with increased depth, and to the untrained eye these deeper targets could be mistaken for larger objects.

However, the true diameter of a target cannot be derived from the shape of a hyperbola. Layers are continuous boundaries, like the base of a slab or an air void under the slab, that can be tracked along a profile. Like targets, layers can vary in phase and amplitude but their characteristics are based on the nature of the overlying and underlying materials.

To an experienced GPR operator, the phase and amplitude of targets and layers reveals additional information to enhance data interpretation. GPR energy cannot penetrate metallic targets, so a large amount of energy is reflected back to the antenna and registers as a high amplitude target. This is convenient for locating metal reinforcement and conduit, but solid metal structures like pan decking are impenetrable to GPR energy. Any features of interest on the other side of pan decking, or thick layers of metal reinforcement, will not be resolved. Nor can GPR image the contents of metal pipes. Additionally, metal objects display a white-black-white pattern of stacked reflections. This pattern, along with high amplitudes, typifies metal targets and demonstrates that the energy decreased in speed as it passed from concrete to the metal.

In other cases, the pattern of reflections will be reversed (black-white-black). This pattern suggests that the energy increased in speed at a material boundary, such as the air void in a PVC pipe or an air void within or beneath a concrete slab. These reflections will often exhibit lower amplitudes and could be masked by hyperbolas from reinforcement.

Common GPR Uses in Concrete Scanning

GPR is a non-destructive method that provides insight into the condition, composition, and structural characteristics of concrete elements. This helps in ensuring the safety, durability, and efficient management of concrete structures. The non-destructive nature of the method makes it a rapid, safe, and cost-effective means of identifying slab contents and potential hazards.

Concrete scanners typically use GPR to investigate concrete prior to saw cutting or core drilling. At predetermined cutting locations the operator marks out reinforcement, conduit, and structural elements such as beams, cables, and pan decking. This allows the cutting and coring crew to avoid damaging important elements in the slab.

GPR is also used for NDT and structural forensics to assess the construction and health of existing concrete structures. In this application, inspectors employ GPR to ensure the reinforcement in the slab and slab thickness match the planned specifications. Commonly measured factors include rebar spacing, rebar depth in the slab, and the presence of post-tensioned cables and other forms of reinforcement. These measurements are also carried out when renovating older buildings, helping to verify that the concrete slabs are strong enough to support the planned loading.

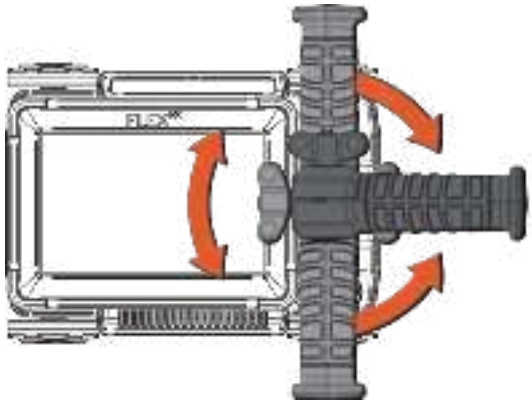
In some cases, voids form under concrete slabs due to erosion or soil compaction. Subgrade materials can be removed by water below the slab, and compaction occurs from soil settling or loading from above. In either case, the resulting void space poses a major risk to the integrity of the structure. GPR is sensitive to the transition from concrete to air and can determine the areal extent of void spaces. The slab can then be remediated, usually by injecting polyurethane foam through numerous tiny holes drilled in the concrete. GPR can help ensure that the holes are drilled safely, too!

This is certainly not an exhaustive list. There are many more applications for GPR, and technological advancements like Flex NX will greatly expand the possibilities.

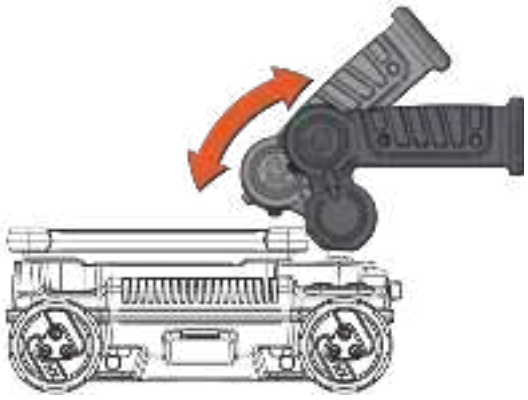
Flex NX Hardware Overview

Handle Orientations and Removal

The Flex NX handle is ergonomically designed to promote ease of use and maximum flexibility. The handle is highly configurable, with a wide range of adjustment angles and built-in safeguards to prevent screen damage. To adjust the handle, simply loosen the knob, reorient the handle, and tighten. To remove the handle, fully loosen the knob. Use the attached RAM Mount ball to connect an extension handle or a custom RAM solution.



Full range of horizontal rotation



Vertical movement limited to prevent display damage

Touchscreen Display Care and Maintenance

Integrated into Flex NX is a large (7.0-inch diagonal) multi-touch display. The display is not removable and should damage occur the entire Flex NX system should be returned to an authorized repair facility.

Unlike other touchscreen devices, adding a protective, polarizing, or anti-glare film is not recommended.

To ensure proper care and maintenance of the Flex NX touchscreen display, consider the following recommendations:

- **Clean the screen regularly**. Use a soft, lint-free cloth to gently wipe the screen surface. Avoid using abrasive materials, paper towels, or rough fabrics that may scratch the screen. If necessary, lightly dampen the cloth with water or a screen-cleaning solution specifically designed for electronic displays.

- **Turn off the display before cleaning.** This allows for better visibility of smudges and reduces the risk of accidental actions on the screen.

- **Avoid harsh chemicals.** Harsh chemicals, solvents, or ammonia-based cleaners can damage the screen's protective coating. Use only mild screen-cleaning products.

- **Be mindful of pressure.** Apply gentle and controlled pressure when interacting with the touchscreen. Excessive force or tapping can lead to cracks or damage.

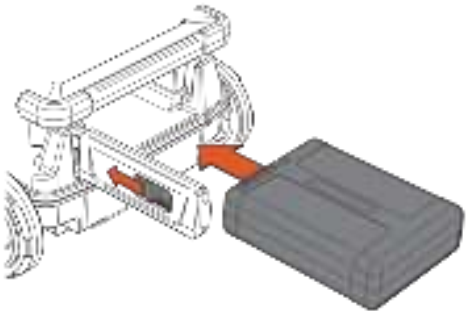
Battery Usage and Care

The Flex NX system and NX25 satellite antenna (sold separately) each include two Lithium-ion batteries.

Note: the batteries are not compatible between the Flex NX and the NX25, but both battery styles use the same charging station.

Flex NX Battery Use

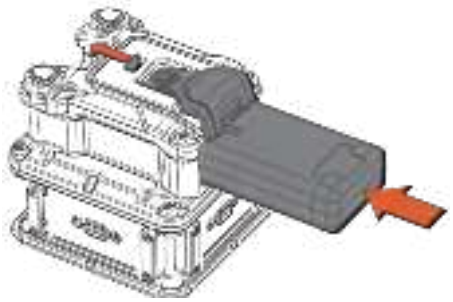
To insert the battery, slide the battery door latch to the left and open the door. Insert the battery with the battery contacts upwards and towards the Flex NX system. Ensure that the battery latch is fully engaged.



To eject the battery, simply slide the latch to open the door, then remove the battery. An internal spring will partially eject the battery, and the battery can then be removed by hand.

NX25 Battery Use

To insert the battery, orient the battery contacts downward. Next, slide the battery latch lock forward and then use the battery to push up on the battery latch.



To eject the battery, use your index finger to slide the battery latch lock, then insert your thumb into the front access window and push the battery out of the latch.

Powering On Flex NX and NX25 Satellite Antenna

Insert a fully charged battery, then press and hold the two power buttons to power on Flex NX and NX25. This process is also recommended to power down these devices; GSSI does not recommend ejecting the battery to power down.

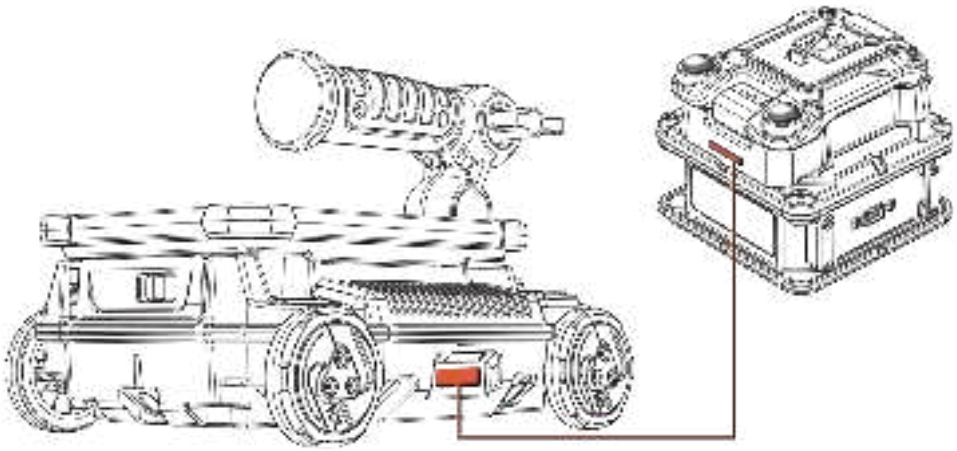
Pairing Satellite Antennas

Flex NX uses near-field communication (NFC) to pair with satellite antennas like NX25 (sold separately).

Paring a satellite antenna to the Flex NX is simple. First, power on Flex NX and wait for the Main Dashboard to appear. Next, power on NX25 and wait for the indicator light to flash blue. The last step is to bring the Flex NX and NX25 NFC labels together. Your devices will then be paired, and future scanning sessions will not require the pairing procedure.

Flex NX displays NX25 data and provides complete access to NX25 configuration options and collect mode functions. Use your satellite antenna to collect data while viewing the results on Flex NX's screen. Alternatively, connect a Wi-Fi enabled smartphone, tablet, or computer to mirror the data collection screen.

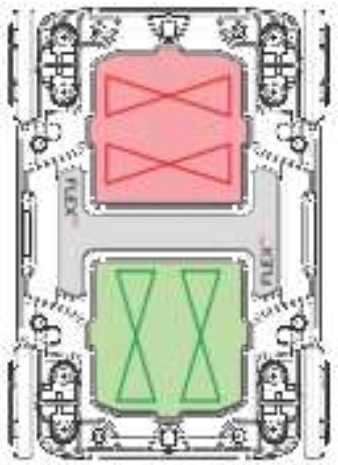
External display devices must be Wi-Fi enabled for pairing with Flex NX and for remote viewing. See the Connecting an External Viewing Device section for more information.



Holding the NX25

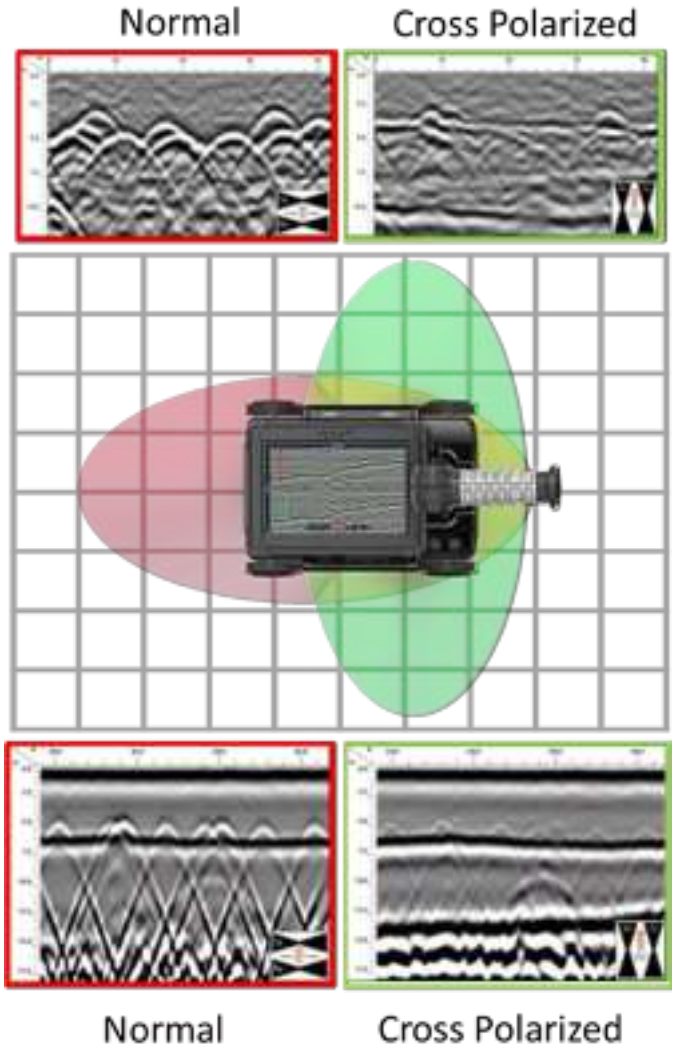
GSSI recommends observing safe W-Fi practices when holding NX25.

Using Two GPR Antennas: Standard and Cross-Polarized



Flex NX contains two separate antennas with their transmitter-receiver pairs in different orientations. The front antenna, with red lasers, is in the standard orientation for commercial GPR systems. The rear antenna, with green lasers, is cross-polarized. The side lasers mark the center of each antenna, as do the front and rear lasers.

When displaying both data channels in Stacked Mode, the standard antenna (Channel 1) is the top profile and the cross-polarized antenna (Channel 2) is the bottom profile. You'll notice that the two channels do not align horizontally, nor do the two backup cursors, yet targets in both channels are aligned. Channel 2 is shifted to the right relative to Channel 1. The offset corrects for the physical distance between the antennas, as Channel 2 does not display data until it has passed the starting point of Channel 1.



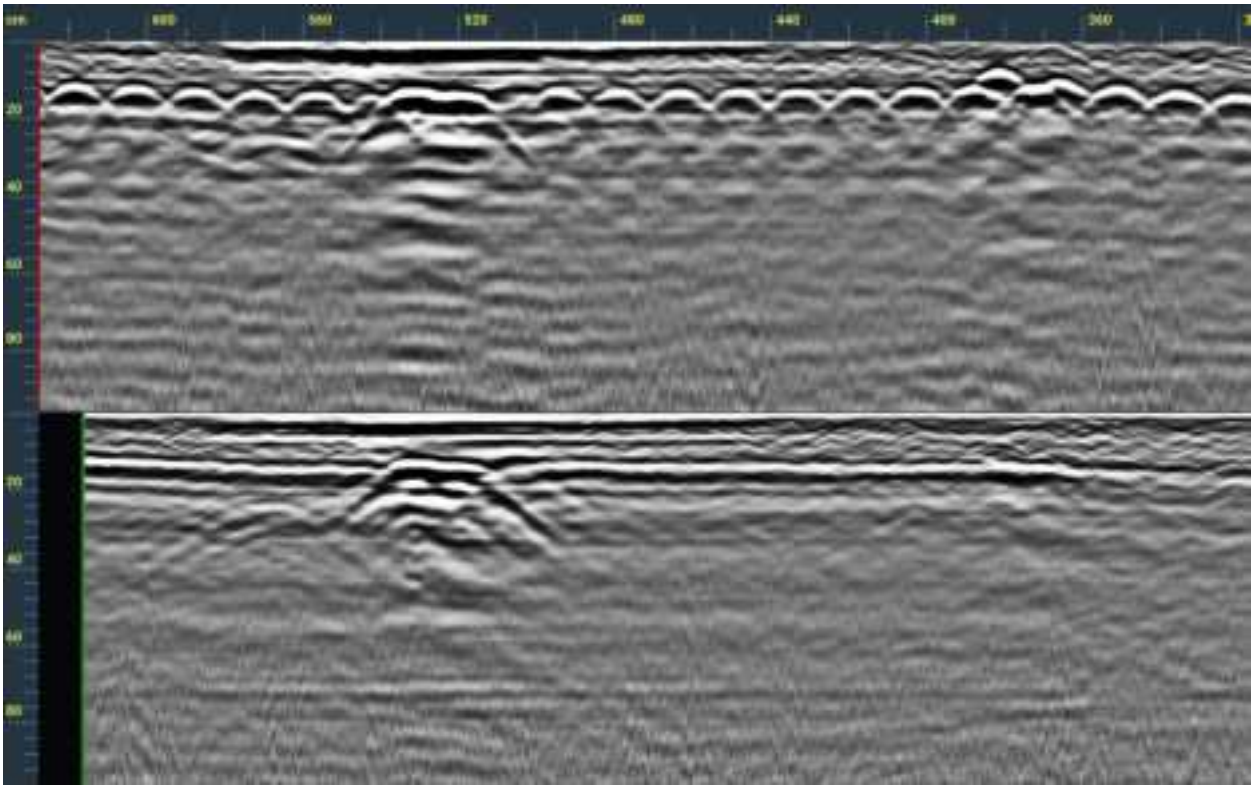
The two Flex NX antennas are designed to work in tandem, providing an exceptional scanning experience employing one-pass cross-polarization. Both antennas have specific strengths. The standard antenna is aligned perpendicular to the path of travel, as is common for most commercial GPR systems. In this orientation it is optimized for imaging metallic targets that run perpendicular to the direction of travel. This means that rebar, metal conduit, and other metal targets will stand out, appearing as high amplitude (bright) hyperbolas with expansive tails.

The standard antenna orientation is the scanning workhorse, but some targets will be difficult to image due to the nature of concrete installations. This includes PVC and other synthetic materials that are 'overshadowed' by the amplitude of metallic targets. Additionally, the expansive hyperbolas from wire mesh, dense rebar, and other reinforcement often overlay and obscure deeper targets.

The cross-polarized antenna is not as sensitive to metallic targets, though they will still appear in the data. The main advantage is the reduction of amplitudes

from metal targets, and the downplaying, or sometimes altogether removal, of hyperbolas that obscure deeper targets. This leads to a more refined view of deeper slab elements, including the slab/grade contact where air voids may be present.

By utilizing data from both standard and cross-polarized antennas (see image above), GPR systems can better discriminate between different types of objects or materials and improve overall data resolution and accuracy. GSSI recommends scanning with both antennas active so you can view a complete picture of the slab contents.



Flex NX Collection Mode displaying Stacked profiles. The top profile (standard orientation) exhibits shallow wire mesh and a possible conduit bank. In the bottom profile (cross-polarized) the wire mesh is not visible, and the removal of hyperbolic tails reveals more details about the conduit bank and a previously obscured target to its left.

Flex NX User Interface

This section will familiarize new users with the Flex NX user interface. By the end of this section, you will be able to navigate through the system, create and manage projects, and be ready to collect data.

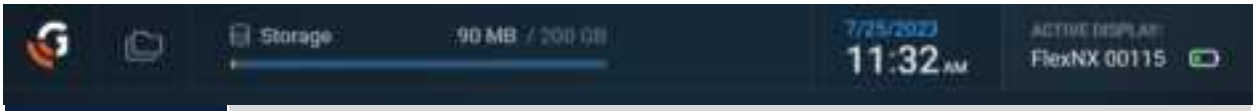
Dashboard

The Main Dashboard is the control center for your Flex NX. From here, you can:

- Start a New 2D Scan
- Access Projects
- Access System Settings
- Wirelessly connect to your personal device
- Access Technical Support
- Connect and configure NX25

The Main Dashboard is separated into three panes: Top Navigation, System and Support, and Recent Projects. Keep reading for a detailed description of these panes and their features.

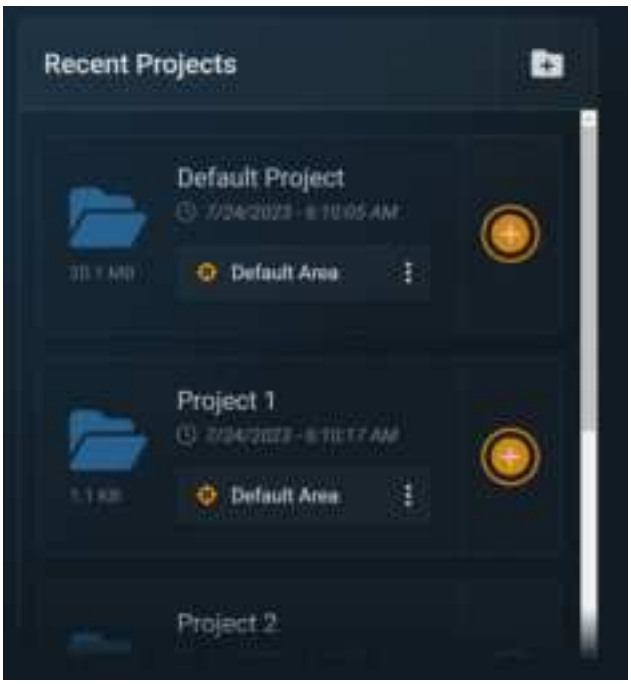
The Dashboard Top Navigation menu provides access to the Projects Portal, displays system storage and date/time, and shows the currently active device. See below for a more detailed functionality overview.



	**Return to Main Dashboard.** Tap this icon to return to the Main Dashboard. This icon is also available on the Data Collection, Projects Portal, and Project Profile screens.
	**Projects Portal Icon/Access Project Portal.** Tap the Projects Portal icon to access all project folders on your Flex NX. Click an individual project folder to access the Project Portal and view associated data and results.
	**Current (orange) and Total (blue) Storage Bar.** You can transfer data and results from your Projects to the Fusion software platform, or delete existing project folders, to free up more storage space.
313 MB / 200 GB	**Current / Total Storage Count.** Flex NX has a total storage capacity of 200 GB.
	**Battery Life Indicator.** Displays the charge state of the currently active device. This will usually refer to the Flex NX battery, though it will show the NX25 battery if it is the active device.
5/31/23 **10:45** AM	**System Date and Time.** Set the current date and time for an accurate timestamp. The time and date will determine file naming.
ACTIVE DISPLAY: **FLEX NX**	**Name of Active Device.** If a different antenna is connected and activated, such as the NX25, that antenna will be displayed as the active device. Tap this icon to quickly switch between active devices.
	**Battery Status for Active Device.** This icon displays the battery status for the device currently active. Activating a satellite antenna, such as the NX25, will display its battery status.

The Main Dashboard System and Support pane features the device carousel, device serial number, current software version, and the System Settings icon. It also includes the Wireless Connect and Technical Support icons. See below for a detailed description of functionality.

	**Battery Life Indicator.** A fully charged Flex NX battery can provide up to 3.5 hours of continuous use. An NX25 battery provides over 6 hours of continuous use.
	**System Settings Icon/Access System Settings.** Tap this icon to access the System Settings and Health Settings screens.
	**Technical Support Icon/Access Technical Support Portal.** Tap this icon to display GSSI's Technical Support phone number and business hours, as well as a QR code linked to helpful resources.
	**Wireless Connect Icon/Access Wireless Connect Portal.** Tap this icon to wirelessly connect a personal device, then mirror your collection screen using a web browser. Proceeding screens will walk you through the connection and display process.
	**Carousel Menu.** Swipe left or right to change the device, then tap a device image or the System Settings icon to view System Settings or Health Settings information.



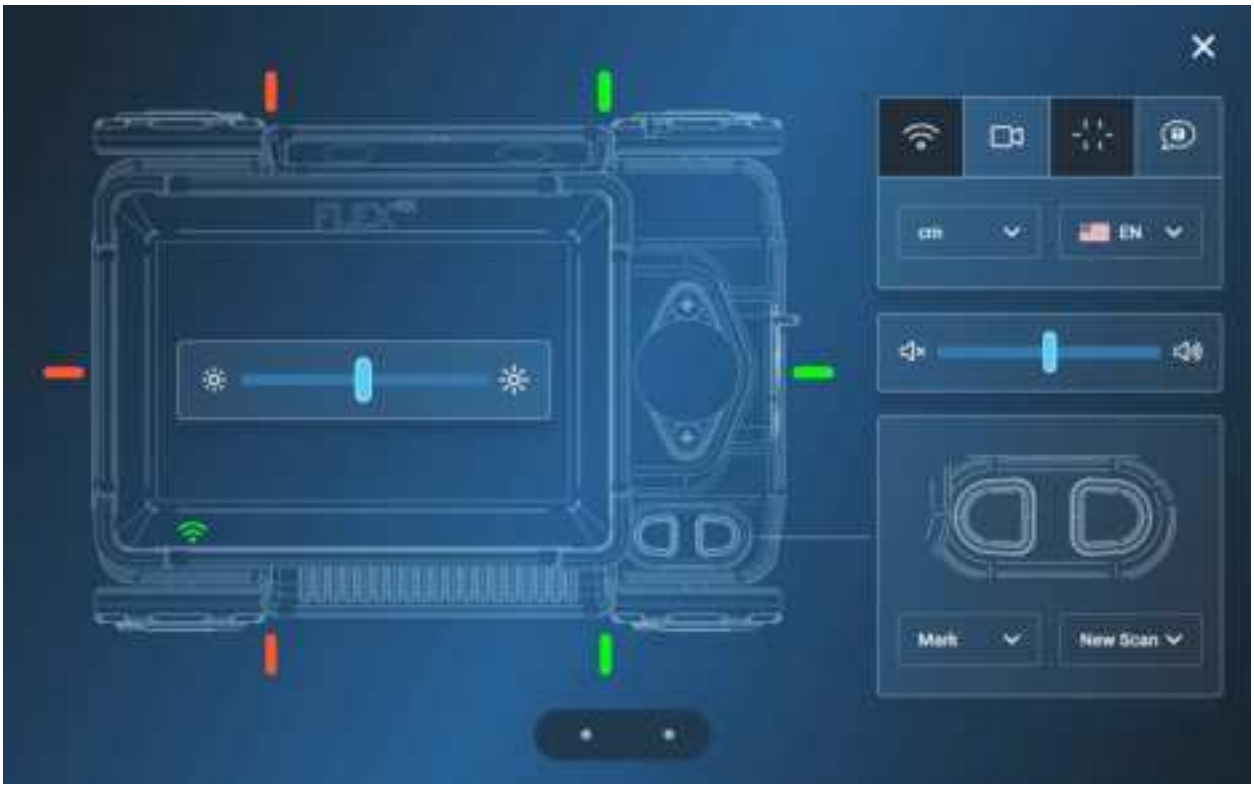
The Recent Projects Pane displays a list of your most recently accessed project folders. When first used, your Flex NX will only have a Default Project folder. As you add more projects they will appear in this pane, ordered by most recent use.

The main function of the Recent Projects pane is to quickly select a working folder and begin scanning. There are other useful features here, and they are outlined below.

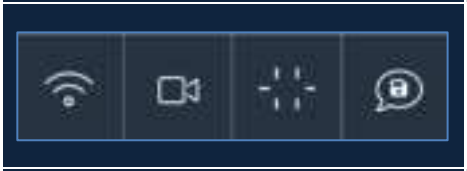
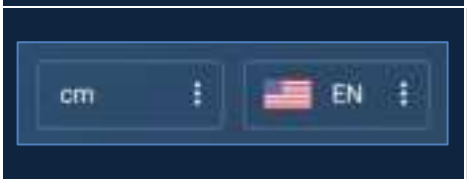
	**Create New Project Icon.** Tap this icon to create a new project. You can then save data and results to different areas of interest within the project.
	**Start New 2D Scan Icon.** Tap this icon to start a 2D scan in the selected Project.
	**Current Area of Interest/Switch Area of Interest.** Change areas of interest to save data and results to a specific location within your work site or project.
	**Project Icon/Storage Used by Project.** Tap this icon to access and view saved project data and results.
	**Project Name/Last Updated Time Stamp.** This icon displays the Project Name and the last time the project was updated.

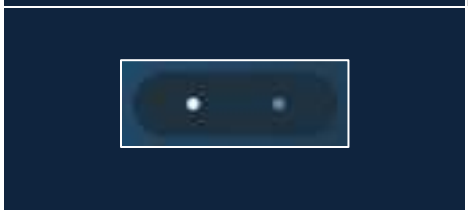
System Settings

Use the System Settings screen to customize your Flex NX or NX25 preferences. This portal is the Flex NX command center for enabling or disabling Wi-Fi, lasers, and the Save Prompt. You can also change the vertical and horizontal units and language settings, adjust system volume and screen brightness, and assign quick actions to Flex NX and NX25 programmable buttons. Tap the gear icon on the Main Dashboard to navigate to the System Settings screen.



See below for a rundown of System Settings icons and their function.

	**Screen Brightness.** Adjust screen brightness to reduce battery consumption or to improve screen visibility.
	**System Settings.** Customize settings to enable/disable wireless connections, the Flex Positioning System, lasers, and the save prompt. The Flex NX graphic will highlight enabled features.
	**Units of Measurement/Language.** Adjust units of measurement (cm, in) and select the display language (English, Spanish, Japanese, Korean, Chinese, and French).

	**Volume Adjustment.** Adjust the system volume to increase, decrease, or silence the system's audio cues.
	**Button Functions.** Flex NX and the NX25 satellite antenna each have two user programmable buttons. Available functions include Mark, Start New Scan, Delete and Screen Grab. Functions can be set to either button. Note: Flex NX and NX25 button functions are independent; each device can have different functions assigned.
	**System Settings/System Health Toggle.** Located at the base of the System Settings and System Health screens. Switch between System Settings (left dot) and System Health (right dot) for Flex NX and an NX25 satellite antenna (if paired and activated).

Health Settings

The Health Settings portal is the second screen in System Settings. Access Health Settings by tapping the second dot at the base of the screen. This portal includes icons for updating software and downloading system log files. Log files are intended for GSSI technical support use and can be downloaded to a USB drive and emailed to the GSSI team when requested.

NX 25 System Settings

Connecting an NX25 provides access to its own System Settings screen.

At the Main Dashboard, swipe your finger left or right on the Carousel Menu to change between the Flex NX and the NX25. Alternatively, you can switch to NX25 from the Active Devices menu in Collection Mode.

Tap the NX25 icon to advance to the NX25 System Settings screen or tap the gear icon next to the battery indicator.

In the System Settings screen, you can customize the functions of the two buttons. The available options include Mark, Start New Scan, Delete and Screen Grab. The assigned button functions are independent of those set on Flex NX.

Tap Disconnect NX25 to end the pairing session.

Tap Software Update NX25 to update the software; this procedure requires updating Flex NX first. For more details, see the Updating Flex NX and NX25 Software section of this User Guide

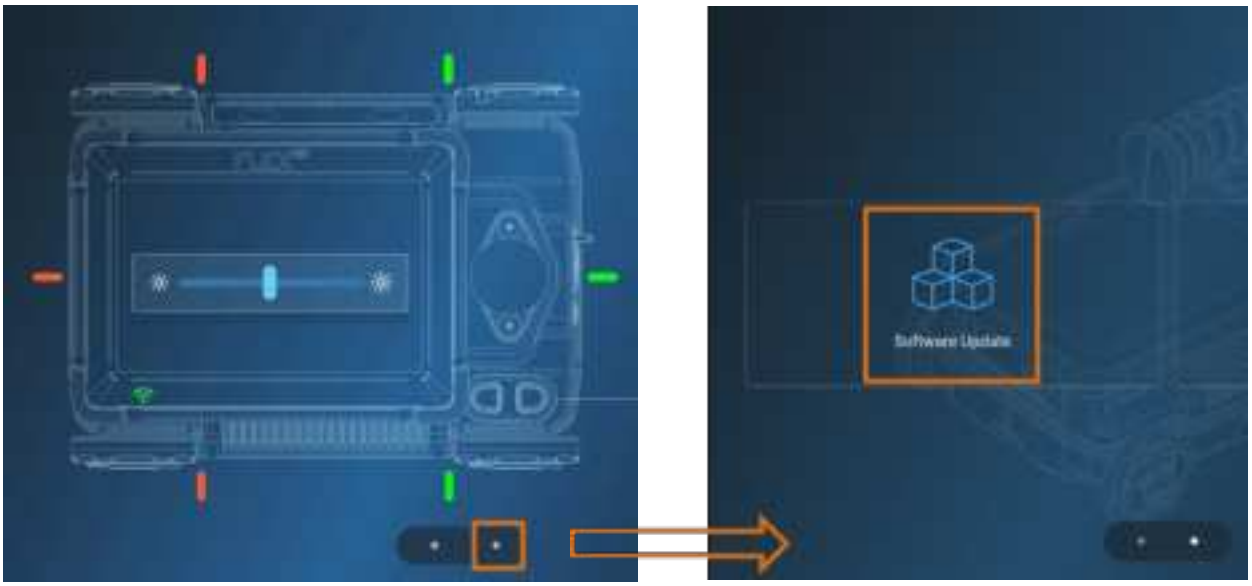
Updating Flex NX and NX25 Software

We will periodically release software updates for the Flex NX and the NX25 satellite antenna. Future updates will fix bugs and other software issues and could implement new user features. GSSI recommends regular visits to the Flex NX support page (Flex NX Support Page) to check for new software releases. You can also scan the QR code on the Flex NX Quick Start Guide's cover or use the QR code provided by the Flex NX Software Update function.

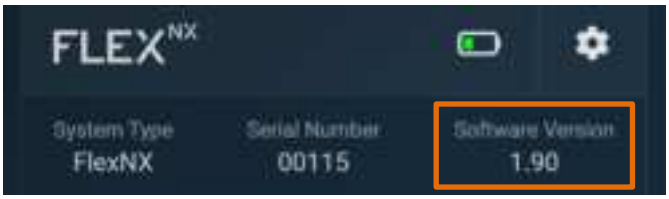
To update Flex NX and NX25, visit the Flex NX Support Page with your computer and download the latest update to a USB drive. Consult the following procedure to initiate and complete the update process.

Updating Flex NX

1. Power on FlexNX and make sure the battery is near full charge.
2. Insert the USB drive containing the installation package.
3. On Flex NX, navigate to the System Settings panel and then to the System Health screen. Tap the Software Update icon to continue.



4. Flex NX will then transfer the install package from the USB drive. You'll see a Confirm Install icon once the transfer is complete.
5. Tap Confirm Install. Feel free to remove the USB drive; it is no longer needed.
6. Once the installation is complete, the system will reboot. Use the Flex NX Main Dashboard to verify that the latest version number is displayed.



Updating NX25

The NX25 software update is controlled by Flex NX, therefore your Flex NX must be updated before NX25. Before continuing, confirm that your Flex NX has the latest software version.

Use the following steps to update NX25.

1) Power on FlexNX and make sure the battery is near full charge.
2) Insert a fully charged battery and power on NX25.
3) Pair NX25 with Flex NX. See the Pairing Satellite Antennas section for more information.
4) Navigate to System Settings > Health Settings.
5) Flex NX will transmit the update files, resulting in an installation routine. NX25 will reboot when the update is complete. On Flex NX, follow the on-screen prompts to initiate and complete the NX25 update.

Step 1: Tap the Software Update window.

Step 2: Insert the USB drive into your Flex NX system. The system will automatically complete the updating process.

All other files must be removed from the USB drive prior to downloading the update.

You will then power on both devices and pair NX25.

Log File Download

The Log File contains system-related data to help our technical support team.

Download the log files to a USB drive and import them to your personal computer. You can then email the files to our Software Support Team if instructed to do so.

Connecting an External Viewing Device

Flex NX can cast its data collection screen to a personal device, such as a phone, tablet, or computer. You can then view your data on another device during collection. Try pairing your Flex NX to a tablet for a larger viewing screen, or to a smart phone for a lighter and more portable display.

Step 1: Connect Mobile Device

From the Main Dashboard, tap the Wireless Connect icon. Scan the QR code to connect to Flex NX's wireless network. Tap Next.

If using a computer or a device without a camera, select and connect to the Flex NX SSID from the wireless networks in your device's settings.

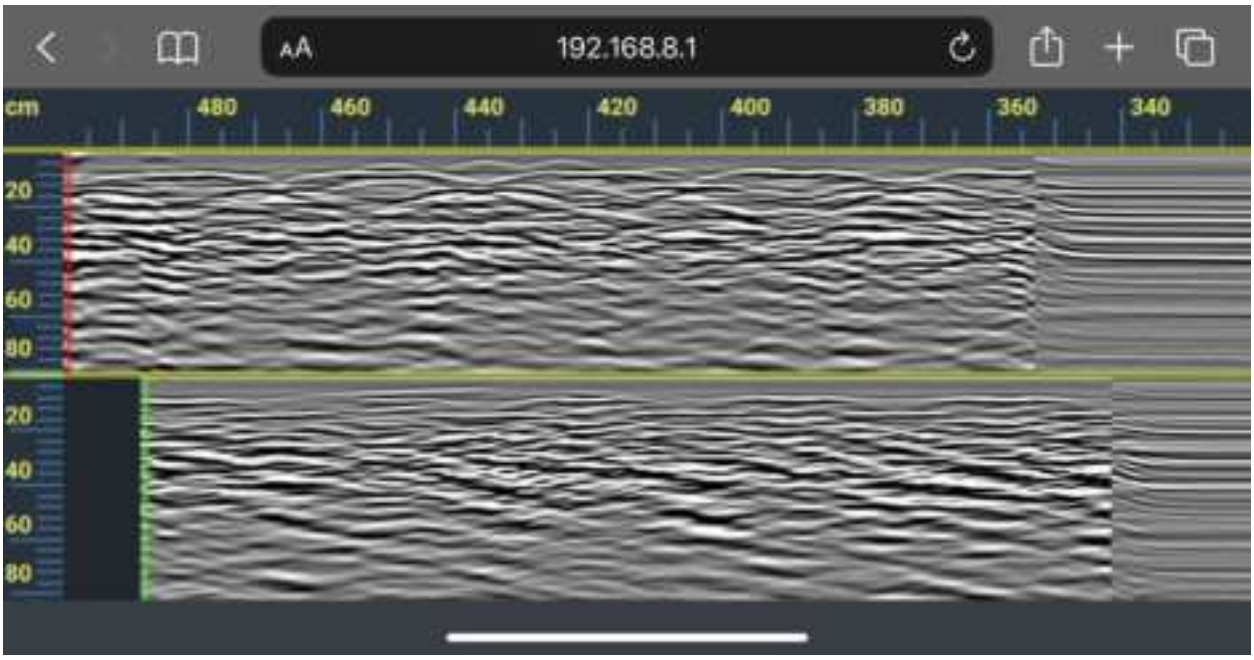
Step 2: Mirror Data Collection Screen

Scan the QR code. A webpage will open to a blank Flex NX collection screen. GPR data will be visible when you begin collecting data.

If using a computer connected to the Flex NX SSID, type the URL into your web browser. A webpage will open and will mirror your GPR profile when you begin collecting data.

Tap Done and return to the Main Dashboard.

On your external device, the Data Collection screen will populate with data once collection is initiated. Refer to the Collecting Data with Flex NX section for more details.



Flex NX data collection mirrored to a cell phone.

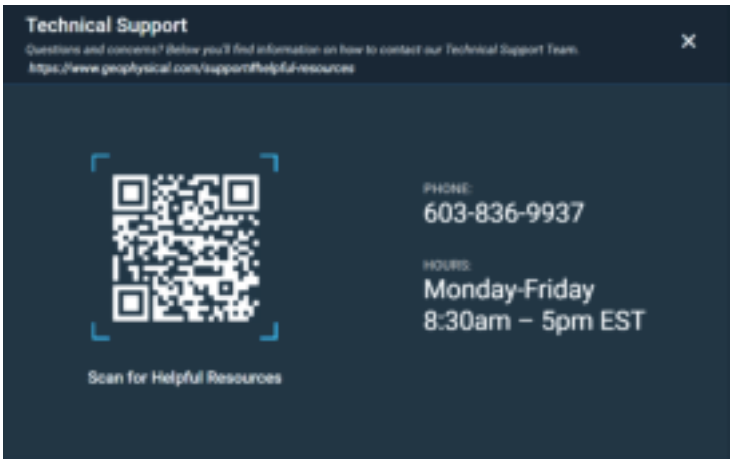
Data collection can be live-shared using an internet-connected device and a variety of 3rd party applications, such as FaceTime. GSSI does not guarantee the quality or performance of live streaming from 3rd party applications.

Technical Support

From the Flex NX Main Dashboard, tap the Technical Support icon.

Scan the QR code to open the Flex NX support page. You'll find links to download Flex NX documentation and firmware updates, a list of upcoming Flex NX training classes, and Flex NX training videos.

You may also call the number provided to speak with a member of our Technical Support Team.



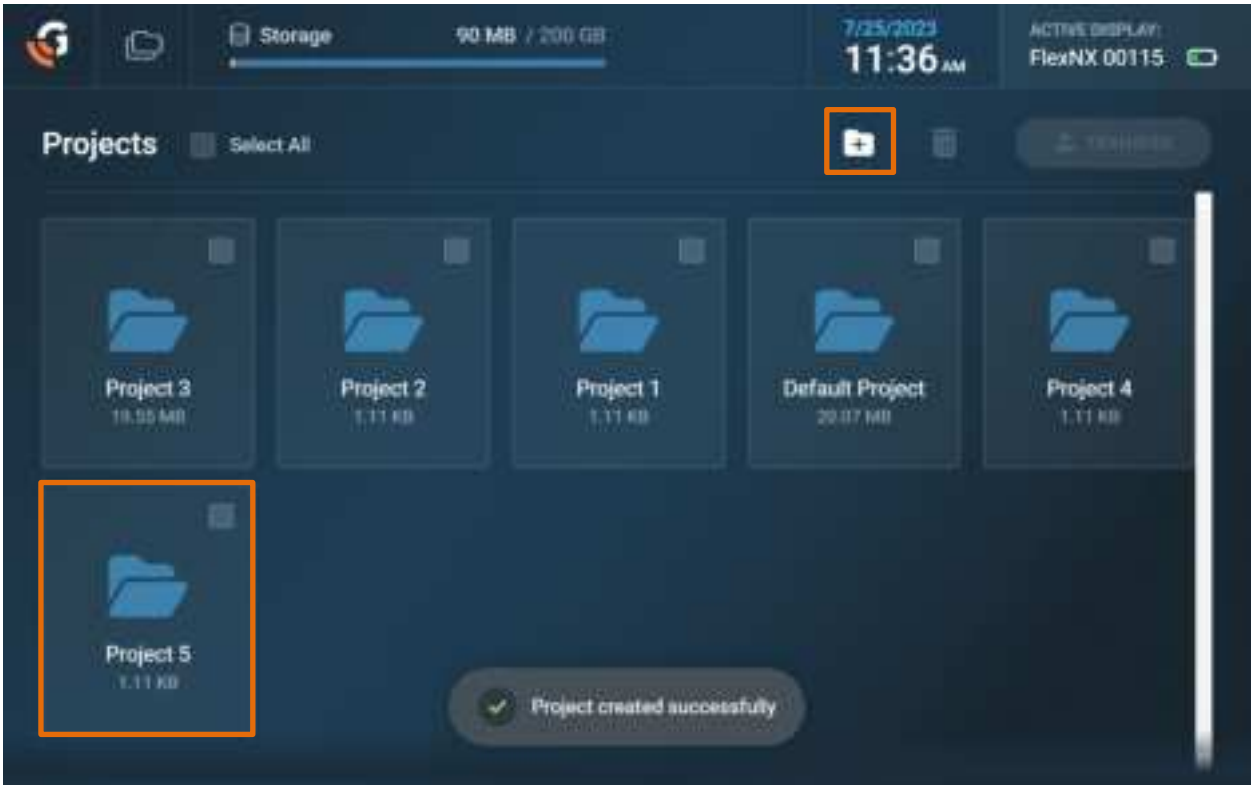
Please feel free to email training@geophysical.com with any questions, comments, or feedback.

Project Management

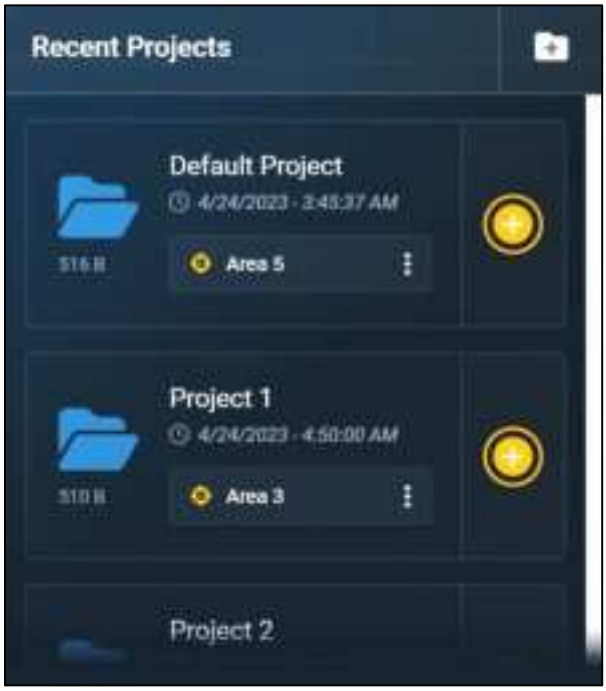
Flex NX's project management structure integrates seamlessly with our Fusion software, allowing you to easily transfer Fusion-ready data and results from Flex NX to your personal device. Flex NX and Fusion projects are designed around a unique project folder, and the ability to create multiple areas of interest within a project. Use this to your advantage on job sites with multiple working areas. Keep projects organized by creating individual project folders and areas of interest, and then save data and results into these areas. You can then upload your data to our Fusion software.

Creating New Projects

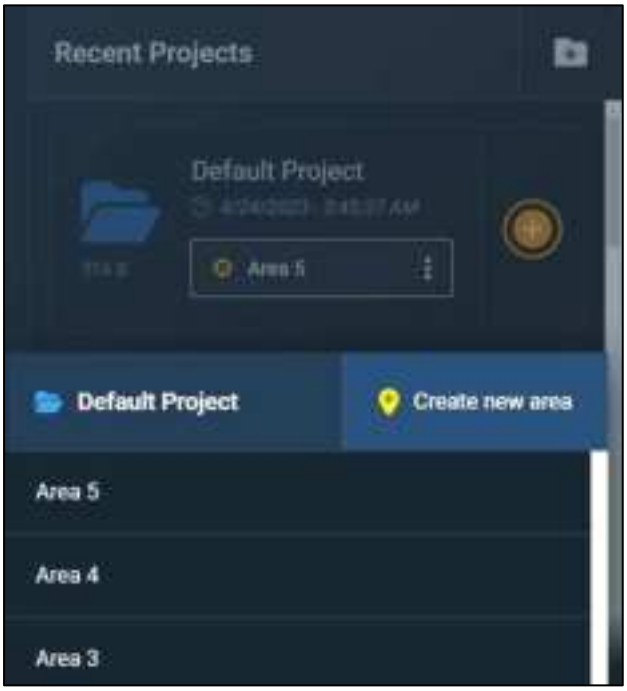
From the Main Dashboard, tap the Projects Portal icon to view saved projects. You may then open an existing Project Profile by tapping a folder or create a new project by tapping the Create New Project icon. A confirmation will appear once a new Project is created.



Alternatively, create a new project from the Main Dashboard's Recent Projects Pane.



From the Main Dashboard, tap the Create New Project icon. A new project will be generated.



To create a new Area of Interest within a project, tap the stacked 3-dot icon, then tap Create new area.

Flex NX's project management system streamlines report generation in GSSI Fusion. Make sure to spend the time organizing your projects around Areas of Interest. When you upload your projects to Fusion, your data will already be organized and ready for report creation. See section Uploading to GSSI Fusion for additional information.

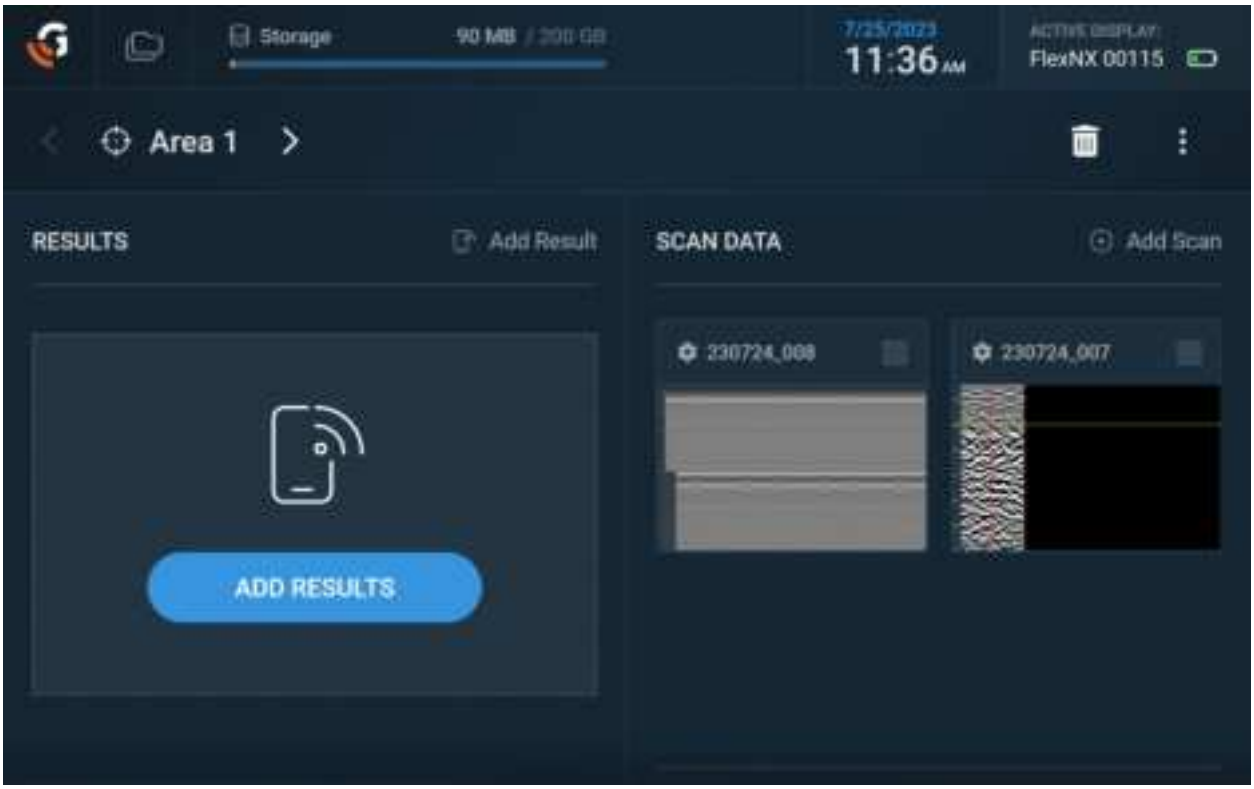
Projects Profile

Tap any existing folder on the Projects Portal to open the associated Project Profile. Toggle between Areas of Interest to view related Results and Scan Data.

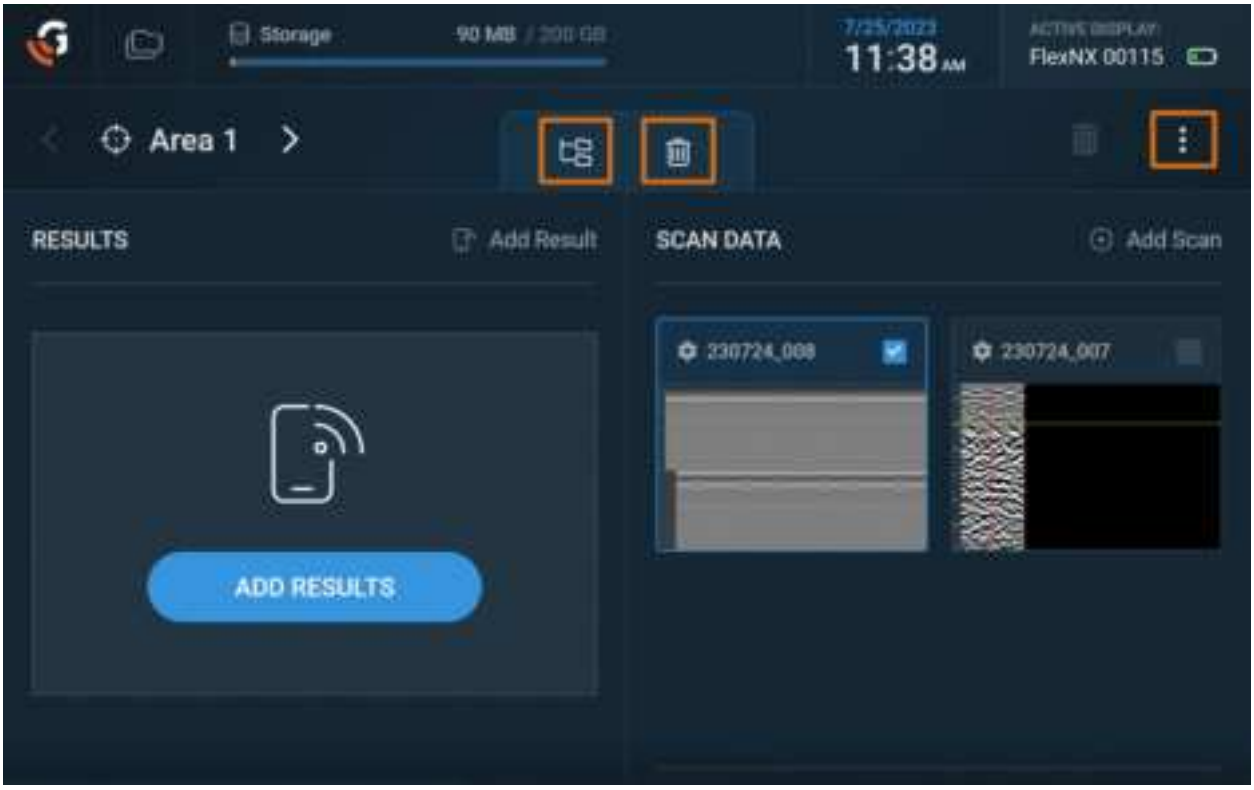
Results will typically be screengrabs taken during data collection. Select an image in the Results section to open it in a viewer.

Tap the Add Results icon to begin transferring photos to the current Area of Interest from a Wi-Fi connected device, such as a phone, tablet, or computer. This is a useful organizational tool, especially if you'd like to keep all project-related information organized on Flex NX. This is not a required step: you can also upload photos to Fusion separately

Scan data are GPR data files for use in GSSI's Radan 7 software. Tap Add Scan to collect a new data file within the current Area of Interest. You can also select a data file to open it in Playback Mode.



Project Profile screen, accessed by tapping any Project folder.

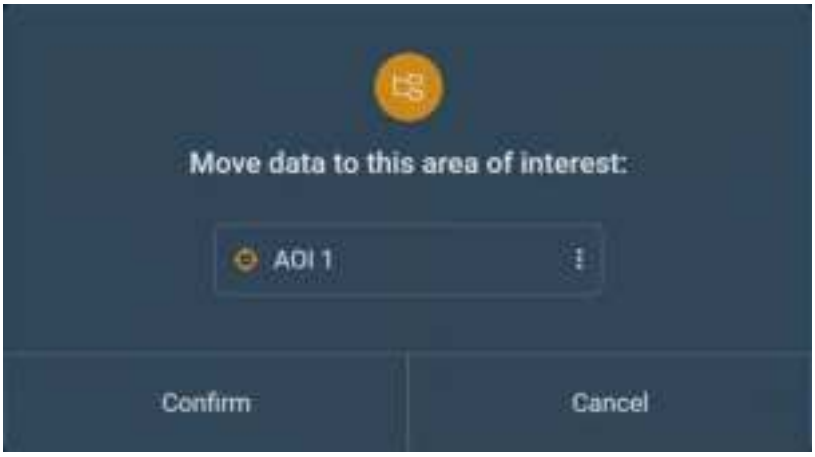


Project Profile screen. Select one or more Results or data files to see File Management tools.

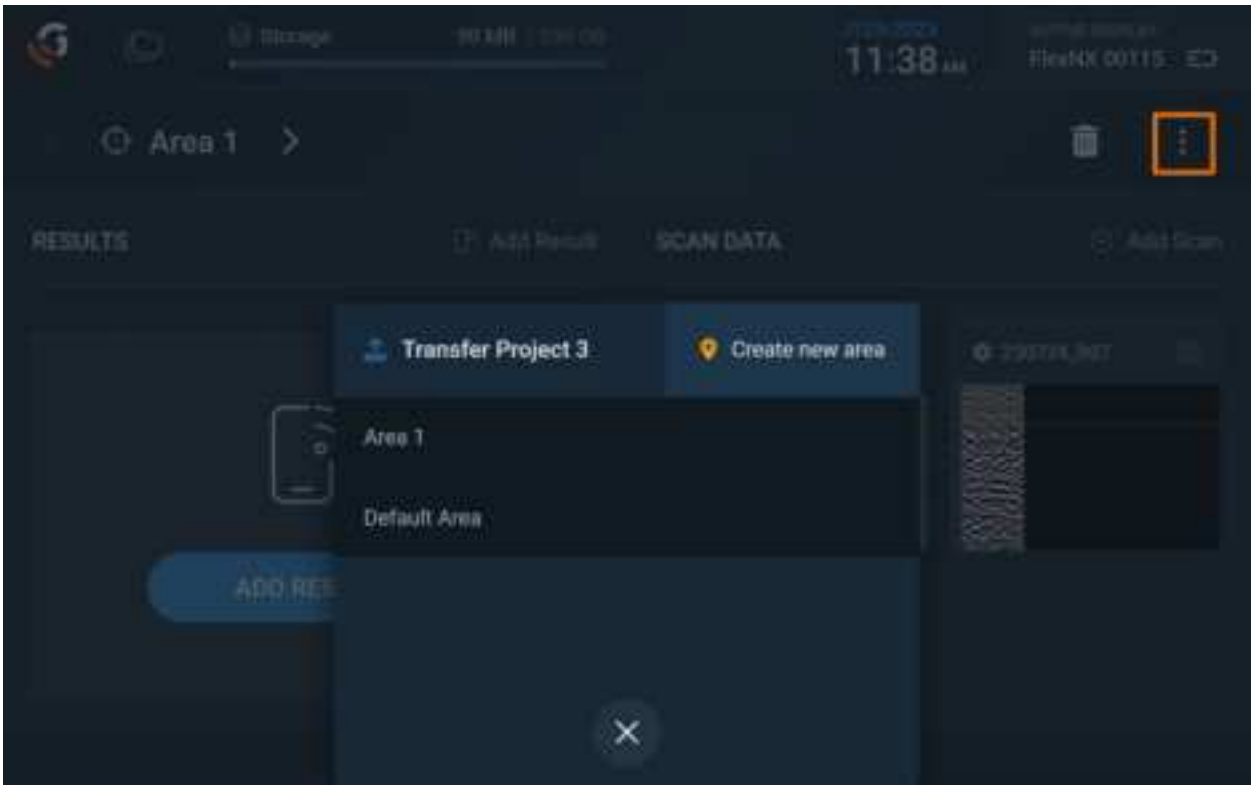
Select Results or Data files to perform file management. New icons appear once files are selected.

Select one or more data files to transfer to another Area of Interest using the File Management icon

You may also select one or more files and permanently delete them using the Trashcan icon.



To create a new Area of Interest, or to Transfer the Project to a USB drive or connected device, tap the stacked 3-dot icon in the upper right corner.

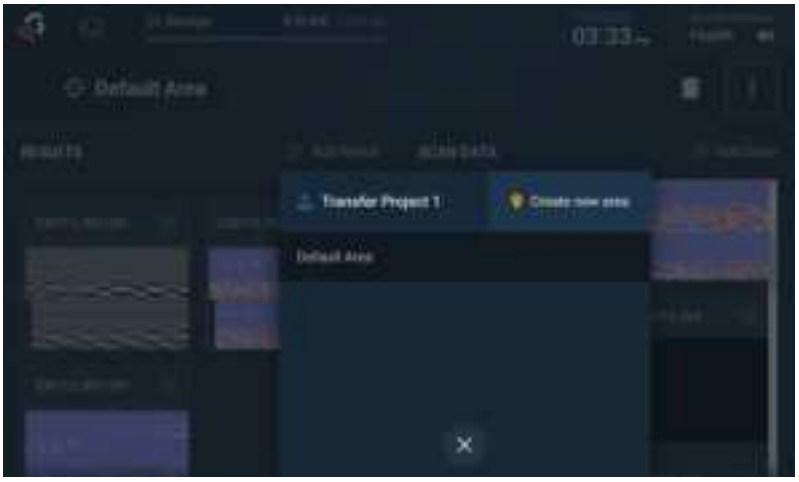


To change the area of interest, tap the three dot stack menu icon at the top right of the screen. Select an existing area of interest, or tap Create new area to add a new area of interest. You can also delete an area by tapping on the area and selecting Delete Area.

Transferring Data

Transfer project Results and Data Files from your Flex NX system to a personal device, such as your smartphone or personal computer. You can transfer .DZT or Fusion format files by USB drive or Wi-Fi. The .DZT option packages GPR data files for use in Radan 7 software. The Fusion format packages the results and data files, with their on-device organization, for easy upload to GSSI Fusion and further project management.

USB Transfer



In the Project folder of choice, tap the three dot stack menu icon at the top right of the screen.

Then, tap Transfer Project.

At the Transfer Project screen, insert a USB drive into the Flex NX system. Tap the USB icon to begin the process of transferring project data by USB drive.

Make sure to toggle the Include GPR Data checkbox to export your scan data.

Tap the Transfer icon in the top right corner of the Project Profile screen.

Tap the file type you want to export.

.DZT files are compatible with our RADAN 7 software. Fusion files are compatible with our Fusion project management software. Results, such as screengrabs, can be transferred in the Fusion format and they will also transfer with related .DZT data files. Tap Create Zip.

When your zip file is ready, tap Initiate Transfer to transfer your file to an inserted USB drive. Do not remove the USB until transfer is complete.

You'll see a confirmation message when the transfer is finished. You can then remove the USB and transfer files to other devices.

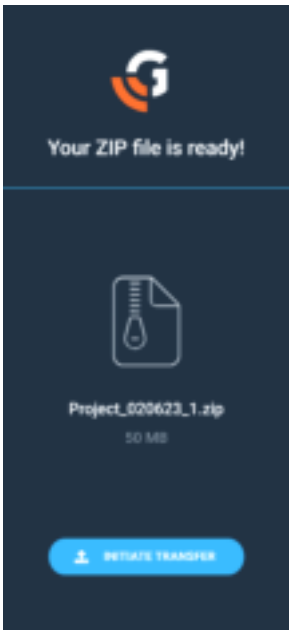
Wireless Transfer

Tap the wireless device icon to begin the process of transferring project data.

Toggle the Include GPR Data checkbox to export your scan data.

Scan the QR code with your phone or tablet. This will prompt your device to connect to Flex NX's Wi-Fi network and allow the Flex NX to transfer project results and data.

Tap the Transfer icon in the top right corner of the Project Profile screen. Tap the file type you want to export. Tap Create Zip.



When your zip file is ready, tap Initiate Transfer to wirelessly transfer your data to a personal device.

Uploading to GSSI Fusion

The Flex NX system was specially designed for seamless project management with the GSSI Fusion platform. Transferring data and project folders to Fusion is simple and easy.

Stay tuned for more information on our GSSI Fusion platform.

Collecting Data with Flex NX

Scanning and Marking Overview

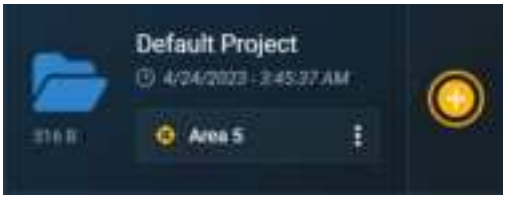
When using GPR to scan concrete, the objective is to identify objects within and below the slab and accurately mark their location on the surface. This helps drillers and saw cutters avoid damaging important reinforcement, utilities, and other slab and subgrade installations.

This is generally accomplished by collecting GPR data in a 2ft x 2ft grid pattern around each core penetration, or within a foot on either side of the entire linear distance of a saw cutting line. The lasers on the side of Flex NX demarcate the center of each antenna so you can align the onscreen backup cursors with a target. You can then accurately translate the target's location onto the slab surface using chalk, tape, or a wood crayon. Mark linear features in at least three places so you can capture their layout.

GPR cannot reliably determine the diameter of targets. Be sure to include extra width when marking reinforcement, conduit, and other targets. GPR scanners often use black for reinforcement and red for conduit. You can use other colors as needed, but red should be reserved for conduit. When using non-standard colors, reserve a dedicated, bright and highly visible color for conduit markouts.

A more in-depth description of scanning and marking techniques can be found in the Additional Resources section of this manual.

Before You Scan



To start a new scan from the Main Dashboard, tap the Start New 2D Scan icon in the project folder of your choice. This action will bring up the Select Concrete Type screen. You can also start a new scan from the Project Profile screen.

Select a concrete type that best represents your working conditions. This setting will affect your depth accuracy.

Select from Very Dry, Moderately Dry, Damp, or Wet concrete types.

Use your knowledge of the age of the slab to inform your decision. If the slab's curing state is unknown, consider using the Matching feature (see Depth Panel sections) to refine the depth scale calibration.

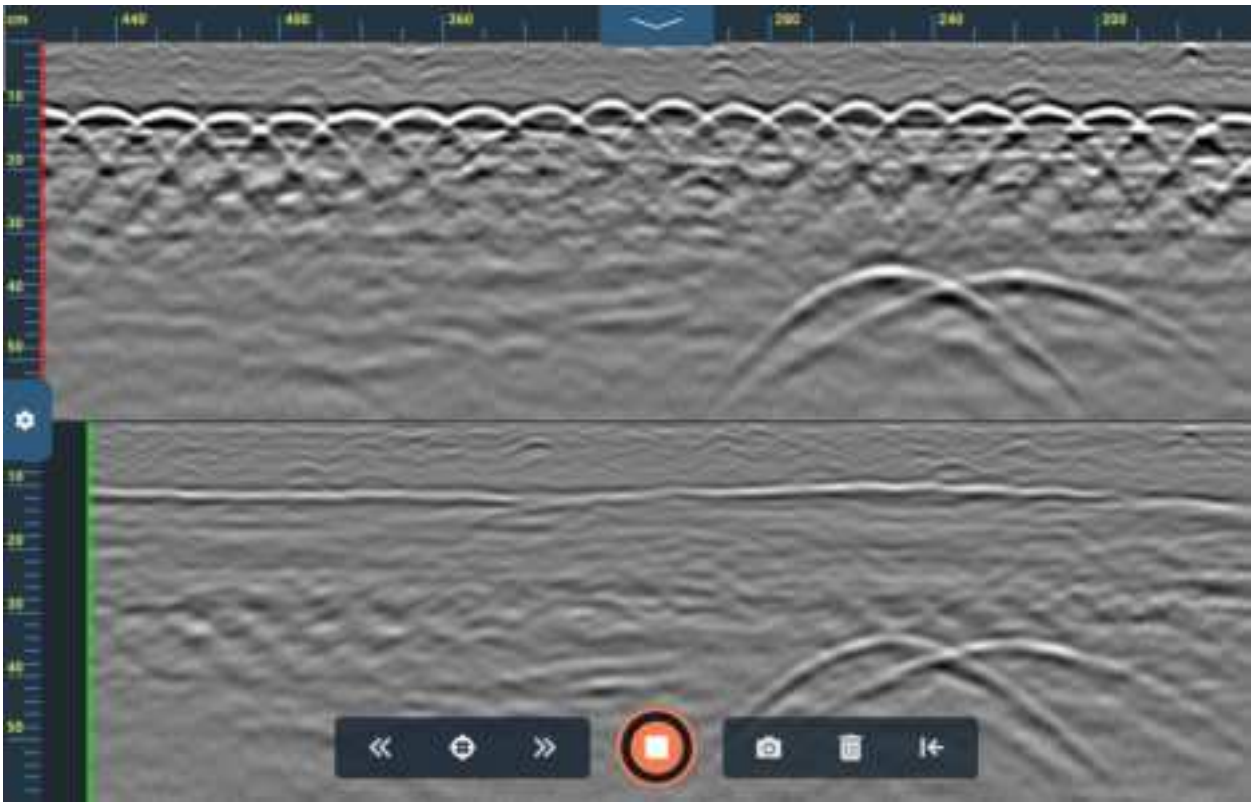
Dielectric constant, or relative dielectric permittivity [RDP], is a measurement of a material's ability to store, and then transfer, electromagnetic waves. By selecting a Concrete Type you are setting an estimated dielectric constant, which could improve depth accuracy of objects in your data. Use the Concrete Cure screen for an initial benchmark, then further refine the dielectric (and your depth scale) by using the Depth Panel options in Collection Mode

Data Screen and Basic Collection

The Data Screen is where you collect 2D profiles, place user marks, and save screenshots.

Tap the Start Scan icon to begin a new scan. The icon will now have a white square at its center. The data screen will remain blank until you push Flex NX forward. Push Flex NX forward to begin collecting data; the profile will begin building from left to right on the screen. The filename is displayed in the Top Navigation Panel (minimized by default) and is named using the current date and an affix representing the scan number.

Stacked Mode is the default display method, showing both the standard orientation antenna (top) and the cross-polarized antenna (bottom). As you collect data you will notice an offset in the two profiles. This offset represents the physical distance between the two antennas. Move the system in reverse to see a backup cursors: red for standard orientation (front antenna) and green for cross-polarized (rear antenna).



You can playback a file by opening it from the Project Profile screen. The playback and collect screens are identical and offer the same range of functionality. When finished with Playback, simply tap the New Scan icon to collect new data.

The Data Collection screen features the following functions:

	**Top Navigation Access Icon.** Tap to access Return to Dashboard, Active Project options, Area of Interest options, File Information, and Current Display options. Tap again to minimize the Top Navigation Panel.
	**Side Navigation Menu.** Tap to access the Gain, Display and Depth panels. See Gain, Display and Depth sections below for more information. Tap again to minimize the Side Navigation Menu.
	**Start/Stop Scan.** Tap to start collecting a new scan. Push Flex NX forward to begin building your GPR profile.
	**Previous Target/Next Target.** Toggle between user marks, displaying the depth and distance traveled information. You can also edit or delete the user marks.
	**Target Marking.** Use your finger to drag and place the crosshair on a feature of interest, then tap the Target Marking icon to place a user mark. You can change the color of your user mark before saving it. Tap again to exit Target Marking mode.
	**Screen Grab.** Tap this icon to take a screenshot of the on-screen data. The Flex NX system will save the screenshot as a PNG image file for later transfer. Screen grabs are saved to the Results section of the current Project and Area of Interest.
	**Delete Current Scan.** Tap to discard your current scan.
	**Reset Cursor.** This function will reset the cursor to the end of the current scan. You can then resume collecting data without starting a new file.

Pinch Zoom and Pan: You can zoom in on features by pinching the screen using two fingers. You can return the screen to its original dimensions, or stretch it further, by moving your fingers apart. When zoomed, drag one finger to pan the display right, left, up, and down. Pinch zoom and pan affect both channels in Stacked Mode.

Top Navigation Panel

The Top Navigation panel, located at the top of the screen, can be accessed during data collection by tapping the upward arrow.

Tap the Top Navigation Access icon to display the following functions:

Return to Main Dashboard. Tap to exit collection and return to the Dashboard.

Active Project. Tap the arrow icon to view the current project's saved content. From here, you can access results and data files saved to Areas of Interest.

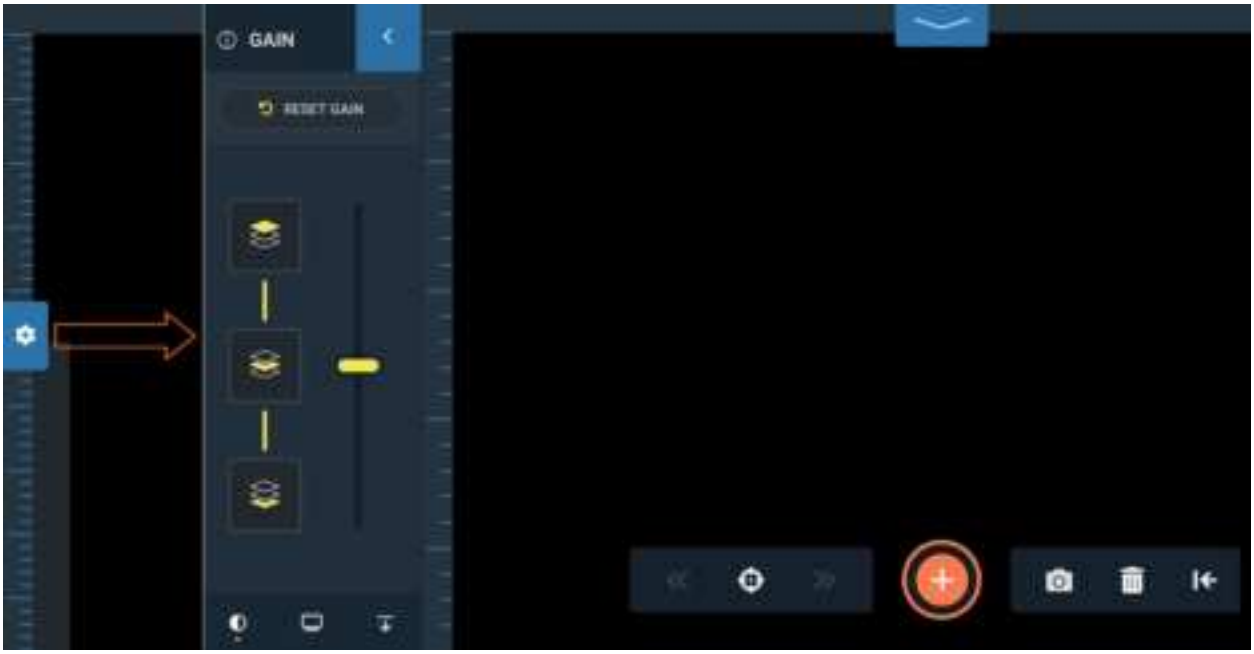
Current File. View the name of the current file. Data files are named incrementally based on the calendar date and the order of collection. The naming prefix uses two numbers each for day/month/year, followed by an underscore and the file number.

Area of Interest. Tap the arrow icon to change the Area of Interest. You will see Default if no Areas of Interest are available.

Current Display. View or change the currently active device. For example, if NX25 is connected to Flex NX you can toggle between the two. The toggle option is not available when only using Flex NX.

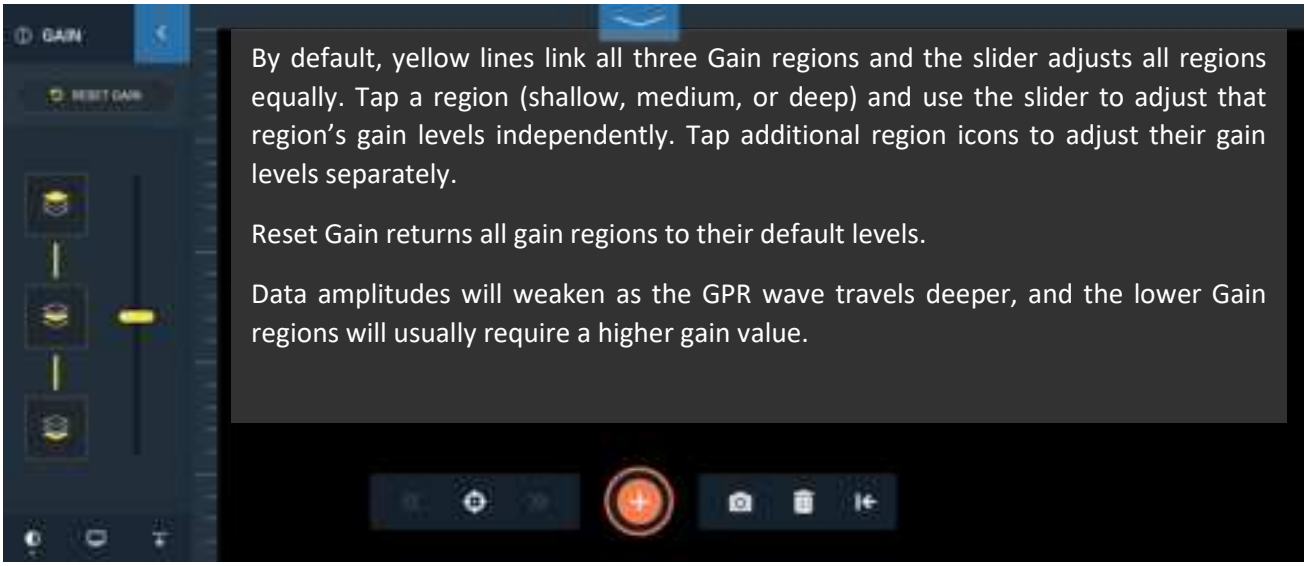
Side Navigation

Activate the Side Navigation panel by tapping the gear icon on the left side of the Data Collection screen. This panel is always accessible in the Data Collection screen before, during, or after data collection or Playback. The Side Navigation panel contains the Gain, Display, and Depth panes. The icon for each pane is located at the bottom of the panel.



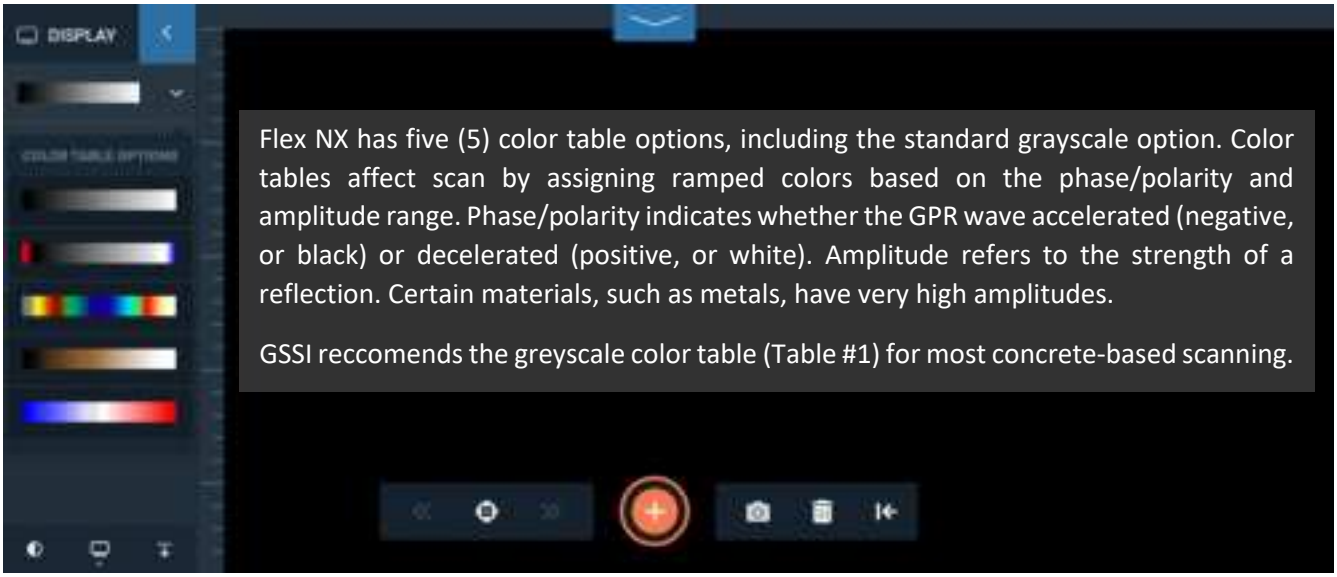
Side Navigation: Gain Panel

Use the Gain Panel to adjust the visual contrast of your data.



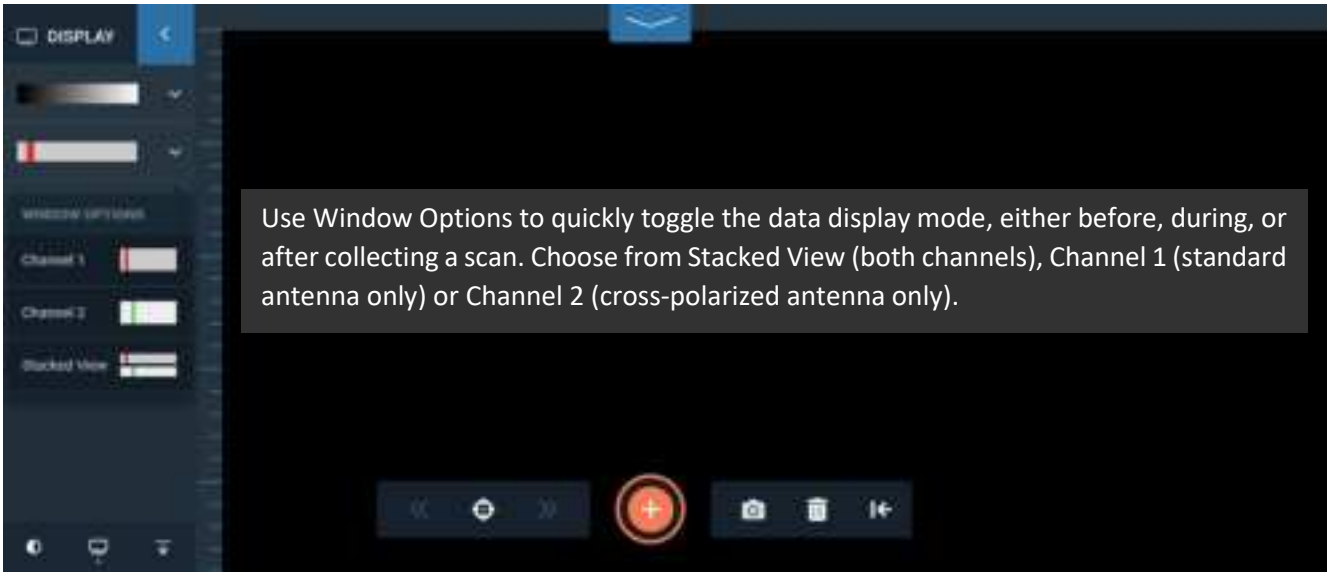
Side Navigation: Display Panel: Color Table Options Submenu

Use the Display Panel submenu to select from a list of several color tables.

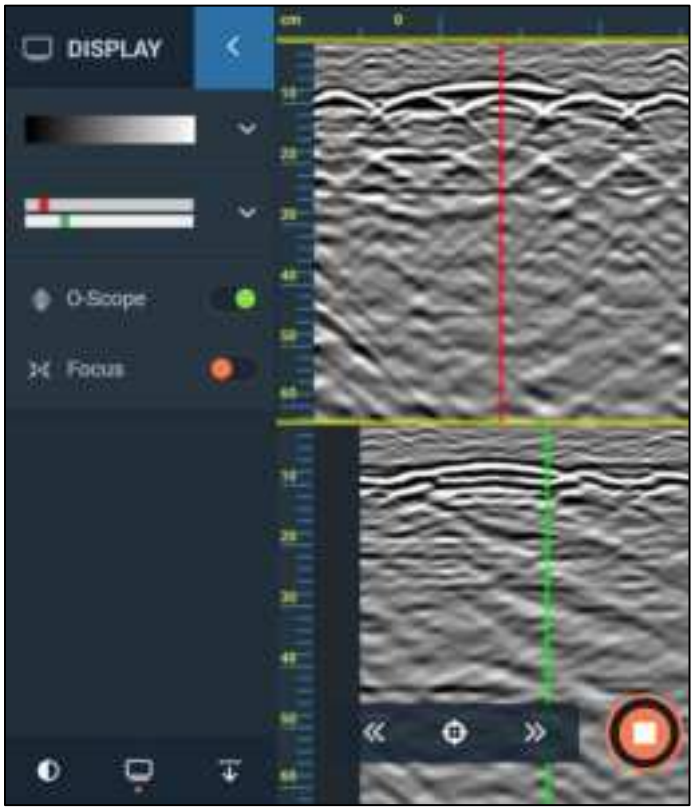


Side Navigation: Display Panel: Window Options Submenu

Use the Window Options submenu to switch between three data display modes. Options include Stacked, Channel 1, and Channel 2 viewing modes. You can also toggle on/off the O-Scope and Focus Mode.



Window Options Submenu: Stacked View



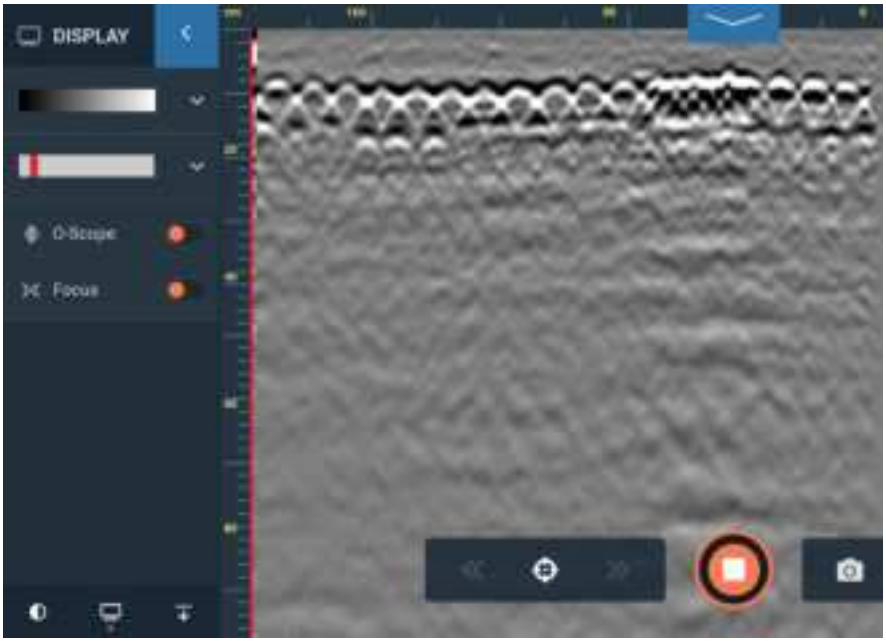
Stacked View displays both the standard antenna and the cross-polarized antenna

The front antenna (Channel 1, on top) is standard polarized and corresponds with the red backup cursor and red lasers.

The rear antenna (Channel 2, on bottom) is cross-polarized and corresponds with the green backup cursor and green lasers.

Use the Pinch Zoom function to zoom in on features of interest in both channels. When zoomed, use one finger to pan both profiles.

Window Options Submenu: Channel 1

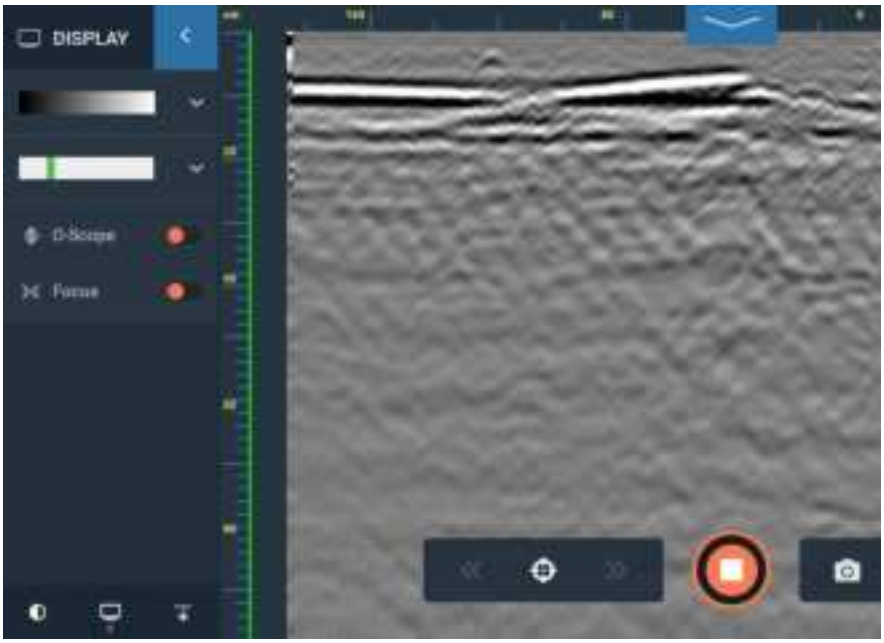


Selecting Channel 1 will only display data from the standard polarized antenna. Note the **red** back up cursor corresponds with the red side lasers of the standard antenna.

Additionally, with Channel 1 activated you will only see the **red** side and front lasers.

Use the Pinch Zoom function to zoom in on features of interest. When zoomed, use one finger to pan.

Window Options Submenu: Channel 2



Selecting Channel 2 will only display data from the cross polarized antenna. Note the **green** back up cursor corresponds with the green side lasers of the cross polarized antenna.

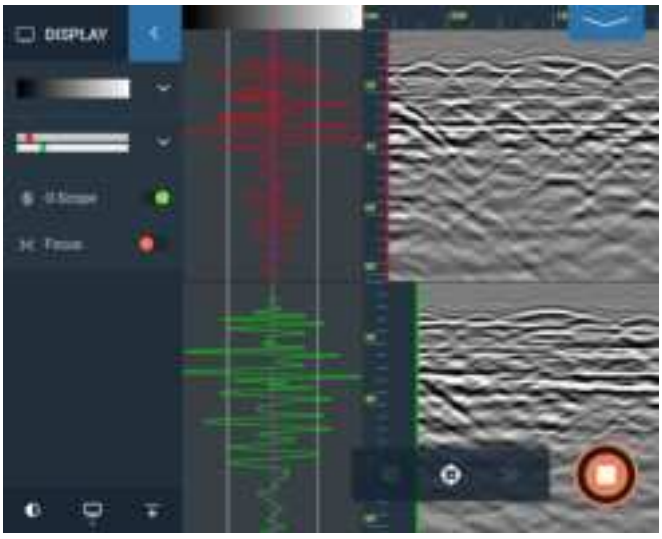
Additionally, with Channel 2 activated you will only see the **green** side and front lasers.

Use the Pinch Zoom function to zoom in on features of interest. When zoomed, use one finger to pan.

Each antenna has individual, yet complimentary, strengths. The standard antenna is more sensitive to metallic targets, while the cross polarized antenna can make it easier to resolve non-metallic targets. Use both antennas to make informed decisions.

Window Options: Oscilloscope

The Oscilloscope waveform, or O-Scope, can be toggled on and off. When on, it will be displayed on the left side of the profile. With experience, the O-Scope can be used for a more nuanced analysis of the data.



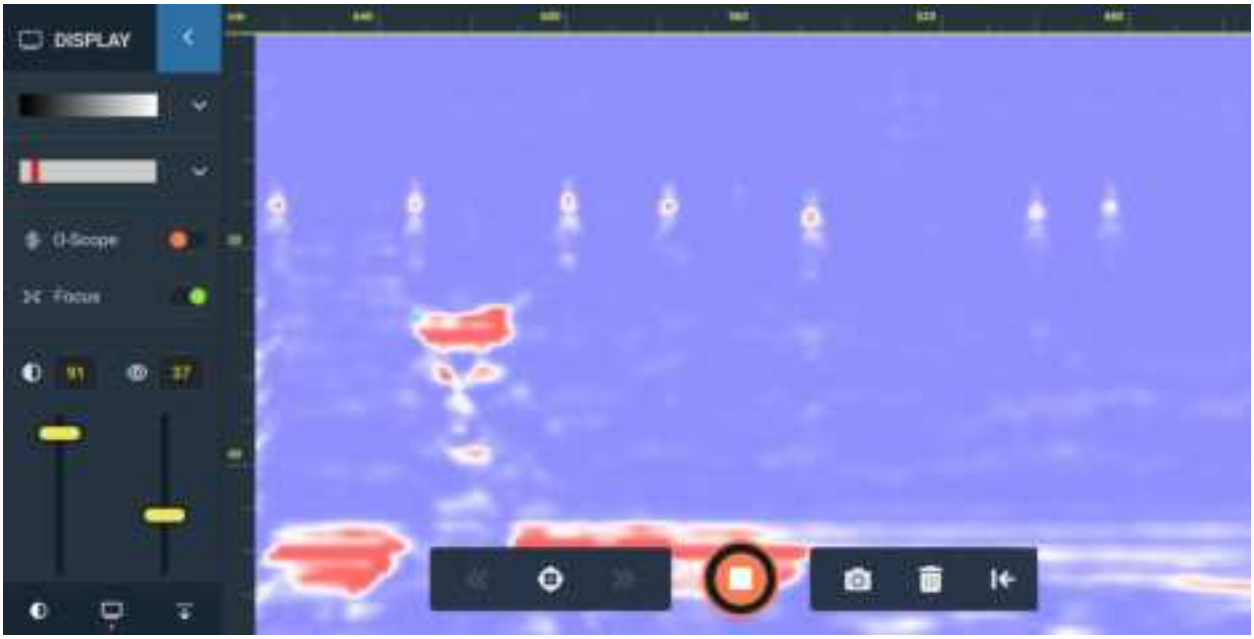
The O-Scope displays the individual GPR trace associated with the backup cursor's current location. The vertical axis mirrors the scan's depth scale, with increasing depth from top to bottom. The width of the O-Scope peaks represents amplitude. Stronger reflections, such as from metal, create larger O-Scope peaks on both sides. Phase/polarity is represented by the peaks on either side of a centerline. Peaks to the right indicate normal phase/polarity, while peaks to the left indicate negative phase/polarity.

The O-scope is a visualization of the raw data collected by the GPR unit. With practice you'll

find that the O-Scope is essential for advanced analysis and aligning the horizontal Target Marking line with a target's highest amplitude peak. It is also helpful to use the O-Scope when performing functions like hyperbola matching and Set Depth. Lastly, the O-Scope can provide information on data quality, depth penetration, and the presence of external electromagnetic interference. Periodic external noise (such as cellular network communication) will make the trace look 'jittery' and jagged, while continuous external noise (such as radio and television transmissions) can cause the trace to shift off the centerline of the O-scope.

Window Options: Focus Mode

Focus Mode creates an envelope of data that removes phase/polarity information, displaying only amplitude. It also collapses hyperbolic tails, transforming hyperbolas into discrete objects. Use focus mode to improve visualization of features that may not be obscured in non-Focused data.



Optimizing Focus Mode requires an accurate dielectric; an incorrect dielectric will result in incomplete collapse of hyperbolas. See the Depth Panel section (below) to discover methods for calibrating dielectric.

The removal of hyperbolic tails can reveal targets that are closely spaced, or deeper targets obscured by hyperbolic tails from reinforcement elements and other materials within the slab.

For example, Focus Mode may assist in visualizing the slab bottom, and potential air voids, that were previously obscured by the abundant hyperbolic tails from a layer of wire mesh. In other cases, Focus mode can collapse the hyperbolas from the flanges and top ribs of pan decking and could reveal conduit or other targets between the top and bottom flanges.

Focus Mode displays the focused data and raw data in a single screen. Focused data are overlain on the original scan, and you can adjust the contrast and transparency sliders to modify the resulting image. The contrast slider enhances the focused overlay, amplifying weaker targets. The transparency slider reveals more or less of the underlying scan, allowing a direct comparison of the two visualizations.

The contrast slider adjusts the color contrast of targets seen in Focus Mode.

The transparency slider adjusts the level of transparency of Focus Mode, allowing a direct comparison of the focused data and the original (non-focused) data.

Depth Panel: Depth Options Submenu

The Depth Panel provides three options for adjusting your dielectric constant and thereby refining your depth readings. From least accurate to most accurate, the choices are Concrete Cure, Matching, and Set Depth.

Concrete Cure applies a predefined dielectric based on established values. This can be an accurate method, but it relies on knowledge of the state of concrete curing.

Matching involves fitting a digital hyperbola to a target in your data. This is an accurate, and widely used, method for calibrating the depth scale.

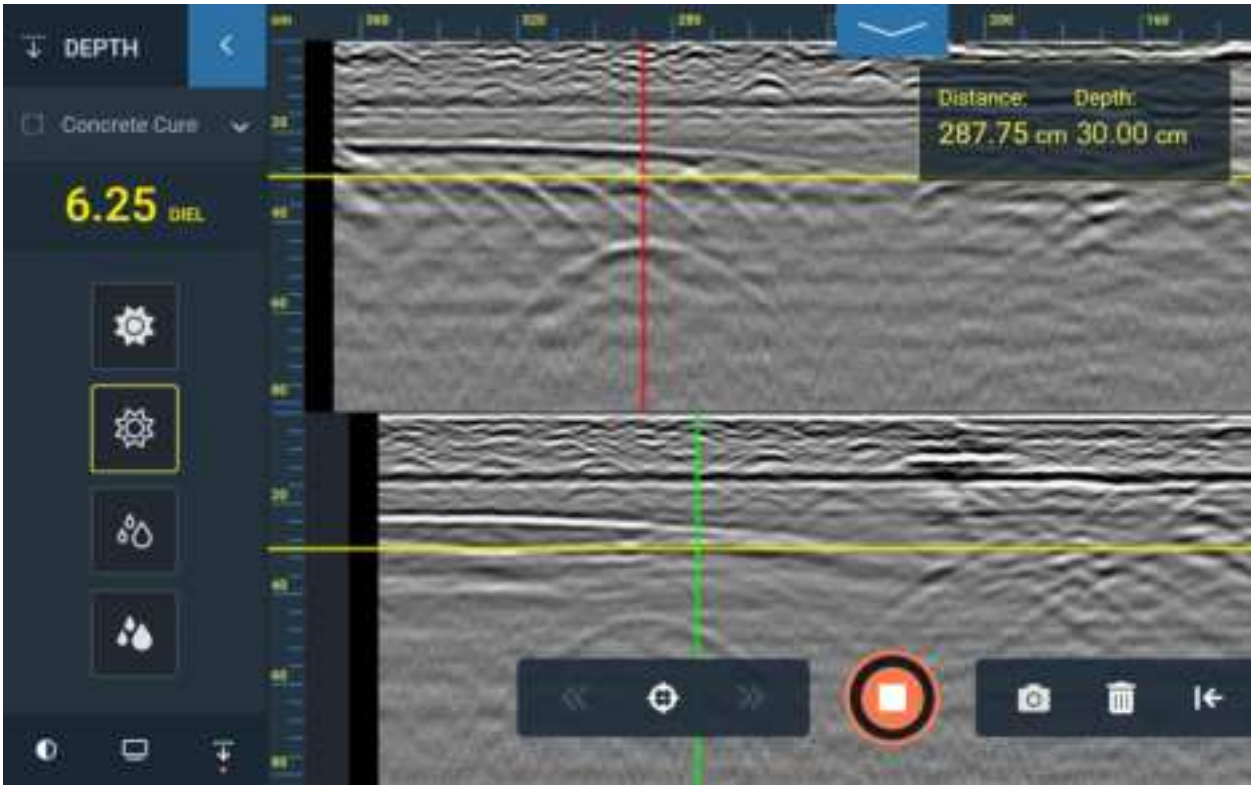
Set Depth is the most accurate method, but it requires a physical measurement of the depth of a target. This information is not always available, so Matching will likely be a more appropriate choice.

Depth Options Submenu: Concrete Cure

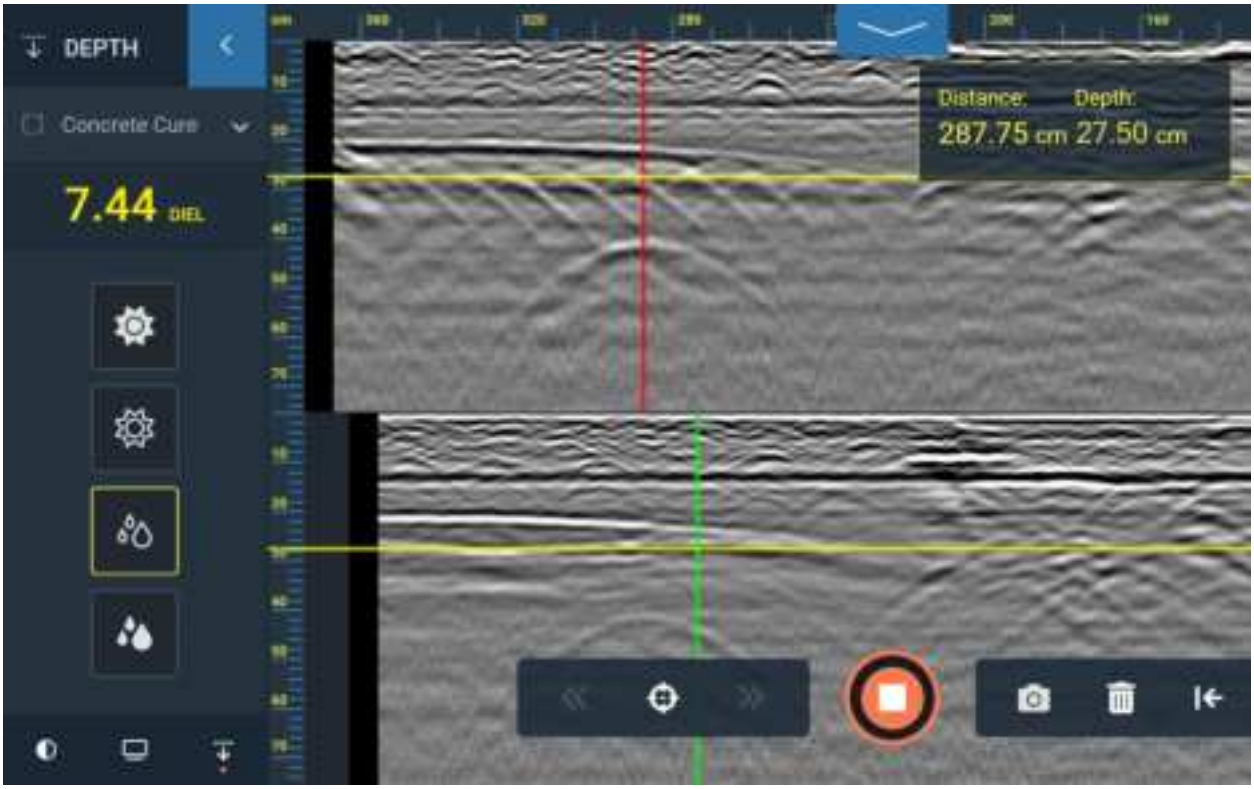
Concrete Cure is the simplest, yet least accurate method for calibrating the depth scale. You will be prompted to select Concrete Cure when starting a new 2D scan. Use your knowledge of the age and condition of the concrete to inform your decision. Select a Concrete Cure by using preset dielectric values based on four standard concrete curing stages: Very Dry, Moderately Dry, Damp, and Wet.

Using one of the preset Concrete Cure types will only adjust your depth scale; it will not affect the GPR data quality. In the images below, note how a change in Concrete Cure Type expands the depth scale but does not visibly alter the GPR data.

GSSI recommends starting with Moderately Dry (6.25 dielectric) for most concrete types. However, not all concrete slabs are the same. Consider using the Matching tool (see below) if you cannot readily determine the concrete curing state. Once an accurate dielectric is established, the targets in the slab will be displayed with a more accurate depth. We recommend using the Depth Panel options any time you are scanning a new slab.



Concrete Cure set to Moderate Dry. The yellow cursor is placed at 30.00 cm below the surface.



Concrete Cure set to Damp. The yellow cursor is now located at 27.50 cm below the surface.

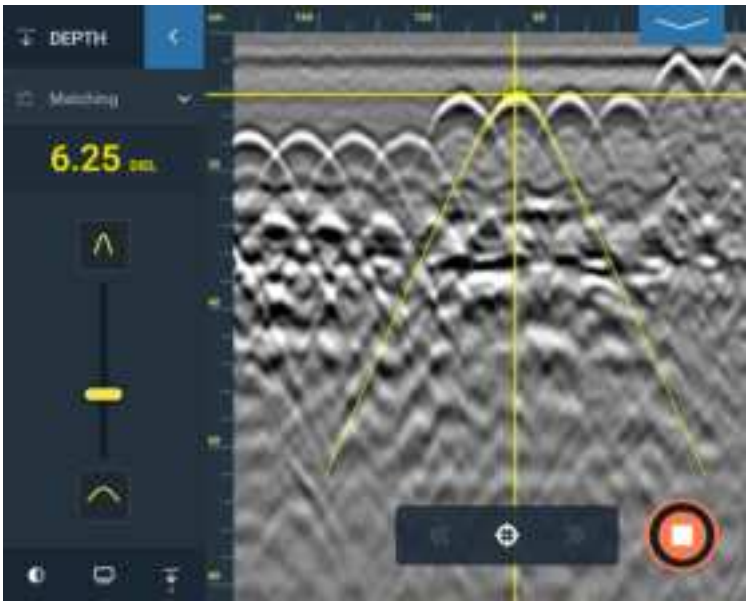
As the dielectric value increases, the calculated depth of targets becomes progressively shallower. This effect is due to the slowing of the GPR wave in higher dielectrics. For example, using a dielectric of 4.59 (Very Dry) a target is observed at 35 cm deep. Changing the dielectric to 6.25 (Moderate Dry) changes the target's depth to 30 cm. Dielectric values of 7.44 (Damp) and 14.10 (Wet) reduce the target's depth to 27.5 cm and 20 cm, respectively.

The takeaway point is that the dielectric value can dramatically change the depth reading for a given target. The target itself is not changing its true depth, but Flex NX is using the available information to calibrate its depth scale. A more refined dielectric value will greatly improve the overall depth accuracy, leading to improved markouts and increasing safety for cutting, coring, and drilling teams. Selecting a Concrete Cure Type is a good first step, but it should always be followed by Matching and Set Depth (when possible).

GPR effectiveness improves as concrete continues to cure. GPR depth and data quality are reduced when scanning green (uncured) concrete due to enhanced electrical conductivity.

Depth Options Submenu: Matching (Hyperbola Fitting)

Improve the depth accuracy of targets by using the Matching tool. For best Matching results, GSSI recommends using the standard antenna in single channel mode.



During collection, locate a hyperbola in your profile. It must represent a target that you scanned perpendicular to its length. If you are unsure whether you are scanning perpendicular to the object, scan it at multiple angles and find the scan angle that produces the narrowest hyperbola. This is the perpendicular scan.

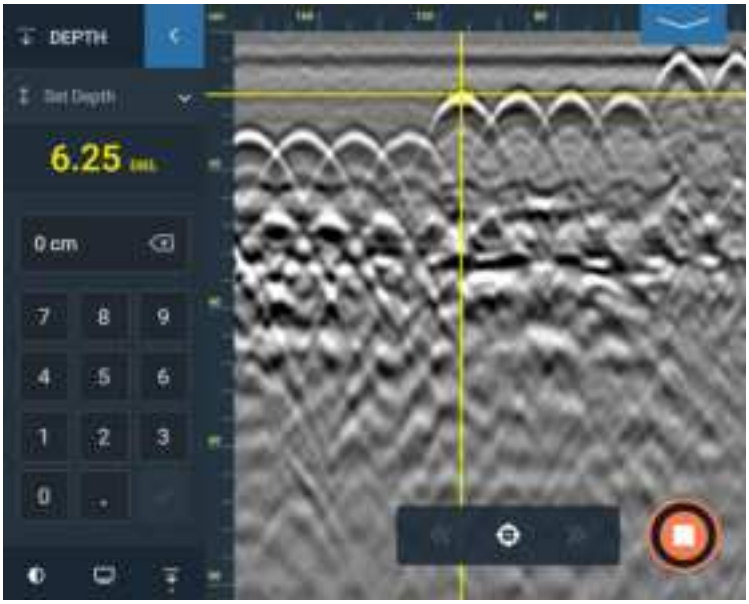
Alternatively, locate a target and mark it on the slab. Collect an adjacent scan and mark the target again, then draw a line between the marks. Using this method, you can accurately determine a target's orientation.

To use the Matching tool, use your finger to position the crosshair and the digital hyperbola overlay at the peak of the first brightest band of color. Use the O-Scope (see Display Panel) to assist with placement.

Use the vertical slider to narrow or widen the hyperbola overlay. As you reshape the hyperbola the dielectric value and depth scale will update in response. Match the shape of the hyperbola overlay to the tails of the target hyperbola. Target depths will now be more accurate.

Use the Matching tool on multiple hyperbolas to check your accuracy. If your results are inconsistent, you have likely crossed targets at an incorrect angle or the target sizes are much larger than their depth.

Depth Options Submenu: Set Depth



For homogenous materials, like most concrete, you can greatly improve depth accuracy by using the Set Depth tool. For best results, use only the standard orientation antenna in single channel mode. In some situations, the true depth of a target can be determined through drilling or observation of slab edges.

To use this feature, scan over a target with an established depth. Collect enough data on either side of the target to fully image the resulting hyperbola.

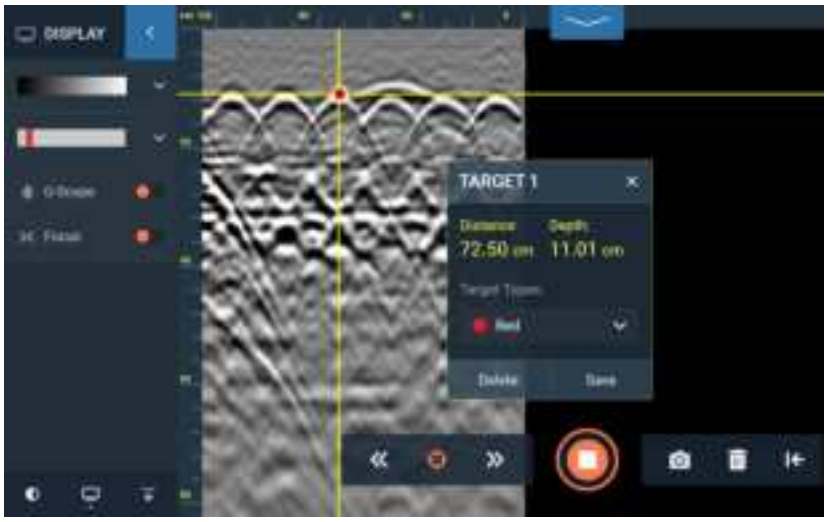
Use your finger to tap the screen, then drag the crosshair reticle to the top center of the hyperbola. Align the cursor with the first strongest band of color; this band corresponds with the top of the target. Use the O-Scope to assist with cursor placement.

Using the number pad, type in the known depth of the target. This process will update the dielectric and calibrate the depth scale. Target depths will now be more accurate, especially in homogenous concrete.

The Set Depth tool is only applicable to a target of a known depth; it will not be useful in all cases. Avoid entering a depth based on assumptions or guesses. When in doubt, use the Matching tool instead of Set Depth.

Target Marking

Use the Target Marking feature to place user marks in your data. These points will assist in marking, referencing, or plotting the distance along the profile and depth below surface of features of interest. Consider using specific colors for target interpretations. Your on-screen marks will appear in screengrabs and can be useful additions to project Results.



Target Marking icons

Disabled  Enabled

To mark a target, activate Target Marking by tapping the Target Marking icon. Tap the screen and then drag your finger to place the crosshair over a target of interest. As with other target-related functions, like Matching and Set Depth, place the crosshair at the center of the hyperbola and within the first strongest color band. Use the O-Scope to fine-tune crosshair placement.

In the accompanying popup window you'll see the target's distance along the profile and its depth. Note that the depth reading is only as accurate as the current dielectric value. If in doubt, use Matching or Set Depth (where applicable) to refine the dielectric and improve depth accuracy. Reposition the popup window by tapping and holding with one finger, then moving your finder to drag the window.

You can also select a target color from the dropdown menu. GSSI recommends using designated colors for specific target types, such as red for conduit and blue for reinforcement. Press Save to place the mark or Delete to discard it.

 Use the Previous Target / Next Target icons (found on the Bottom Navigation Bar) to quickly jump between multiple targets within a single scan.

In the System Settings screen, try assigning the Mark function to one of the Flex NX or NX25 programmable buttons. Using the assigned Mark button during 2D collection will place a dotted vertical line in your data.

Additional Resources

Scanning and Marking Best Practices

There is a wide variety of objects that may be present in a concrete slab, including reinforcement, conduits, post-tensioned and pre-tensioned cables, and other elements of the slab construction. An exhaustive list is beyond the scope of this document but see below for an introduction to the basics of scanning concrete and identifying targets within and just below the slab.

Basic Scan and Mark Techniques

GSSI recommends collecting as much data as possible to ensure you are making the most informed decision. When starting a scan, take a long scan of the area to get an idea of the general reinforcement and utility layout.

To mark a target on the slab, or on your data collection grid sheet, scan over and past it and roll the antenna backwards until the cursor is centered on the peak of the hyperbola. To avoid error, don't scan too far past the object, as you may not roll the antenna backward along the same path. Place a small mark on either side of the antenna, both at the same distance from the antenna, using the laser associated with the antenna you are aligning with the target. Move the antenna and place a final mark in the direct center of the two small marks or move the antenna backwards until the front laser is centered between the two small marks and place the final mark.

This process results in a mark directly where the center of the antenna was when it crossed the center of the target. Repeat this process until you have at least three marks representing the object (if it is a linear object) and draw or mark out the object on the slab or grid sheet in accordance with CSDA-BP-017, the Concrete Sawing and Drilling Association's best practices document on properly marking your GPR findings.

Generally, reinforcement should be marked in black (or a non-red color if black is not appropriate for the surface) using a permanent marker or wood crayon. Conduit should be marked in red, or another color if appropriate, but never mark conduit with the same color that you use to mark reinforcement. Mark at least a 1" exclusion zone on either side of the center point of the object, as GPR cannot reliably determine the size or width of embedded objects. If the object is much wider than this, such as a beam or duct bank, mark an exclusion zone of at least 1" beyond either end of the object. If the object is not travelling in a straight line, mark as many locations as necessary to properly capture its path of travel through your scan area. The owner or contracting agency should mark the extents of your scan area, though you might have to mark them if it is not done for you. If the scan area is free of embedded objects, mark "OK" within the scan area.

Keep in mind that you need direct access to the concrete slab in order to scan. Insulating foam, waterproofing plastic, wood, or an air gap between the antenna and the top of the slab will all prevent the radar signal from entering the concrete slab and should be removed by the owner/contractor before you arrive. Standing water on the surface of the slab will also reduce the effectiveness of GPR.

See the CSDA best practices document available at csda.org for further details on properly marking GPR findings.

GSSI Academy Training

When pursuing mastery of concrete scanning there is no substitute for experience. Whether you are about to collect your first scan or your 100th, improving your knowledge of GPR is always time well spent. Training and dedication are the keys to success, and our GSSI Academy classes are designed with all experience levels in mind.

We highly recommend enrolling in one of our live Flex NX classes at GSSI headquarters in Nashua, NH or our training location in Henderson, NV. If you can't get to a class right away, or you've already completed a class and want more information, this User Guide provides guidance for scanning and identifying concrete reinforcement scenarios and other concrete-related targets like post-tensioned cables and air voids beneath slabs. These data may or may not be already loaded onto your Flex NX, depending on your software version. The following discussion will walk you through selected concrete data examples, provide information on construction techniques, and offer scanning tips to improve your scanning experience.

Need more information? You can visit our dedicated Flex NX support site by scanning the provided QR code or visiting us at www.geophysical.com/support/flexnxsupport.com. You can then download or share a PDF of this User Guide, browse other Flex NX documentation, access video tutorials, and download the latest Flex NX software.

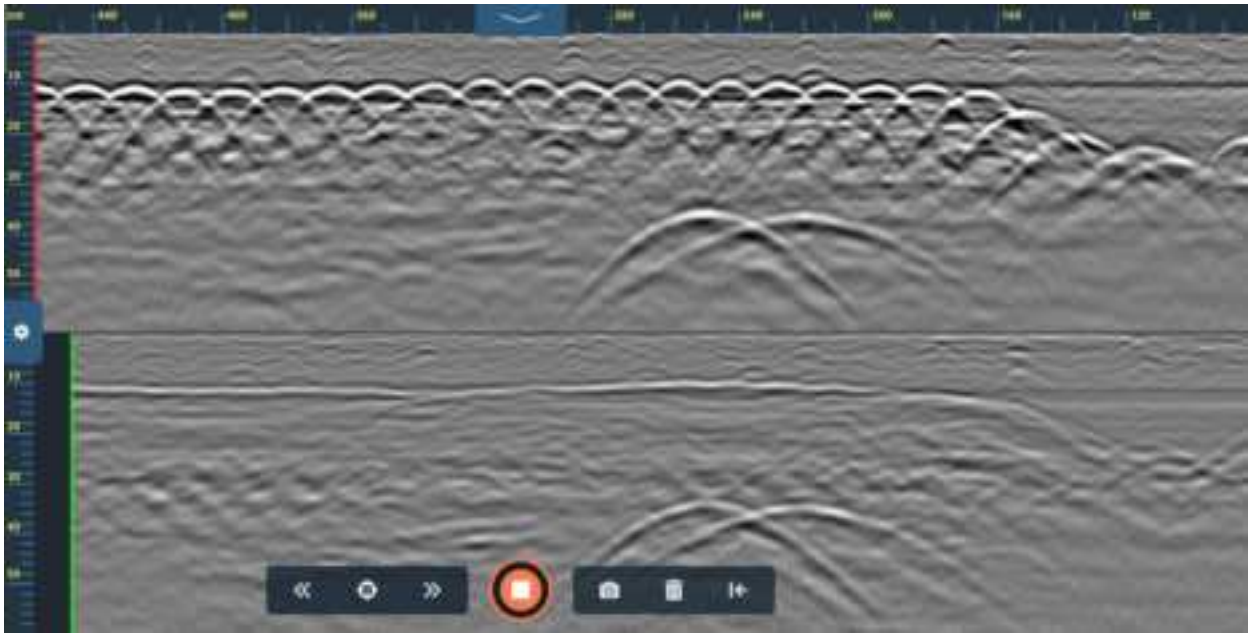
Data Examples

We have compiled Flex NX data examples covering some common concrete scanning scenarios. Depending on your software version, your Flex NX system may or may not have data examples preloaded.

GSSI does not recommend scanning green (freshly poured) or uncured concrete. The conductivity of immature concrete dissipates the GPR energy, resulting in greatly reduced depth penetration and data quality.

DISCLAIMER: Your data may look different from the examples featured below. The following examples are no replacement for knowledge and experience and they do not represent all real-world conditions and scenarios. Please use your best judgment when scanning.

Wire Mesh



Wire mesh, located near the top of the profiles. Note the following features:

- Dipping mesh at far right of the profiles.
- Close spacing of targets. Note the hyperbolic tails overlapping due to the close spacing.
- The presence of two deeper, larger targets in the middle of the profiles.
- The cross-polarized data show abundant and shallow hyperbolas from wire mesh. These hyperbolas appear as a flat layer in the cross-polarized profile.

Wire mesh is a metal mesh made by welding small-gauge wire into square or rectangular patterns. The mesh provides a small amount of reinforcement to concrete slabs and prevents cracking. It is often placed into the slab just before the concrete is poured and is usually the shallowest object in the slab.

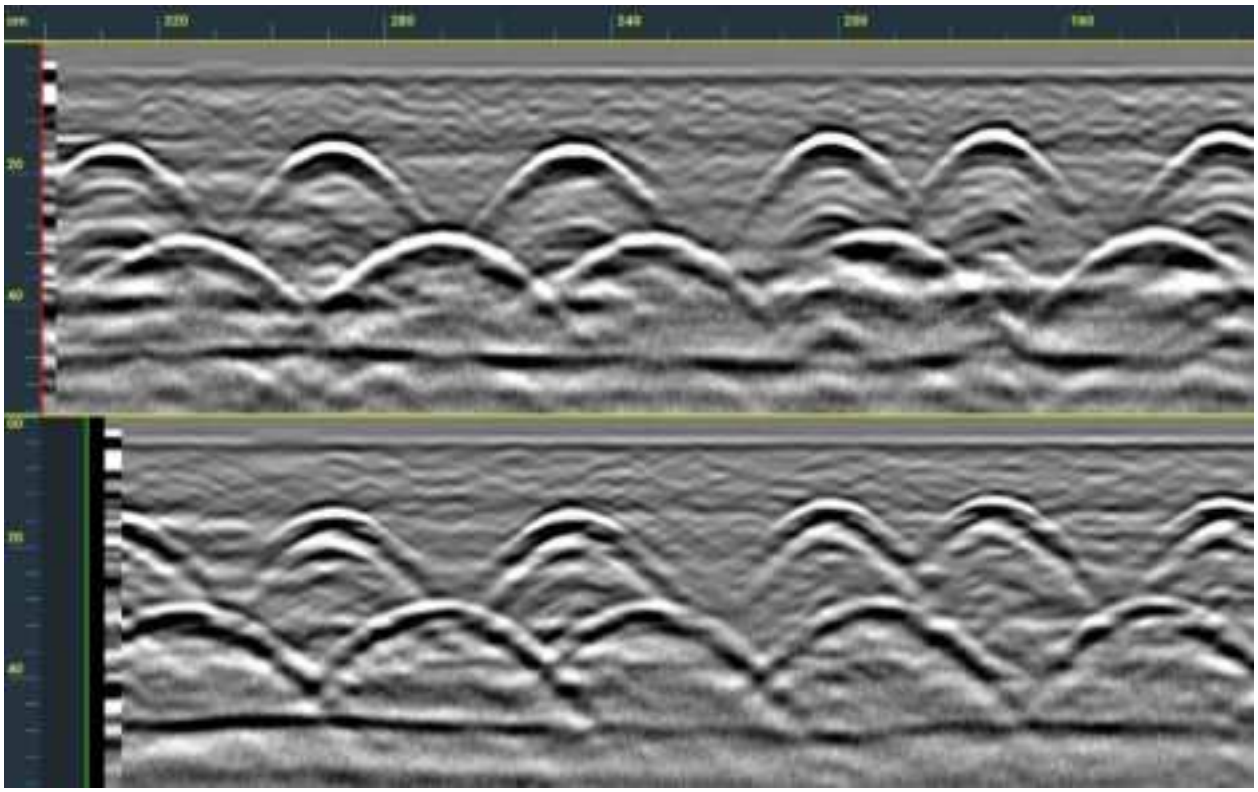
Mesh often retains some curvature when unrolled because it is stored and transported in tightly wrapped cylindrical bales. For this reason, the wire mesh in the slab may rise or sink at the ends of each mat. The entire mat may also deform under the weight of poured concrete, leading to the mat sinking deeper into the slab in some areas and rising to a shallower depth in others. When one roll of wire mesh runs out, workers will overlap it with the next roll. As a result, in some locations you may find areas containing double mesh layers.

A wire mesh signature is like a small-size rebar mat. The GPR data will contain consistently spaced hyperbolic reflections from individual wires. While rebar is installed in the slab by hand and can have inconsistent spacing between each bar, wire mesh is a factory-made, prefabricated roll. This means that the spacing is perfectly consistent. When scanned with a cross polarized antenna, mesh appears as a flat reflector with the hyperbolas merged into a continuous line.

Wire mesh with smaller spacing or closely spaced rebar may prevent or greatly inhibit GPR penetration. Conversely, mesh with a larger spacing, or wider spaced rebar, may allow for deeper penetration. Targets under mesh or rebar may be more difficult to identify. Utilizing the cross-polarized antenna will remove, or at least reduce the impact of, the tails from the wire mesh hyperbolas. This makes it easier to image and interpret deeper targets. Similarly, cross-polarization will reduce the length of the 'tails' of the hyperbolas created by rebar reflections, as well as reducing the amplitudes of metal targets, which can aid in visualizing objects beneath upper layers of reinforcement.

Rebar

Steel reinforcing bars (rebar) are, along with wire mesh, the most common targets in concrete structures. They are often the primary reinforcement for a slab, and typically run in two perpendicular directions. In thicker slabs there may be two layers of rebar: one closer to the top of the slab and one closer to the bottom. When oriented perpendicular to the survey line they produce clean and strong hyperbolas with long tails and are especially apparent in profiles from the standard antenna. The amplitude (signal strength) of rebar reflections increases with rebar diameter. They will still create a hyperbola when scanned in cross polarized orientation, but it will have lower amplitude and will be less expansive.

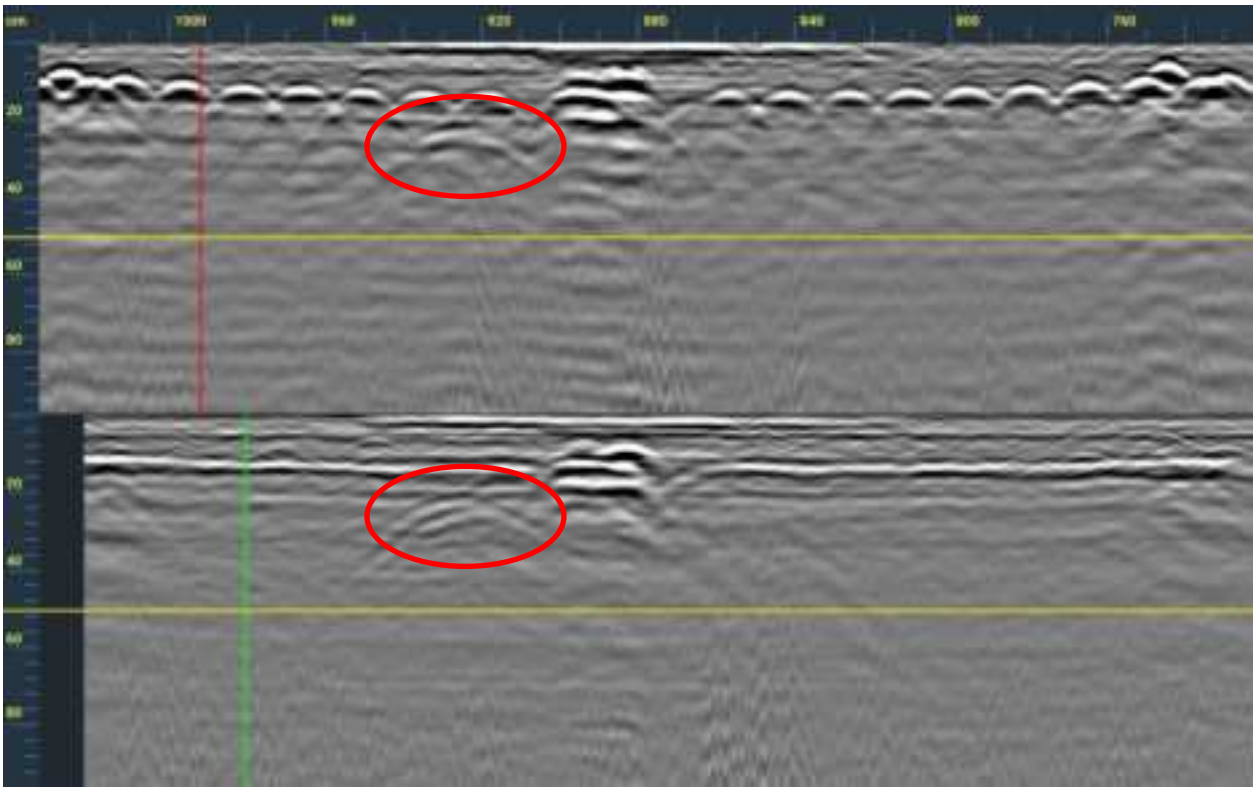


Top and bottom layer of rebar. Due to the increased width of the GPR's cone of energy, the lower rebar layer produces wider hyperbolas. The slab bottom is more easily seen in the cross polarized data, at a depth of 12 inches.

Rebar is used in most concrete structures, not just floor slabs. Rebar is typically present in jersey barriers, beams, retaining walls, above ground storage tanks constructed with concrete, columns, and any other concrete structures that require reinforcement. Rebar is also used when connecting a new section of concrete to an old section. These ‘dowels’ are short pieces of rebar and can be identified by scanning along the top to confirm their length, which can be as little as one foot. Check the surface of the slab for evidence of different aged sections of concrete, or obvious seams or saw cuts, which may suggest the presence of dowels.

Conduit

Conduit refers to hollow, metallic or non-metallic pipe installed inside a slab. It is one of the most important targets to precisely locate, as it can contain live power lines or data cables. It may be placed into the slab prior to the concrete pouring. Alternatively, it could be installed in a trench cut into cured concrete, which is then backfilled with fresh concrete. A threading wire is used to pull power or data cables into and through the empty conduit. When placed prior to concrete pouring, a conduit may be tied directly to or underneath rebar, which can increase the difficulty of locating it. Buildings are constructed with extra conduits for future expansion and renovation, so some conduits may be empty even in an active building.



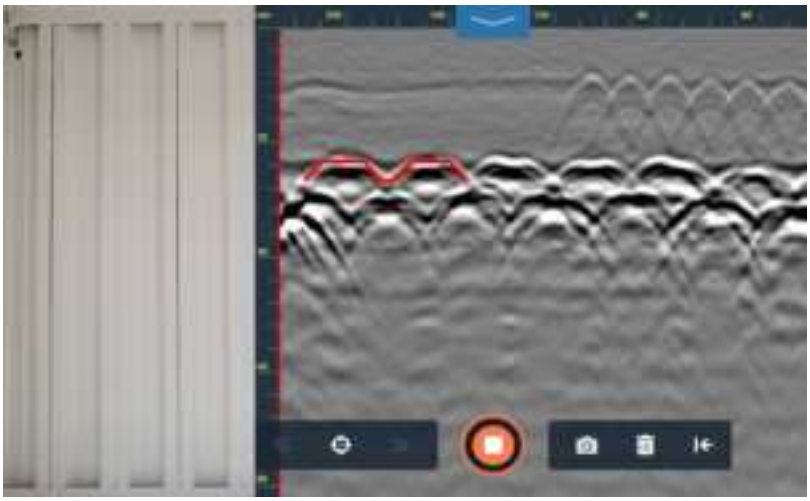
Conduit located beneath a wire mesh layer. The wire mesh hyperbolas disappear in the cross-polarized data, becoming a coherent layer and further revealing the conduit beneath.

Steel conduit may appear identical to steel rebar of the same diameter, though rebar will exhibit a more predictable layout pattern. GPR energy does not penetrate metal, so there is no difference between reflections from a solid rod or a hollow metal pipe. In GPR profiles a large diameter conduit, duct, or pipe (over 2" or 5 cm) will, relative to smaller diameter objects, produce a hyperbola that is noticeably larger. However, despite relative differences in hyperbola size the diameter targets is not discernable with GPR. A non-metallic conduit will have a lower amplitude reflection and is more likely to change depth within the slab, bend side-to-side, or change directions.

The polarity (or color) of the reflection will change depending on the material type and the contents of a non-metallic conduit. When the radar wave reflects off an object with a higher velocity than the surrounding material, the reflected wave will change polarity. In practice, this means that metal conduits and plastic conduits filled with metal wires (or water) will have a positive-amplitude strongest signal, with hyperbolas exhibiting a white-black-white color pattern (when using the standard black-to-white color scale). Empty plastic conduits will often produce a negative-amplitude strongest signal, with a black-white-black color pattern, caused by the wave reflecting off the higher-velocity air void inside the conduit.

Pan Decking

Pan decking is a corrugated metal sheet supporting concrete slabs. The concrete is poured onto the decking, providing strength and durability to the slab above. Pan deck slabs will usually only contain wire mesh without rebar, as the decking itself provides most of the reinforcement. Conduits may be installed in the decking's bottom flanges (troughs) prior to pouring the concrete. The decking will create complex reflections at the flange shoulders that typically obscure targets set into the bottom flanges, creating a challenging environment for GPR. Try using the cross-polarized channel to reduce the impact of hyperbolas. In addition, consider using Focus Mode for a different and complimentary view of the data. In Focus Mode, the conduits in bottom troughs, or along the sloping sides, could appear as discrete dots against the continuous surface of the decking.



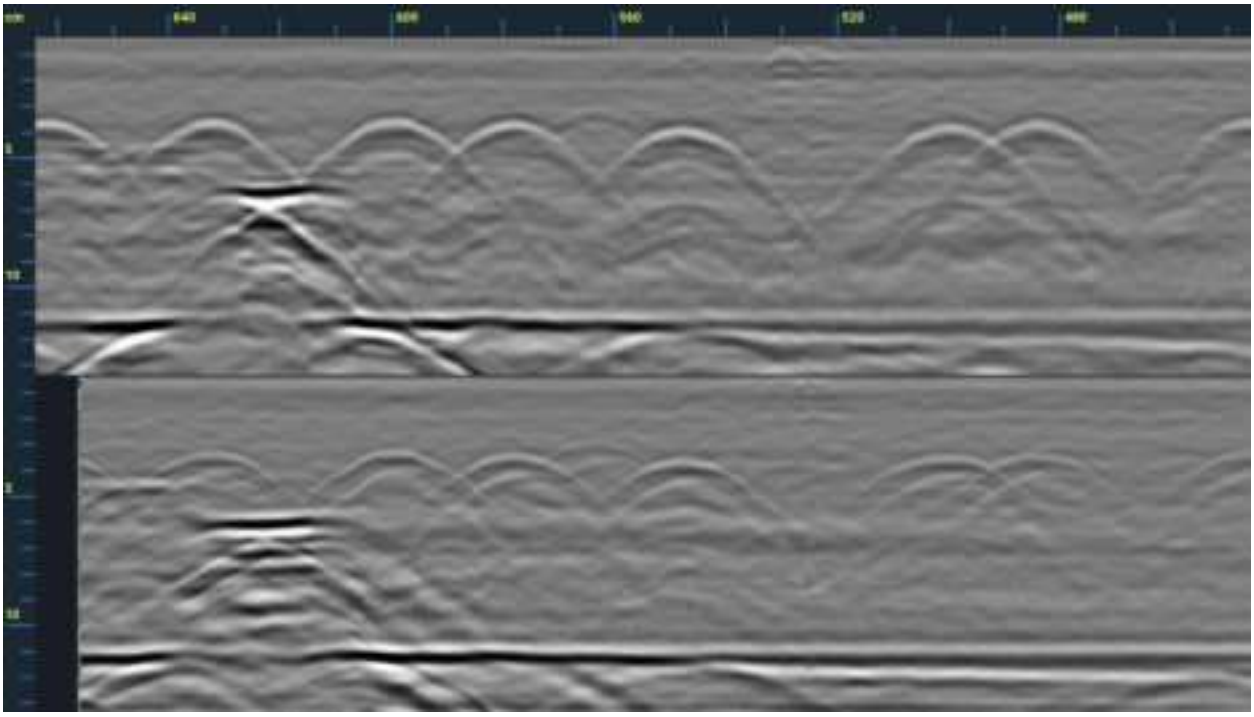
Left: View of pan decking from below. Right: pan decking running across the center of a GPR profile. The metal sheet alternates between higher and lower flanges and is visibly similar to the cross section of cardboard (red line overlay). Top flanges are resolved as elongated hyperbolas; bottom flanges (troughs) appear offset below as hyperbolas. The bottom flanges may have conduit installed within them. The shoulders of the top flanges and sloping sides generate reflections, often preventing radar from 'seeing' into the low points.

Beams and Objects Strapped to the Slab

Many concrete slabs have metal beams directly beneath them, and the beams may or may not be tied into the slab using vertical metal fastenings. Stud anchors and channel anchors are two such examples. It

will not be possible to image beams below pan decking because the radar wave will not pass through the metal deck. If the beam is directly below the concrete, it will present as a strong, flat, wide hyperbola at or just below the depth of the slab bottom.

Similarly, conduit or anchors may be attached directly to the bottom of a concrete slab. In this case, you will see a hyperbola – smaller than the hyperbola created by a beam – at or just below the depth of the slab bottom. It can be difficult to see objects strapped to the bottom of a very thick slab, as the radar wave must travel all the way to the bottom of the slab and back, losing signal strength along the way.



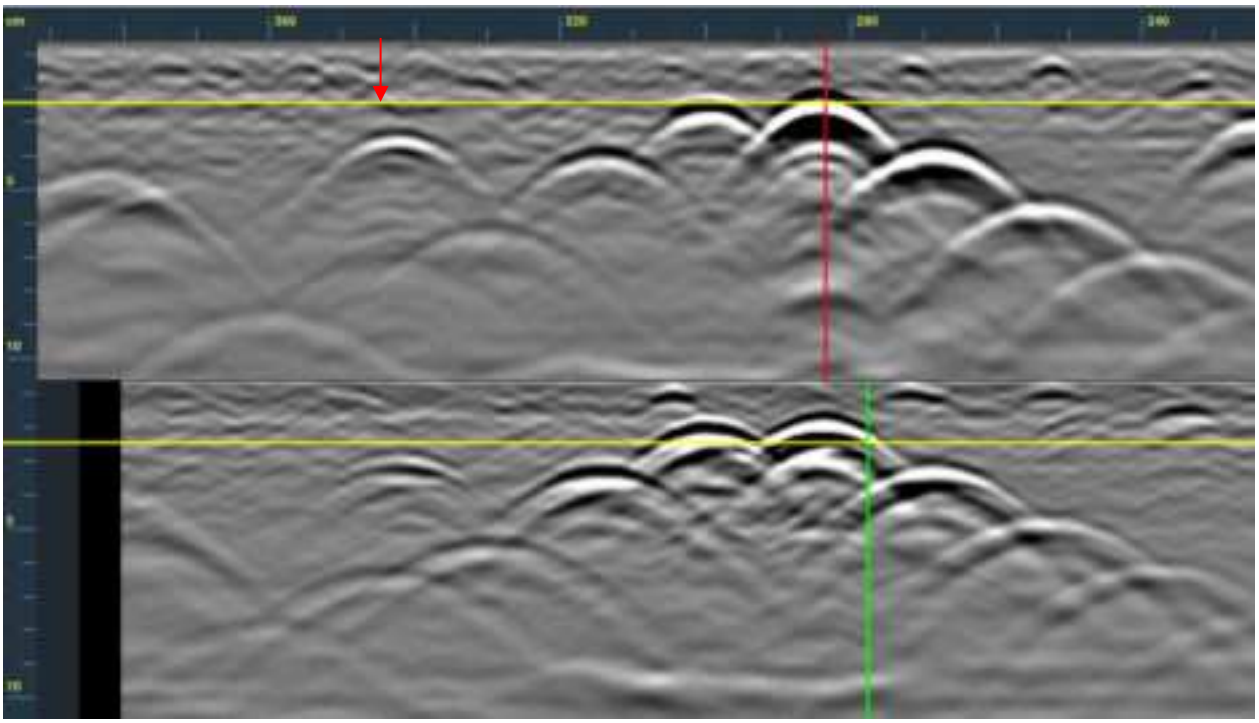
An I-beam in a wall observable as a flat, planar reflection at a depth of 6.5 cm. The other side of the wall is generating a planar reflection at a depth 11.5 cm. The hyperbolas underneath this reflection represent conduits strapped to the other side of the wall.

Pre-Tensioned Cables

Pre-tensioned cables commonly appear in precast sections of concrete that are used to quickly assemble structures. They are pulled to a high tension and concrete is poured around them. The cables help support additional weight and provide durability to the concrete sections. As with all metal targets, they can be difficult to distinguish from rebar or a metal conduit. It is important to use pattern recognition and understand which structures are likely to contain pre-tension cables. The most common use for precast concrete is in parking decks, including double tees and hollow core planks, both used for the garage deck, and spandrels, which form the walls between the columns of the parking garage.

PVC vs. Metal Targets

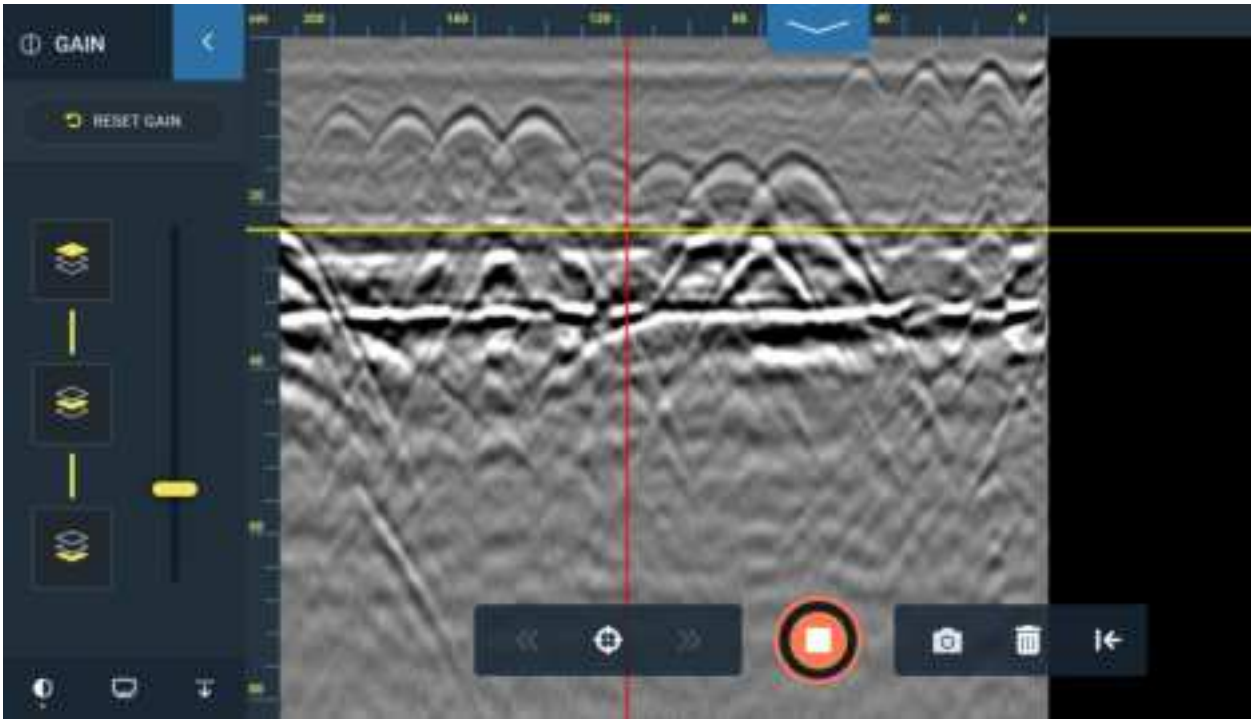
A Polyvinyl Chloride (PVC) pipe or non-metallic conduit in concrete generally produces low-amplitude hyperbolas of the same shape as hyperbolas from metal targets. PVC is nearly transparent to GPR, so targets inside or underneath a PVC pipe can still be visible. This means that we do not directly detect the PVC pipe; we detect the air, water, or other substance inside it.



Rebar located on the right side of the profile, visible as high amplitude hyperbolas. PVC targets are located on the left side of the profile, exhibiting lower amplitude hyperbolas compared to their metal counterparts. A single rebar on the left side (red arrow) obscures two conduits beneath it. The PVC pipes are more easily detectable in the cross polarized channel due to the antenna's lower sensitivity to metallic targets. Hyperbolas in the cross polarized data are less expansive, making it easier to see deeper targets.

Air Voids Under Concrete Slabs

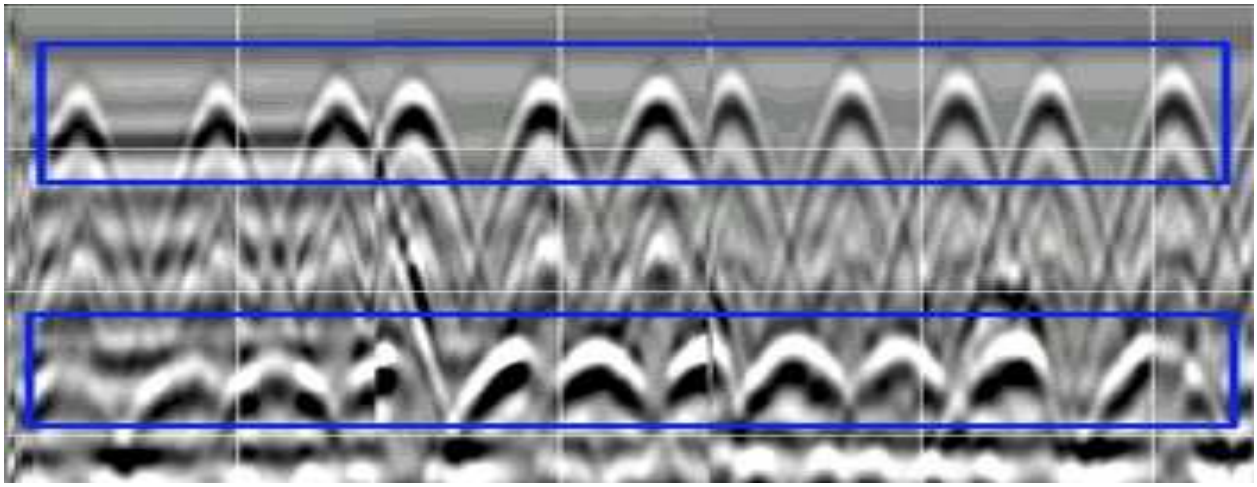
Voids in concrete, either air or water filled, produce observable targets when small and continuous layers when large and expansive. An air-filled void below concrete will produce a moderately strong, black-white-black reflection pattern. Air voids exhibit a higher GPR velocity than the concrete, causing the GPR energy to reverse polarity at the concrete/air boundary. In contrast, the slab/grade contact will often appear as a white-black-white reflection pattern because the GPR energy decelerates at the slab/grade contact (assuming typical water content in the grade materials). It is difficult to distinguish between the slab/grade contact and water-filled void spaces. Both should produce the same reflection pattern, though water-filled cavities should produce a higher amplitude reflection and will likely manifest as a more complex layer reflection.



Air filled PVC pipes appear as hyperbolas, and produce reflections with black as the first strongest band of color.

Multiple Reinforcement Layers

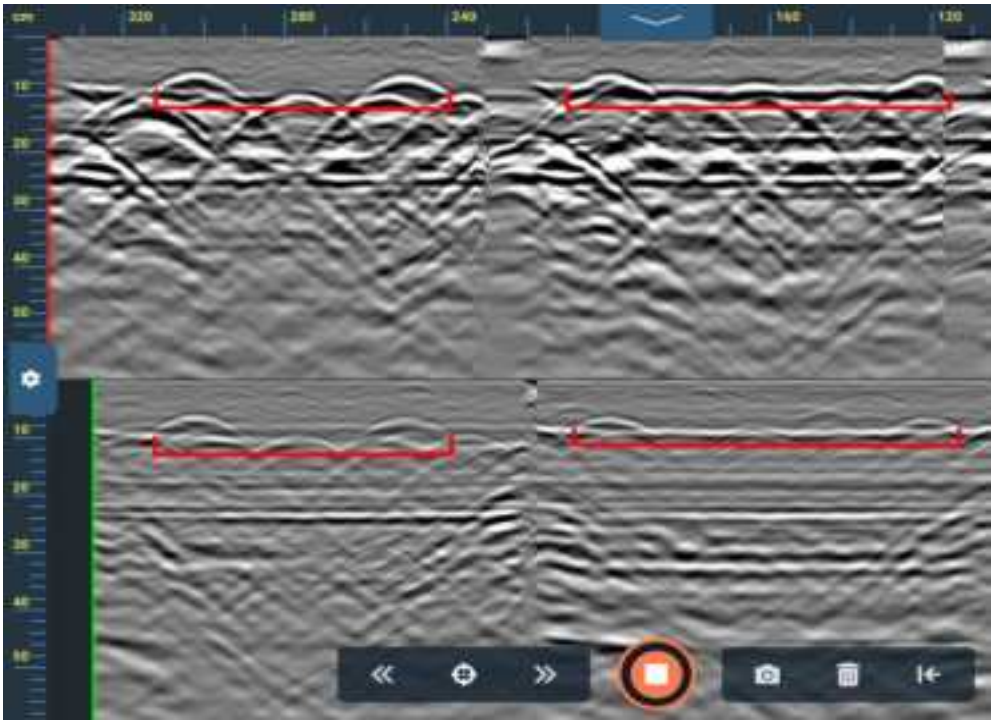
In structures with two layers of rebar, visibility of the second layer depends on the bar spacing in the first layer and on the amount of attenuation and scattering in the concrete. Staggered rebar are more likely to be visible, whereas a deeper layer of rebar set parallel to the top layer will be much less visible. If you have access to the bottom of a thick concrete slab you can scan from below to more easily mark deeper targets.


Left: two closely spaced layers of rebar (blue box outlines). Note the lower layer of rebar is shielded slightly by the top layer of rebar, resulting in incomplete or misshapen hyperbolas.

PT Cables

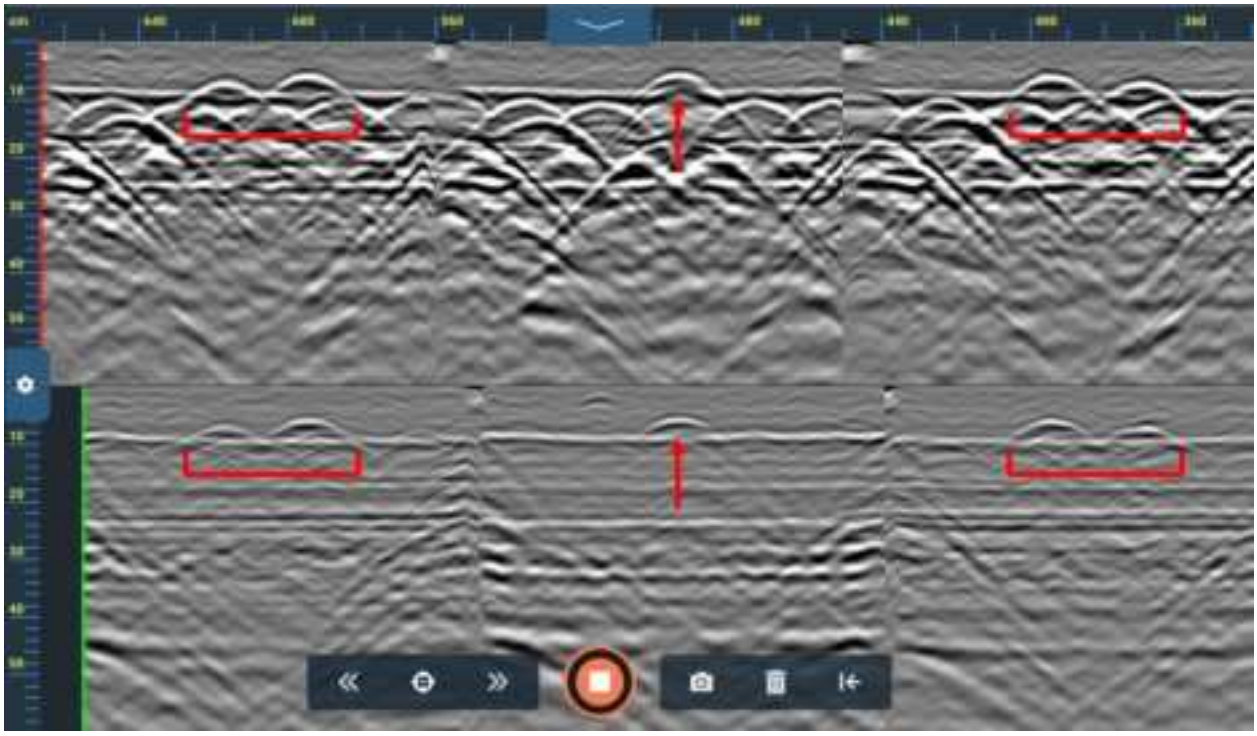
Steel post-tensioned (PT) cables are present in some structures along with reinforcing bars. The cable strands are housed in sleeves and are ratcheted to a high tension after the concrete has been poured, increasing the strength of the slab. Any damage to the PT from cutting, sawing, or coring could cause catastrophic failure, leading to loss of life and severe infrastructure damage. The cables are often laid in a fan pattern, where multiple cables are spread apart at either end of a slab and they move closer together towards the middle of the slab. They also change depth within the slab, rising and falling across the span and often ranging in depth from shallow on the sides to deeper in the middle.

Their typical appearance in a GPR profile is comparable to rebar. An uncoated steel cable and a rebar of the same size would produce identical hyperbolas. In real structures cables are placed into plastic conduits and/or coated with plastic, which may affect their reflection amplitude. When compared with rebar, PT cables may produce a weaker reflection on cross-polarized antennas. This, combined with the unique way that the cables are routed within the slab, allows for easier identification of the cables. PT cables show why it is important to collect long scans and understand the broader patterns around your target areas. Scanning at multiple locations could identify the changes in PT spacing and depth, and scanning along the top of potential PT cables will reveal if targets are rising and falling in the slab. In some cases, such as post-tensioned tennis courts, the PT cables will neither fan out nor change depth within the slab and may appear very similar to rebar or conduit.



Post-tensioned cables crossing rebar mat at 45° angles. PT cables are visible in both standard and cross-polarized channels.

Note the much lower amplitude and greater clarity of the cross-polarized profile. The hyperbolas from the PT cable are much more obvious.



A post-tensioned cable positioned above a rebar mat. In this example the PT cables converge until they ‘cross’ over, then they diverge further along the profile. These data were collected using a single file number, and the Flex NX was moved to adjacent locations to track PT cable layout.