



Noggin

User's Guide

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s u b s u r f a c e i m a g i n g s o l u t i o n s

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1 General Overview

Noggins are completely self-contained Ground Penetrating Radar (GPR) systems. Once the unit has been assembled into its deployment configuration and powered up you can be carrying out a GPR survey in less than a minute. There are several different Noggin configurations available: the SmartCart, SmartHandle, SmartTow and the Rock Noggin.

This manual describes the assembly of each Noggin configuration, how to set survey parameters and how to run the system to collect data in lines or grids.

Each Smart System's Digital Video Logger (DVL) comes with the embedded software to acquire data and replay data files. Data management software allows the data to be transferred to an external computer for further processing and/or plotting.



Figure: 1-1 Noggin configurations

2 Noggin Components

The Noggin family of GPR systems consists of the Noggin 100, 250, 500 and 1000.

The basic configuration and key components of the Noggin 250, 500 and 1000 are shown in **Figure 2-1** and **Figure 2-2**. The key components of the Noggin 100 are shown in **Figure 2-3**.

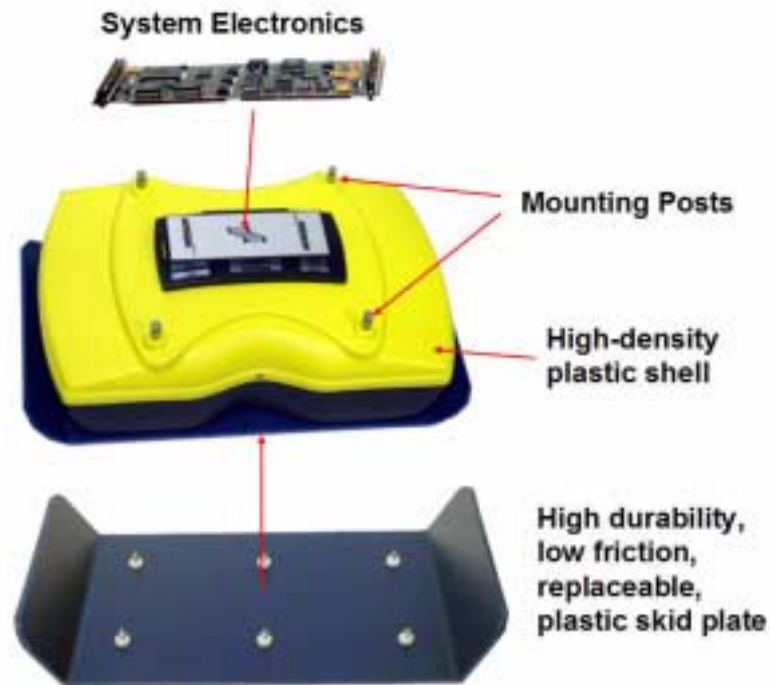


Figure: 2-1 Noggin components

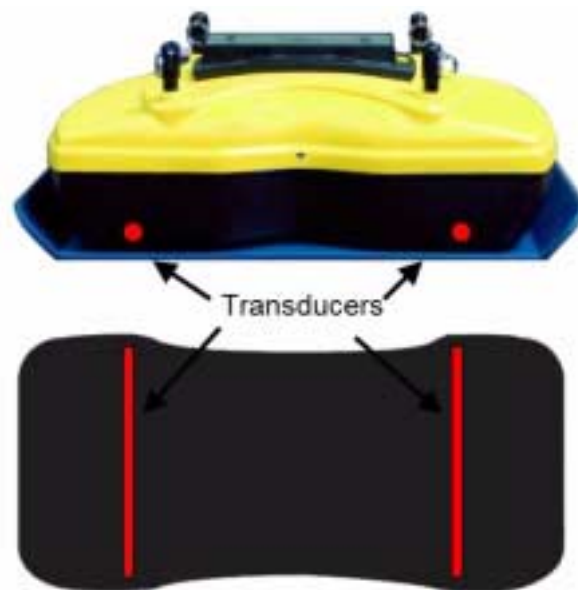


Figure: 2-2 Location of the Noggin transducers

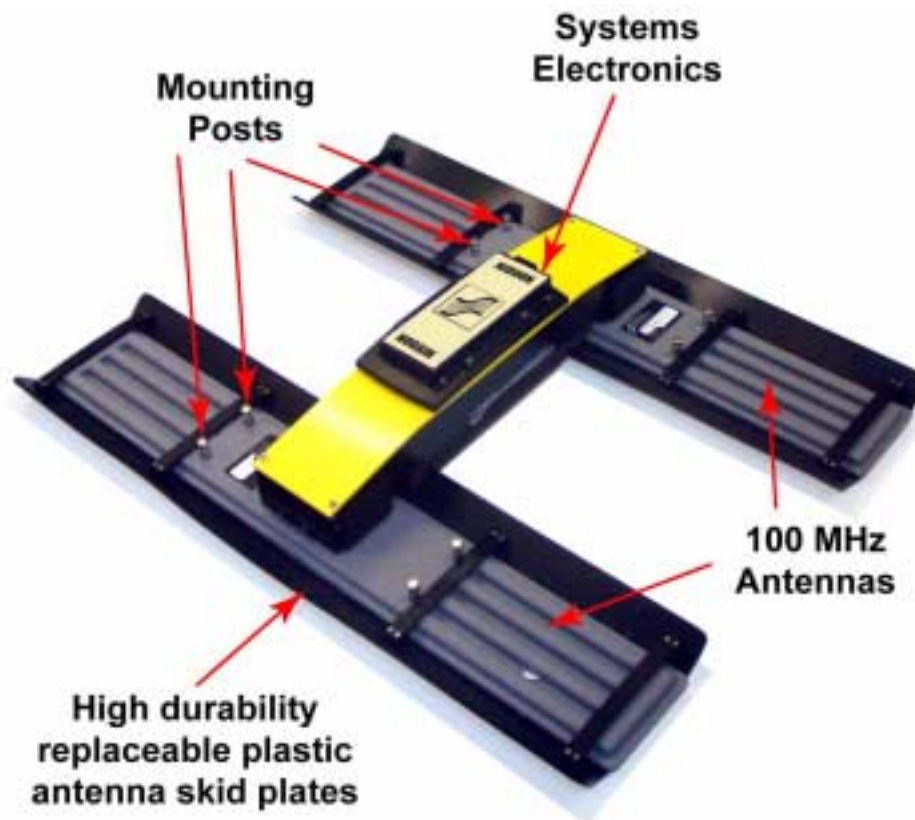


Figure: 2-3 Noggin 100 components

3 Noggin 100 Assembly

Unlike the higher frequency Noggins, the Noggin 100 comes with the antennas and electronics as separate units that need to be assembled.

To assemble, space the 100 MHz antennas about 0.5 meters apart with the mounting blocks facing up.



Figure: 3-1 Noggin 100 assembly of electronics to antenna.

Place one end of the Noggin 100 electronics module over one of the antennas and press downward until it is seated.

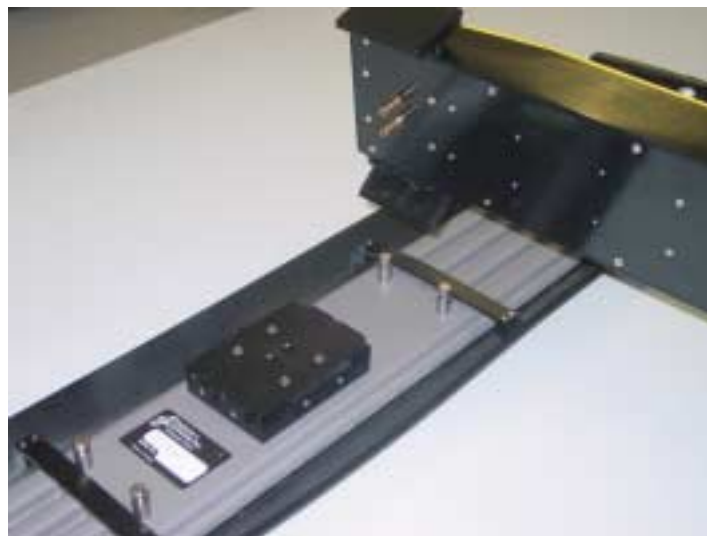


Figure: 3-2 Connecting the electronics to the 100 MHz antenna. The 2 brass sockets in the bottom of the electronics mate with the 2 brass pins in the antenna mounting block.

Secure using the electronics to the antenna using the 2 plastic latches.



Figure: 3-3 Latching the electronics to the antenna.

Do the same to connect the electronics to the second antenna.

See the complete assembly of the Noggin 100 in **Figure 2-3**.

4 SmartCart Assembly

The SmartCart can be configured for operation with all Noggins (100, 250, 500 and 1000).

The fully-assembled Noggin 250 in the SmartCart configuration is shown in Figure 5-1. The system is shown in field operation in Figure 5-2. Follow the directions below to assemble the configuration.



Figure: 4-1 Fully assembled SmartCart with a Noggin 250.



Figure: 4-2 Noggin 250 SmartCart (left) and Noggin 100 SmartCart (right) in operation.

4.1 Unfold the Handle

The Noggin SmartCart comes folded for transportation and storage (Figure 4-3).



Figure: 4-3 SmartCart in collapsed position.

To unfold the SmartCart, refer to Figure 4-4. Pull the ring to remove the handle Clevis pin from the handle support arm. Raise the handle support arm and then the handle and place the open end of the T-shaped tube on the handle onto the end of the support arm (Step 1). Then lock the handle into position by lining up the hole in the support arm with the hole in the T-shaped tube and inserting the handle Clevis pin (Step 2). When folding the SmartCart back up always ensure the handle folds down before the handle support arm.

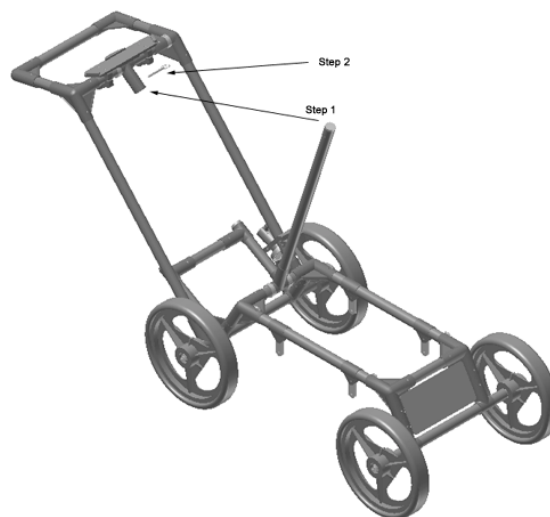


Figure: 4-4 SmartCart set up.

4.2 Attach Wheels

The SmartCart may have been shipped without the wheels attached or they may have been removed for storage. If this is the case, find the axle for each wheel, press the button on the end of the axle, and insert the axle through the wheel and into the SmartCart frame (Figure 4-5).

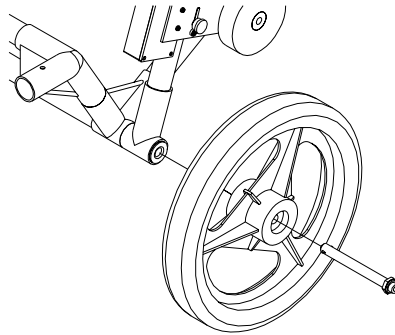


Figure: 4-5 Attaching the wheel.

With the system unfolded, make sure the small odometer wheel makes good contact with the side of the cart wheel.

If the odometer contact with the wheel is too loose, the odometer wheel may slip, resulting in erroneous position measurements. If the odometer wheel seems loose, use a $\frac{1}{4}$ inch Allen (hexagonal) wrench to loosen the screws on the side of the odometer and pivot the entire odometer unit until the small odometer wheel makes good contact with the side of the cart wheel (**Figure 4-6**). Then tighten the screws to lock the odometer wheel in this position.



Figure: 4-6 If the odometer wheel does not make good contact with the wheel, use a hexagonal wrench to loosen the 2 screws (left) and pivot the odometer outward so when the wheel is attached the odometer rolls continuously (right).

After this has been done, it will be necessary to re-calibrate the odometer (**Section 12.5.2 Odometer Calibration**).

4.3 Attaching Separation Bars to the SmartCart

The Noggin SmartCart can be configured to carry a Noggin 100, 250, 500 or 1000 system. Each system has a unique set of separation bars used to attach the Noggin to the SmartCart and suspend it over the surface (Figure 4-7).



Figure: 4-7 The separation bars are attached to the SmartCart to carry the Noggin. Each Noggin system (100, 250, 500 and 1000) has a unique set of separation bars; the Noggin 250 separation bars are shown on the left and Noggin 100 separation bars on the right.

The separation bars are attached to the SmartCart by four thumb screws.

Changing the support arms should only be done after the DVL and battery have been detached from the SmartCart, otherwise the back half of the cart may fall to the ground and be damaged.

Aligning the thumb screws and the support arm is very important. If the hole and insert are not perfectly aligned, the thumb screw will bind after only half a turn and will damage the insert by cross-threading it. As well, if the thumb screw is forced to turn it will also be damaged. If this occurs, the only way to correct this problem is to then run a 10-32 tap through the insert to re-tap the hole.

4.3.1 Separation Bar Assembly

Depending on the Noggin system, it may be necessary to assemble the separation bars before attaching them to the SmartCart. For details, see the separate document "Noggin SmartCart Separation Bar Assembly".

4.4 Attaching the Swivel Adapters (Noggin 250, 500 & 1000)

Before the Noggin 250, 500 or 1000 can be attached to the SmartCart, the 4 swivel adapters (with attached Clevis pins) must be attached to the mounting posts on the Noggin (see **Figure 2-1**). The swivel adapters may have been attached to the Noggin at the factory. If not, follow the instructions below.

Set the swivel adapter down on the post. It may be necessary to loosen the Allen (hexagonal) screw before the swivel adapter will slide down into the proper position. This can be done using the 1/8" Allen (hexagonal) wrench provided. Now, tighten each screw and then loosen ¼ turn so that the swivel adapters are firmly attached to the post but can still rotate. **DO NOT OVERTIGHTEN!**

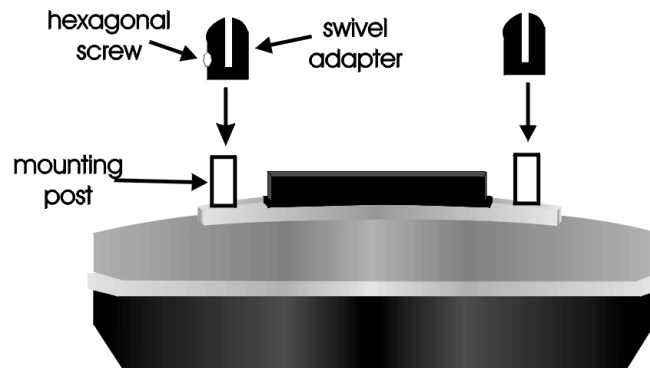


Figure: 4-8 Attaching the swivel adapters to the Noggin.

4.5 Attaching the Noggin to the SmartCart

The Noggin is attached to the cart with the long axis of the Noggin unit parallel to the wheels on the cart (see Figure 4-9 and Figure 4-10). Ensure the 37 socket female electrical receptacle on the Noggin faces the back of the cart so that the cable on the cart will reach the receptacle.

4.5.1 Noggin 250

Remove the Clevis pins from the swivel adapters. Now, on the bottom of the cart, locate the 4 oval, moveable hangers suspended from the frame of the cart (see Figure 4-9). Notice that each hanger has a hole in it. To attach the Noggin 250 to the cart, place each hanger into the slot on the top of the swivel adapters, line up the holes and insert the Clevis pin.



Figure: 4-9 Attaching the Noggin 250 to the SmartCart.

Connect the 37 pin end of the Noggin-to-DVL cable to the receptacle on the Noggin and secure this attachment with the latch.

4.5.2 Noggin 500 & Noggin 1000

Remove the Clevis pins from the swivel adapters. Now, on the bottom of the cart, locate the two, flat, moveable crossbars suspended from the frame of the cart.

Notice that each crossbar has 2 holes, one on each side. To attach the Noggin 500 to the cart, place the crossbars into the slots on the top of the swivel adapters, line up the holes and insert the Clevis pins (Figure 4-10).



Figure: 4-10 Attaching the Noggin 500 and Noggin 1000 to the cart.

Connect the 37 pin end of the Noggin-to-DVL cable to the receptacle on the Noggin and secure this attachment with the latch.

4.5.3 Noggin 100

Unlike the higher frequency Noggins, the Noggin 100 comes with the antennas and electronics as separate units that need to be assembled. Assemble the Noggin 100 electronics and antennas as shown in **Section 3 Noggin 100 Assembly**.

Place the SmartCart over the Noggin 100, aligning the antenna post blocks on the frame with the antenna mounting posts on the 100 MHz antennas. Ensure the 37 socket cable connection on the Noggin 100 electronics faces the back (handle end) of the SmartCart.



Figure: 4-11 Place the SmartCart over the Noggin 100 system with the 8 antenna mounting posts inserted in the post blocks. The 37 socket receptacle



Figure: 4-12 Secure the SmartCart Separation Bars to the Noggin 100 by inserting the pins into each of the 8 post blocks.

Connect the 37 pin end of the Noggin-to-DVL cable to the receptacle on the Noggin 100 electronics and secure this attachment with the latch.

The cable should have a little slack to reduce any stresses on the cable during data collection. Ensure that the cable does not sag and contact the electronics or antennas as this will cause noise in the data.

Connect the yellow odometer cable to the receptacle on the Noggin end of the Noggin-to-DVL cable. This may require use of a short odometer extension cable. Use the velcro straps to route the cable along the frame, keeping it away from the electronics and the the antennas.

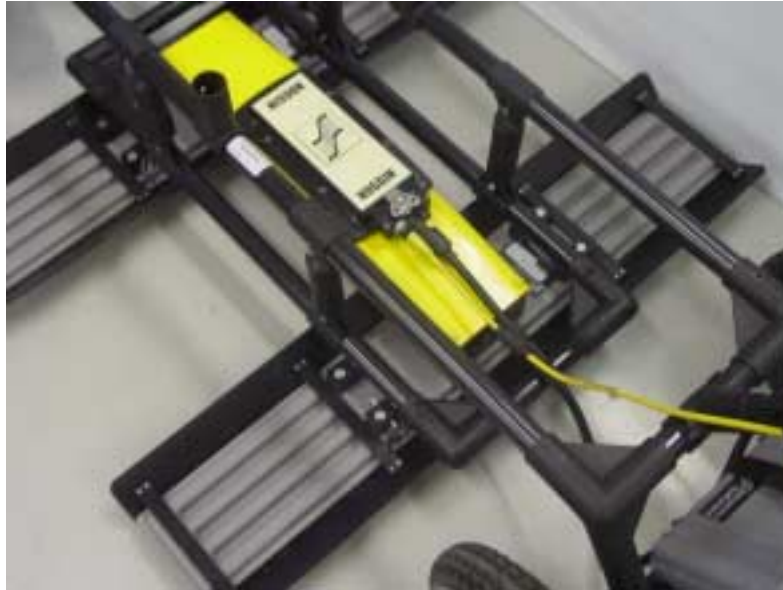


Figure: 4-13 Connecting the Noggin-to-DVL cable to the Noggin 100 electronics. After this connection is made, connect the yellow odometer cable to the round receptacle.

4.6 Attach the Digital Video Logger (DVL)

The bottom of the Digital Video Logger is designed to slide onto the support shelf attached to the SmartCart (Figure 4-14). Line up the bottom of the DVL with the shelf and slide it back onto the shelf. Push the DVL back far enough so that the flexible clip on the front of the shelf catches and holds the DVL firmly in place. Wiggle the DVL to make sure it is firmly snapped in before letting go of the unit. To remove the DVL from the SmartCart, flex the clip downward as the DVL is slid forward off of the shelf.

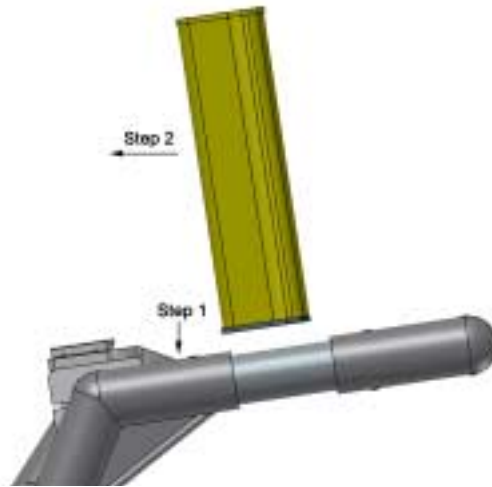


Figure: 4-14 Attaching the digital video logger (DVL). Step 1: Depress flexible clip. Step 2: Slide DVL onto shelf.

The DVL can be pivoted to adjust the view angle. If it is difficult to pivot the DVL, slightly loosen the hand screws on the bottom of the support shelf.

Once the DVL is in place, attach the cable with the 37-socket female D-connector to the 37-pin receptacle on the back of the Digital Video Logger. This attachment can be secured with the latch.

4.7 Attach the Battery Unit

The batteries usually used with the SmartCart are shown in **Figure 10-1**.

Set the battery unit onto the lower inclined shelf on the back of the SmartCart (see Figure 4-15). The handle on the battery unit should be accessible from the back of the cart with the cable receptacle on the right. The battery unit should rest in this area without moving. To secure the battery onto the cart, put the straps provided over the battery unit and lock into place with the plastic buckle. Tighten the straps if necessary.



Figure: 4-15 The SmartCart battery.

Note the battery mass forms part of the overall cart balance which enables users to raise the front wheels with a minimum amount of force. This allows users to easily change direction and assure the rear wheels are always in contact with the ground.

With the SmartCart completely assembled, connect the round 4-pin battery cable to the receptacle on the side of the battery.

4.8 Adding GPS Mount to the SmartCart

The SmartCart has an optional bracket designed to hold a Trimble or Novatel GPS (see Figure 4-16). This bracket can be modified by the user to hold other types of GPS units.

Any GPS unit with a serial output can be attached to the serial port on the back of the DVL and GPS information logged during data collection (see [Section 8](#)).

For more details about configuring the GPS with a Noggin system, see [Section 12.3.5](#).



Figure: 4-16 SmartCart system with the optional GPS mounting bracket.

5 SmartTow Assembly

All Noggins (100, 250, 500 and 1000) can be operated in the SmartTow configuration.

5.1 Noggin 100

The fully-assembled Noggin 100 in the SmartTow configuration is shown in Figure 5-1. The system is shown in field operation in Figure 5-2. Follow the directions below to assemble the configuration.



Figure: 5-1 Noggin 100 SmartTow configuration.



Figure: 5-2 Noggin 100 SmartTow configuration in use. Note the belt battery for power and DVL carrier for conveniently carrying the DVL in the field. The cable runs from the electronics housing and up the handle secured by velcro straps.

Assemble the Noggin 100 electronics and antennas as shown in **Section 3**.

The parts for the Noggin 100 SmartTow frame are shown in .



Figure: 5-3 The Noggin 100 SmartTow frame parts (left) and assembled (right). Ensure the antenna post blocks face outward before assembling. The pieces are connected using the 4 thumb screws as shown in the figure below. The Handle and Big Wheel odometer are not connected to the frame with thumb screws but held in place once the antennas are attached.



Figure: 5-4 Close-up of thumbscrews used to assemble the Noggin 100 SmartTow frame. Be careful not to strip the threads!

Place the SmartTow frame over the Noggin 100, aligning the antenna post blocks on the frame with the antenna mounting posts on the 100 MHz antennas. Ensure the 37 socket cable connection on the Noggin 100 electronics faces the handle end of the frame and NOT the odometer end.



Figure: 5-5 Place the SmartTow frame over the Noggin 100 system with the 8 antenna mounting posts inserted in the post blocks.



Figure: 5-6 Secure the SmartTow frame to the Noggin 100 by inserting the metal pins into each of the 8 post blocks.

Latch the 37 pin end of the Noggin-to-DVL cable to the receptacle on the Noggin 100 and use the velcro straps to secure the cable to the handle (**Figure 5-7**). The cable should have a little slack to reduce any stresses on the cable during data collection. Ensure that the cable does not sag and contact the electronics or antennas as this will cause noise in the data.

Connect the yellow odometer cable to the receptacle on the Noggin end of the Noggin-to-DVL cable. This may require use of a short odometer extension cable. Use the velcro straps to route the cable along the frame, keeping it away from the electronics and the the antennas (**Figure 5-7**).

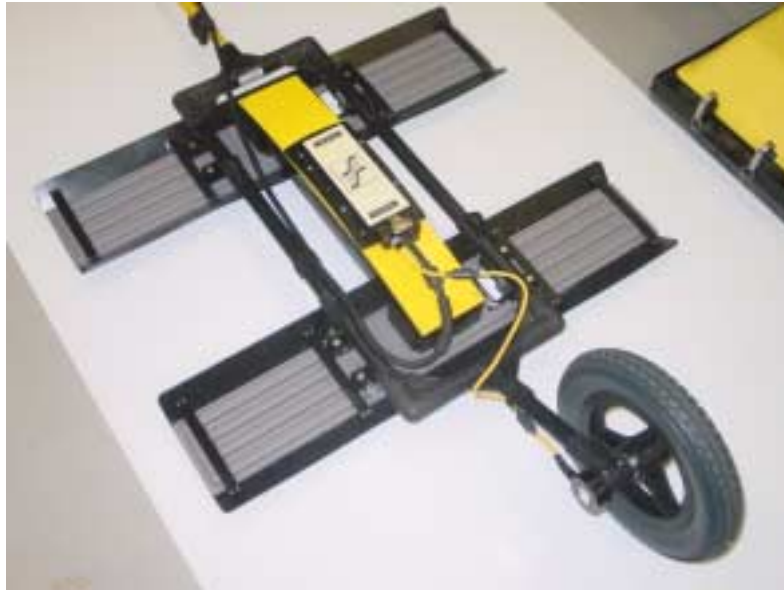


Figure: 5-7 Connect the Noggin-to-DVL cable to the Noggin 100 electronics with the latch. The yellow odometer cable connects to the small round receptacle on the back of the Noggin-to-DVL cable. The odometer cable may need to have the odometer extension cable added to it to reach the connection.

Latch the other end of the Noggin-to-DVL cable to the back of the DVL.

With the SmartTow completely assembled, connect the round 4-pin battery cable to the receptacle on the SmartCart battery and then go to **Section 10 Powering Up the System**.

5.2 Noggin 250

The fully-assembled Noggin 250 in the SmartTow configuration is shown in Figure 5-1. The system is shown in field operation in Figure 5-2. Follow the directions below to assemble the configuration.



Figure: 5-8 Noggin 250 SmartTow system



Figure: 5-9 Noggin 250 SmartTow in operation. Note the belt battery used to power the system.

Attach one of the SmartTow Bracket Assemblies to the two front mounting posts on the Noggin 250 and secure with the metal pins.

Attach the second SmartTow Bracket Assembly to the two back mounting posts on the Noggin 250 and secure with the metal pins.



Connect the large black cable to the Noggin 37-pin female connector and latch into place, ensuring the cable lies on top of the back SmartTow Bracket Assembly.



The large odometer wheel attaches to the back SmartTow Bracket closest to the Noggin connector. Orient the odometer so the small yellow wheel is on the upper rim of the large wheel. Secure the odometer T-bar with the U-brackets and pins. Make sure that the black cable turns to the front of the Noggin so it does not interfere with the odometer wheel.



The yellow cable from the odometer connects to the receptacle on the connector to the Noggin.



Odometer calibration is critical for accurate data images. Odometer calibration instructions are available in **Section 12.5.2 Odometer Calibration**.

Attach the handle to the front SmartTow Bracket Assembly with the U-brackets and pins. The black cable should lie between the SmartTow Bracket and the handle. Secure the cable along the side of the handle using 2 or 3 Velcro straps.



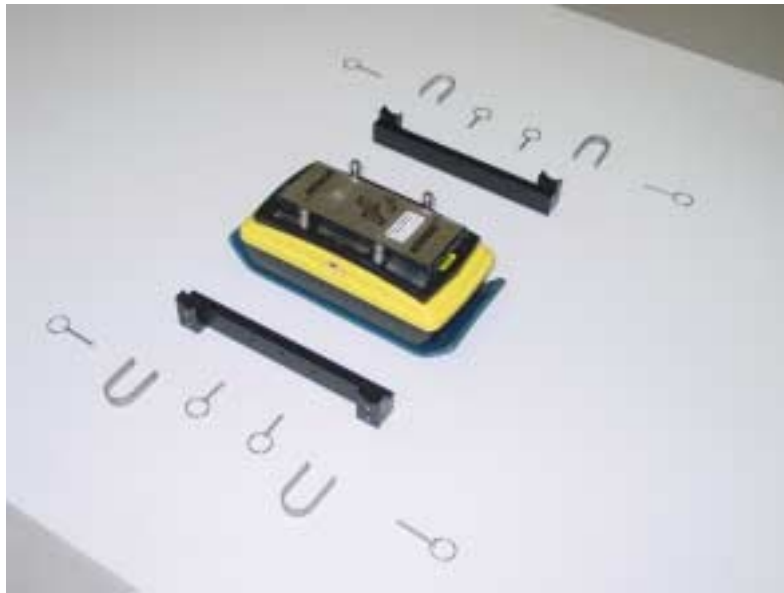
5.3 Noggin 500 and 1000

The fully-assembled Noggin 500 in the SmartTow configuration is shown in Figure 5-10. Follow the directions below to assemble the configuration.



Figure: 5-10 Noggin 500 in the SmartTow configuration

The parts for the Noggin 500/100 SmartTow Brackets are shown below.



Align the two holes on one of the SmartTow Brackets with the two mounting posts on one side of the Noggin, press down firmly and secure with the short metal pins. Then attach the second SmartTow bracket to the other side of the Noggin and secure with the short metal pins.



Attach the handle to the front of the SmartTow Brackets with the U-brackets and log metal pins. The handle should be attached on the end of the Noggin away from the 37 socket cable connection.



Connect the large black Noggin-to-DVL cable to the 37-socket connector on the Noggin and latch into place, ensuring the cable is looped to provide some slack and it is routed along the top of the SmartTow bracket. Secure the cable to the bracket and along the side of the handle using 2 or 3 Velcro straps.



The large odometer wheel attaches on the end of the Noggin with the 37-socket connector. Use the U-brackets and log metal pins to secure the odometer T-bar to the SmartTow Brackets. Orient the odometer so the black thumbscrew on the T-bar is facing upwards and the yellow odometer cable is on the same side of the odometer wheel as the odometer receptacle on the Noggin cable connection.

Make sure that the black Noggin-to-DVL cable turns to the front of the Noggin so it does not interfere with the odometer wheel.

Then connect the yellow odometer cable to the receptacle on the connector to the Noggin. Loop the odometer cable so it does not interfere with the rotation of the odometer wheel and use velcro straps to secure it to the T-bar.



Odometer calibration is critical for accurate data images. Odometer calibration instructions are available in **Section 12.5.2 Odometer Calibration**.

6 SmartHandle Assembly (Noggin 500 & 1000 only)

The Noggin 500 and 1000 can be operated in the SmartHandle configuration.

The fully assembled Noggin 500 SmartHandle system is shown in **Figure 6-1**. The Noggin 1000 SmartHandle system looks very similar.



Figure: 6-1 Noggin 500 SmartHandle system.

Normally the SmartHandle system is used in the “push” configuration shown in **Figure 6-1**. In some situations the “pull” configuration may be a more desirable. **Figure 6-7** shows the SmartHandle system in this configuration.

Note that most Noggin SmartHandle systems come from the factory partially assembled with the odometer bracket, Noggin-to-DVL cable and the handle base already attached to the Noggin unit.



Figure: 6-2 Slide the Noggin odometer bracket over the four, silver mounting posts for both the Noggin 1000 (top) and Noggin 500 (bottom).



Figure: 6-3 Connect the 37 pin connector on the Noggin-to-DVL cable to the 37 socket receptacle on the Noggin unit by tightening the latch.



Figure: 6-4 On the Noggin-to-DVL cable, note the round receptacle on the back of the connector that attaches to the Noggin unit. Connect the yellow odometer cable to this round receptacle.



Figure: 6-5 Press the handle base straight down onto the four, silver mounting posts. The handle base should be pushed all the way down onto the odometer bracket. Insert the four quick release pins to secure the handle.



Figure: 6-6 The full-length SmartHandle is shown in Figure 6-1. The SmartHandle can be shortened by removing the center handle section using the thumb-screws. Use the Velcro straps to secure the cable onto the SmartHandle, ensuring there is excess cable near the connection at the Noggin to allow the SmartHandle to pivot up and down without straining the cable.

6.1 SmartHandle “Pull” Configuration

In some situations, conditions may dictate that pushing the SmartHandle system (**Figure 6-1**) is not practical. An alternative configuration is to pull the SmartHandle system (**Figure 6-7**). To do this, remove the 4 quick-release pins that hold the handle to the Noggin system, remove the handle by pulling straight up and rotate the handle so that it faces the other direction. Then push the handle down onto the Noggin as far as it will go and replace the 4 quick-release pins.



Figure: 6-7 In conditions where pushing the SmartHandle is difficult, it is possible to turn the handle around and pull the system as shown.

6.2 Cable Connections

The DVL to Noggin cable is a Y-shaped cable with 3 connections; one to the Noggin sensor, one to the DVL and one to the power supply (battery or AC).

Noggin Connection: The first connection was done in Figure 6-3 above, that is, the 37-pin connector on the cable was attached to the 37-socket connector on the Noggin. A latch was used to secure this connection.

From the Noggin, the DVL to Sensor Cable runs up the side of the SmartHandle. Use the Velcro straps to secure the cable to the SmartHandle ensuring there is some slack in the cable near the connection at the Noggin so, as the handle is pivots up and down there is no strain on the connection (**Figure 6-6**).

DVL Connection: The second connection from the DVL to Sensor Cable is to the DVL. One end of the Y-shaped cable has a 37-socket connector. This end plugs into the 37-pin connector on the back of the DVL.

Power Connection: The third connection on the SmartHandle cable attaches to a power supply. The round, 4-pin connector attaches to the battery. This configuration usually uses a belt battery.

7 Rock Noggin Assembly (Noggin 500 & 1000 only)

Assembly of the Rock Noggin system for both the Noggin 500 and the Noggin 1000 is described in this section.

The Rock Noggin 500 system is shown in Figure 7-1. The Rock Noggin 1000 system looks very similar when assembled.



Figure: 7-1 The Rock Noggin system (left) and in use (right).

The Rock Noggin shipping case contains the complete Rock Noggin system (see Figure 7-2).

Rock Noggin systems are shipped from the factory partially assembled with the frame and DVL-to-Noggin cable already attached to the Noggin unit (see Figure 7-3). If your system is already partially assembled, skip to Figure 7-11. Detailed assembly starts at Figure 7-4. A fully assembled Rock Noggin system is shown in Figure 7-15



Figure: 7-2 A Rock Noggin system in its shipping case.



Figure: 7-3 The Rock Noggin system components after removal from the shipping case. From left to right are the belt battery, the Noggin already attached to the frame and the Digital Video Logger (DVL). The system comes partially assembled. To continue with assembly from this point, see Figure 7-11 and later.



Figure: 7-4 The Rock Noggin system disassembled into its basic components and ready for assembly. From left to right are the belt battery, the Noggin, the cable (in front), the frame and the Digital Video Logger (DVL). More details of each component are given in the figures below.

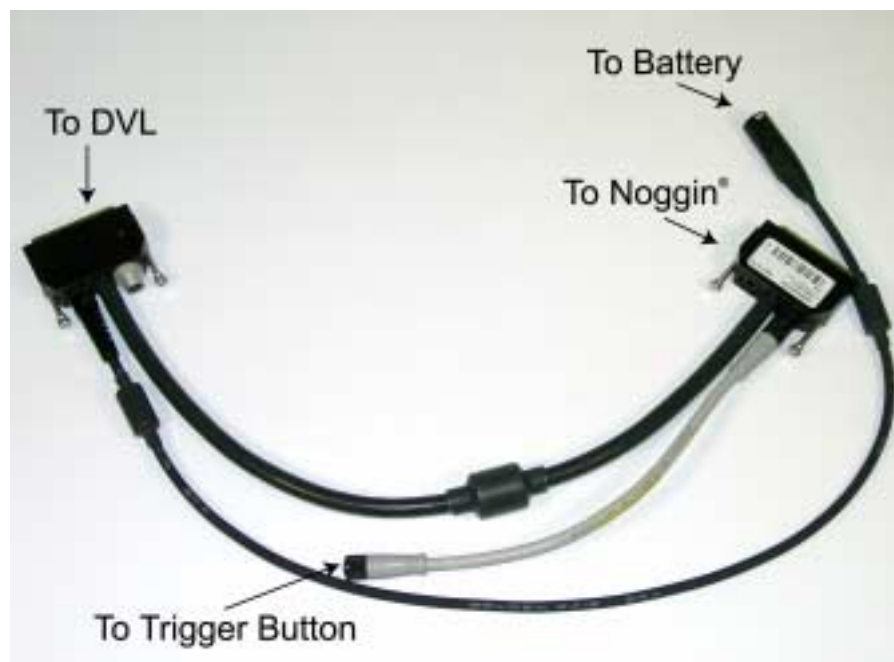


Figure: 7-5 The Rock Noggin cable. The 4 connections are for the Noggin, the Digital Video Logger (DVL), the trigger button and the battery.



Figure: 7-6 The Noggin used with the Rock Noggin can be either a Noggin 500 (shown here) or a Noggin 1000. The connections are identical for both systems. The 4 silver mounting posts visible here are used when attaching the frame to the Noggin (see Figure 7-8).



Figure: 7-7 The Rock Noggin frame. On the bottom of the right handle, note the grey speaker that is used to sound an audible tone as data are collected. Also, on the underside of the right handle, note that Smart button (not visible in this view) used to collect data. The frame is attached to the Noggin using the 4 clevis pins shown (see below). The Digital Video Logger (DVL) clips onto the shelf at the top of the frame (see Figure 7-11).



Figure: 7-8 Using the 4 holes on the bottom of the Rock Noggin frame, place the frame on the 4 mounting posts on the top of the Noggin (shown in Figure 7-6). Push the frame down until it cannot go any further. The Noggin should be oriented such that the 37 socket receptacle on the Noggin is on the same side as the Smart button on the frame.



Figure: 7-9 Secure the frame to the Noggin by pushing the 4 clevis pins into the holes on the frame as shown.



Figure: 7-10 Attach the end of the cable with the 37 pin (male) connection to the Noggin. Use a slotted screwdriver to tighten the connection.



Figure: 7-11 Attach the Digital Video Logger to the frame.

Attach the Digital Video Logger (DVL): The bottom of the Digital Video Logger is designed to slide onto the support shelf attached to the Rock Noggin frame (see Figure 7-11). Line up the bottom of the Digital Video Logger with the shelf and slide it back onto the shelf. Push the Digital Video Logger back far enough so that the flexible clip on the front of the shelf catches and holds the Digital Video Logger firmly in place. Wiggle the DVL to make sure it is firmly snapped in before letting go of the unit. (To remove the Digital Video Logger from the Rock Noggin frame, this clip must be flexed downward as the DVL is slid forward off of the shelf.)

The two handscrews on the bottom of the DVL shelf can be loosened to allow the DVL to be rotated to a different position on the Rock Noggin frame.



Figure: 7-12 Connect the end of the grey cable to the receptacle on the handle at the back of the frame. This receptacle is adjacent to the Smart button.



Figure: 7-13 Attach the end of the cable with the 37 socket (female) connection to the back of the Digital Video Logger (DVL). Use a slotted screwdriver to tighten the connection.



Figure: 7-14 The last connection on the cable is a cylindrical, 4 pin connector for the battery.



Figure: 7-15 The Rock Noggin system is now completely assembled and ready to be turned on.

8 Connecting GPS

For all Noggin configurations, a GPS with a serial output cable can be attached directly to the 9-pin serial port on the back of the DVL (**Figure 8-1**). The DVL can be configured to read in the GPS data and store it along with the GPR data (**Section 12.3.5 GPS Parameters**).



Figure: 8-1 GPS connect to the back of the DVL using a serial connection. GPS supplied with IceMap come with a battery splitter cable to power the GPS from the IceMap battery.

The GPS requires power. User-supplied GPS's will need to be powered using a separate battery.

GPS supplied by Sensors & Software come with a battery splitter cable to allow the 12 Volt system battery to power both the Noggin system and the GPS (**Figure 8-1**).

9 Digital Video Logger (DVL)

Data acquisition is controlled by the Digital Video Logger (DVL). The DVL has software to set survey parameters, collect, display and store data.

9.1 Compact Flash Drive

The DVL has both an internal and a removable compact flash drive. The DVL firmware resides on the internal drive. Data can be saved to either the internal or removable drive (**Figure 9-1**). The removable compact flash drive is accessible by opening the door on the top of the DVL.

Ensure the DVL is powered down before removing or inserting the compact flash drive.

Loosen the finger screws on the top of the DVL, swing the door open and press the button to eject the drive.



Figure: 9-1 The DVL has a removable compact flash drive for data storage.

The DVL comes with a removable compact flash drive but the user has the option to purchase additional drives for data storage. It is best to purchase an industrial grade compact flash drive. Normal compact flash drives work but the higher the transfer rates and temperature ranges the better. The DVL can use cards up to a maximum of 2 GB in size. Sandisk, PSI-APRO, SimpleTech, Kingston, Viking, and Pretech are a few manufacturers of compact flash drives. These are widely available in consumer electronics stores.

To transfer data from the removable drive to a PC the user will need to purchase a card reader (**Figure 12-17**). These are widely available in consumer electronics stores.

9.2 DVL Temperatures

It is very important that the DVL only be operated when it can be kept warmer than -10 C otherwise sensitive electronic components including the LCD screen may freeze. Never start the DVL after it has been exposed to cold temperatures.

If the DVL will be operating in temperatures below -10 C, it should be kept in a wind-proof box insulated with styrofoam or textiles and heated with hand-warmer packs, if necessary. If possible, start the DVL in a warm temperature before placing it in the box. If the protective box is properly insulated, the DVL can usually generate enough heat to keep itself warm.



9.3 Running a DVL Detached from a Smart System

When collecting data with a Smart System, the DVL is powered by the system battery. It is possible to detach the DVL from the Smart System and use it away from the system to review data. There are 2 ways to power the DVL away from the Smart System:

- 1) The optional DVL to Power Supply Cable allows the user to power the DVL away from the Smart System using the system battery. As shown in **Figure 9-2**, the cable connects the battery to the 9-socket connector on the back of the DVL.
- 2) To avoid having to use the system battery to power the DVL, an optional AC power supply is available. This, when combined with the DVL II to Power Supply Cable, allows the user to power the DVL away from the Smart System using AC power. As shown in **Figure 9-3**, the AC power supply connects to the DVL II to Power Supply Cable which connects to the 9 socket connector on the back of the DVL.

9.4 DVL Carrier

For convenience during data acquisition, especially when using the SmartTow and SmartHandle configurations, the DVL can be carried using the optional DVL Carrier shown in **Figure 9-2**.

The bottom of the DVL is designed to slide onto the support shelf on the DVL Carrier. Line up the bottom of the DVL with the shelf and slide it back onto the shelf. Push the DVL back far enough so that the flexible clip on the front of the shelf catches and holds the DVL firmly in place. Wiggle the DVL to make sure it is firmly snapped in before letting go of the unit. To remove the DVL from the DVL Carrier, flex the clip downward as the DVL is slid forward off of the shelf.



Figure: 9-2 The DVL and control module can be attached to the optional DVL Carrier for hands-free operation. The DVL can be adjusted to optimize the view angle.

9.5 Connecting the DVL to the Smart System

Attach the end of the DVL-to-Noggin cable with the 37-pin female D-connector to the 37-pin receptacle on the back of the DVL. This attachment can be secured by tightening the latch.



Figure: 9-3 The DVL-to-Noggin cable connects to the back of the DVL.

10 Powering Up the System

Once all the cable connections are made between the Noggin, the Digital Video Logger (DVL) and any accessories like odometers and GPS's, the final step is to connect the system to a 12 volt power source, typically one of the batteries shown in **Figure 10-1**.



Figure: 10-1 Batteries for Noggin Smart Systems: SmartCart batteries (left) and belt battery (right).

Connect the round 4-pin battery cable on the Noggin-to-DVL cable to the receptacle on the side of the battery.

The upper red LED light on the DVL panel should be lit. If the battery voltage is low, the light will flash for about 30 seconds and go out. If the light flashes or does not appear, check the connections and make sure the battery is fully charged. (See Section 14.1: P.115 for more information on battery care.)

The voltage indicator can be helpful for identifying when the battery needs to be recharged. If the battery voltage drops too low the DVL will cease to operate.

The front of the DVL is shown in Figure 10-2. To start the system, press any button on the front panel. The lower red LED on the front panel should illuminate.



Figure: 10-2 Digital Video Logger (DVL) face

At this stage, the Noggin unit will still be powered down. Once Noggin action is requested (see later menu items), the DVL will enable power to the Noggin. If the Noggin is receiving power, the red LED light on the connector to the Noggin will be illuminated.

The water-resistant membrane keypad has a number of buttons that can be pressed to perform various tasks.

Menu Buttons: The yellow buttons labelled 1 to 8 correspond to menu choices that appear listed on the screen or along the bottom of the screen when the Digital Video Logger is turned on.

In addition, there are two general-purpose buttons labeled A and B. All buttons are DVL application dependent and roles change. The operation will be self-explanatory from the display screen.

Screen: The DVL screen is a grayscale LCD selected for its wide temperature range and visibility in sunlight. Visibility can be a major problem with viewing GPR data displays outdoors and considerable effort has been expended on getting a readily visible outdoor display.

Brightness: The yellow Brightness control arrows are used to increase and decrease the screen brightness. For example, increasing the Brightness setting may improve the visibility of the screen when in a dark area. Note, however, that increasing the screen brightness also increases battery consumption so don't use a bright screen unless necessary.

Contrast: The yellow Contrast control arrows are used to increase and decrease the screen contrast. For example, increasing the Contrast setting may improve the visibility of the screen on a bright, sunny day. Increasing the Contrast can also be useful to see weaker features on the screen. Adjusting the contrast has little effect on battery consumption.

Temperature sensors within the DVL automatically compensate the screen setting so that manual adjustments of Brightness and Contrast should seldom be needed after initial setup.

Once the Digital Video Logger powers up, the Main Menu is displayed with 4 choices:

A – LOCATE & MARK

B – SURVEY & MAP

1 – CONTACT US

3 - SWITCH MENU

5 – POWER OFF

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- Pressing the A button enters Locate & Mark mode (see Section 11: P.49).
- Pressing the B button enters Survey & Map mode (see Section 12: P.67).
- Pressing the 1 button displays contact information for Sensors & Software Inc.
- Pressing the 3 button switches the menu for use with older Noggin and Noggin^{plus} systems (these are systems with a Yellow or Silver Noggin sticker on top of the electronics housing). For details on using this menu system, see the Smart Systems manual.
- Pressing the 5 button will turn the DVL off.

This screen also displays the following information:

- **Battery Voltage:** The system will shut down when the battery voltage reaches about 10.2 Volts (see Section 14.1: P.115 for more details on the battery).
- **Temperature:** The internal temperature of the DVL is displayed on this screen in Celsius and Fahrenheit.
- **Software Version:** The version of the software loaded on the DVL.

When the Noggin Smart System is not being used, do not leave the battery plugged in. The system draws about 0.1 amps even when it is powered off and this will gradually drain the battery.

11 Locate & Mark Mode

Selecting Locate & Mark from the main menu will display the System Settings screen.

11.1 System Settings Screen



11.1.1 Scan

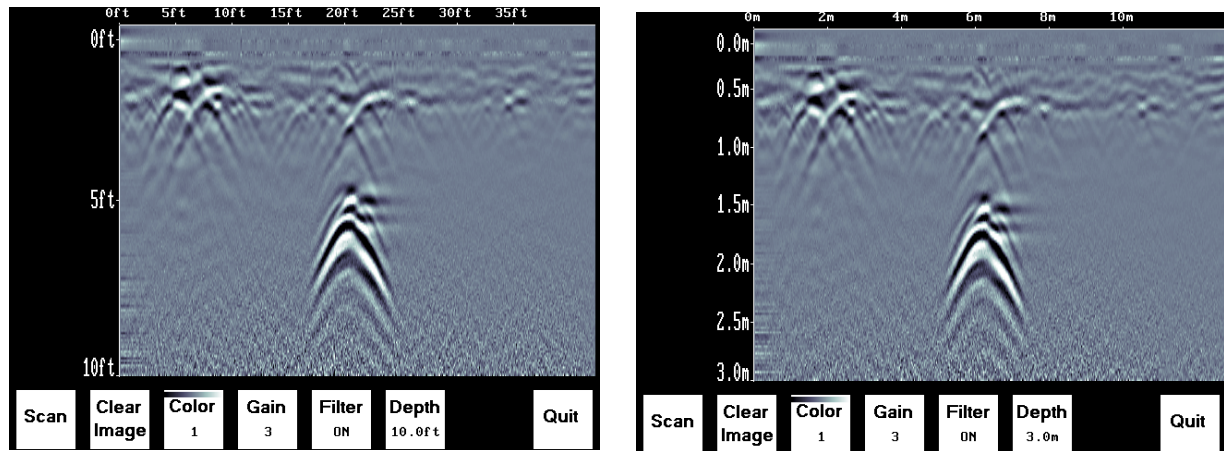
Press the Scan button to start scanning (see Section 3.3).

11.1.2 Language

Select the language for the menus. Current options are English or Icons. This section generally uses the English menus. See Section 3.7?? for a chart showing all the equivalent icons.

11.1.3 Units

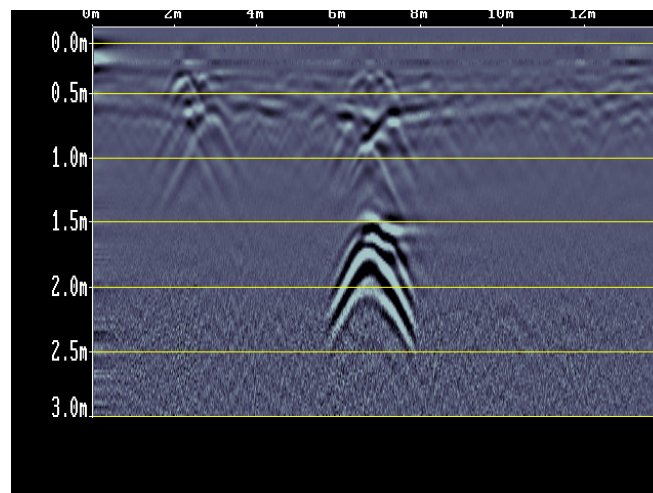
Units for the Position Axis, Depth Axis and Depth Indicator can be either Meters or Feet.



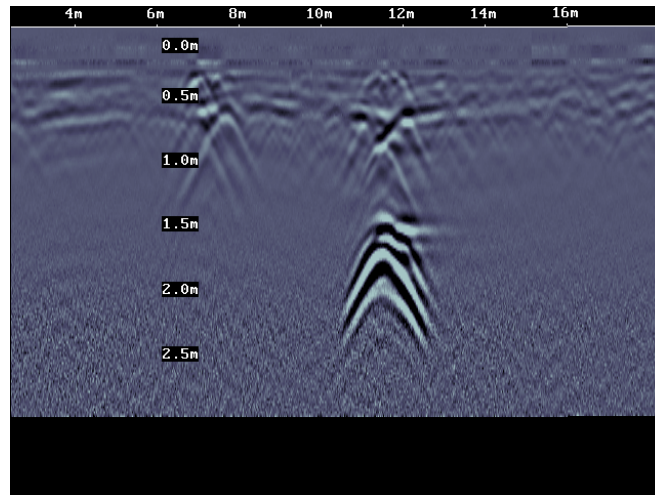
11.1.4 Scale

The Scale button toggles to four different Scale options:

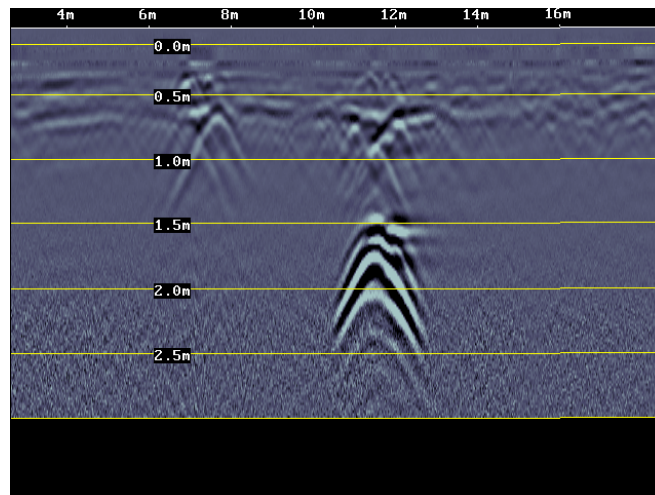
1) Lines means Depth Lines are plotted on the data image to assist with determining the depth of targets (also see Section 3.3).



2) Text means Depth Values are plotted in the center of the data image every 8 metres or 26 feet:



- 3) Both means both Depth Lines and Values are plotted on the data image:



- 4) Off means no Depth Lines and Values are plotted on the data image.

11.1.5 Date

Opens the Date Screen to change the current date (see Section 3.5). Images are saved with this date.

11.1.6 Time

Opens the Time Screen to change the current date (see Section 3.5). Images are saved with this time.

11.1.7 Power Off

Opens a sub-menu to confirm powering off the system. There is also an option to restore the system to factory default settings.

11.1.8 System Information

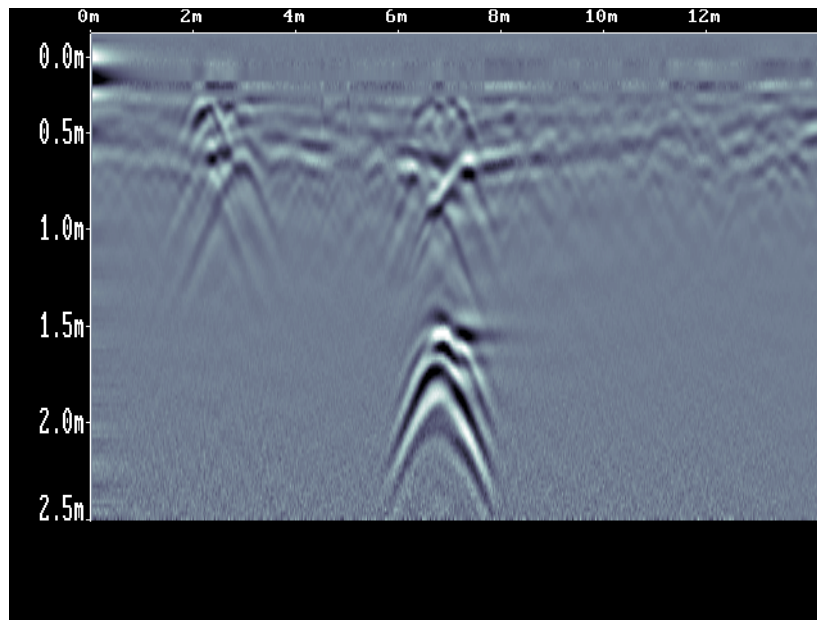
The top of the Systems Setting Screen displays the serial number of the GPR sensor, the software version number, the GPR Sensor frequency (in MHz) and the current battery voltage.

11.2 Scanning Screen

After pressing the Scan button, wait a few seconds for the vertical depth scale to appear on the right side of the screen, and then push the Cart forward.

A cross-sectional image of the ground scrolls onto the screen from the right to left. The position is displayed on the horizontal axis at the top while the depth is displayed on the vertical axis. The position and depth axes units are meters or feet depending on the units set in the Systems Setting Screen (Section 3.2).

If the Scale or Both option is selected (Section 3.2), horizontal depth lines appear on the image to assist with determining the depth of targets.

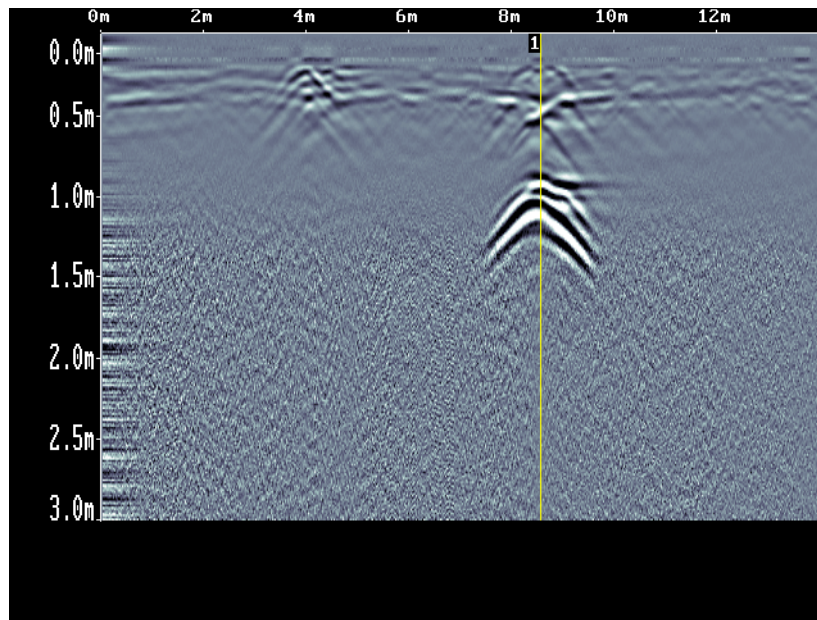


Approximately 16 meters or 50 feet of data is displayed on one screen. If the survey line exceeds this distance the image will scroll off the left side of the screen.

To save the current screen image to file, press the Camera button on the Display Unit. The image number appears on the bottom of the screen with a message to press any button to continue.

A message will appear on the screen if there is no Compact Flash card in the Display Unit. Images are only saved when a card is present.

Pressing any of the number buttons on the Display Unit marked 1 to 8 while scanning adds a numbered marker at the current position.

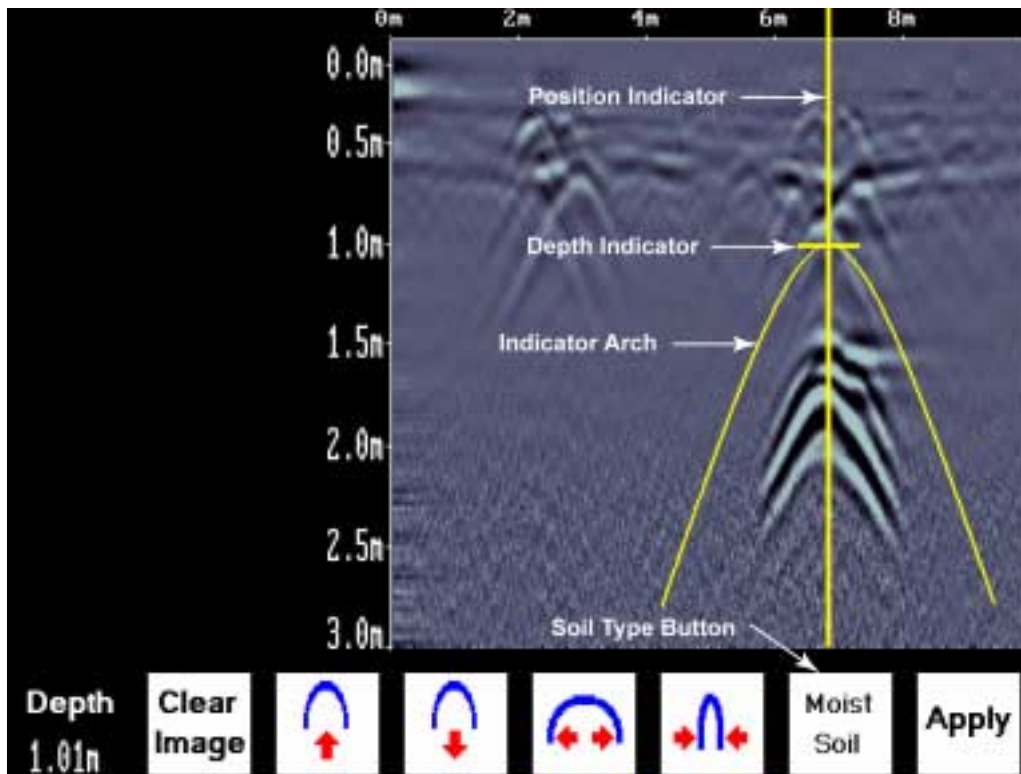


Pressing the Pause button opens the Image Settings Screen to change the current Color Palette, Depth, Filter and Gain (see Section 3.5).

Stopping and pulling the cart backwards along the same path automatically opens the Locating Screen (See Section 3.4) used to pinpoint the position and depth of a target.

11.3 Locating Screen

The Locating Screen is accessed by stopping and pulling the cart backwards while scanning. The cursor moves over the image and menu options appear at the bottom of the screen.



11.3.1 Locating Cursor

The Cursor consists of 3 parts:

Position Indicator Vertical cross-hair is tied to the odometer and corresponds to the location at the center of the GPR sensor. As the cart is pulled backwards, the Position Indicator moves to indicate the current location of the cart in the image.

Depth Indicator Horizontal cross-hair found at the peak of the soil type indicator arch indicating the depth. The Depth Indicator moves up or down using the Arch Up and Down buttons.

Indicator Arch Idealized representation of a typical pipe-like target response observed on the GPR image. The width of the arch is controlled by soil type setting. The soil type setting is changed using the Arch buttons. Increasing the soil type makes the indicator arch wider while decreasing the soil type makes it narrower.

11.3.2 Soil Type

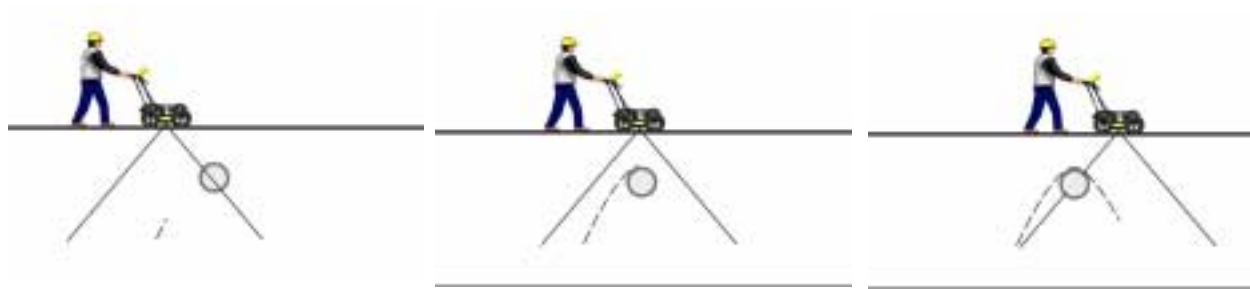
To obtain an accurate depth axis and depth estimations of targets in the GPR image, a Soil Type Calibration must be performed. Soil Type Calibration can be done 3 ways:

- 1) Matching the shape of a target arch,
- 2) Using a target at a known depth, or
- 3) Using the moisture level of the soil.

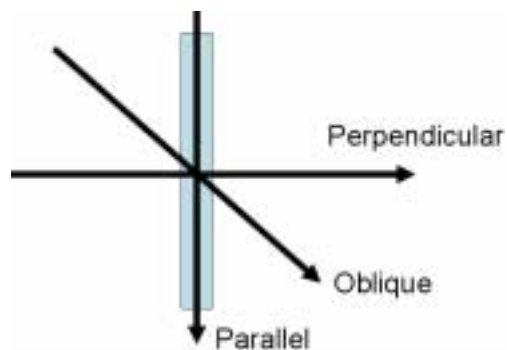
11.3.2.1 Matching a Target Arch

Targets like pipes, cables, buried artefacts, tree roots and rocks generate arch-shaped responses on the GPR image.

Arches occur because GPR energy does not travel into the ground as a pencil-thin beam but more like a 3D cone. Reflections can appear on the record even though the object is not directly below the GPR sensor. Thus, the GPR sensor "sees" the pipe before and after going over top of it and forms an arch-shaped response on the image.

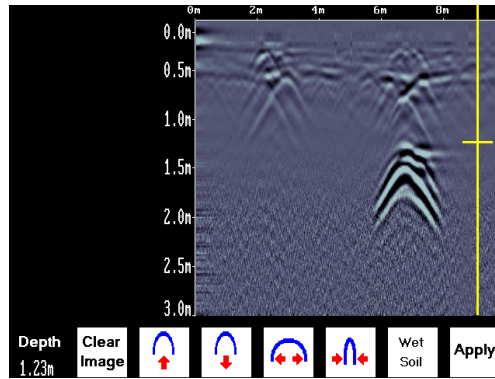


Cross long, linear targets like pipes or cables at a 90 degree angle to produce a target arch suitable for the soil type calibration. The depth estimation of a target will be incorrect if the soil type calibration is done on a target arch produced at an oblique angle (smaller than 90 degrees).

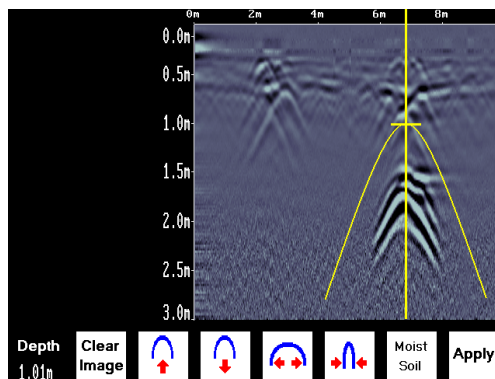


To determine the Soil Type using a Target Arch:

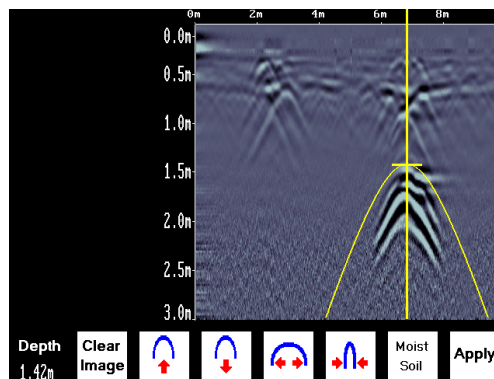
- 1) With a target arch visible on the image, back the cart up until the Position Indicator is centered on the target arch in the GPR image; preferably one with long tails because this provides the most accurate soil type calibration.



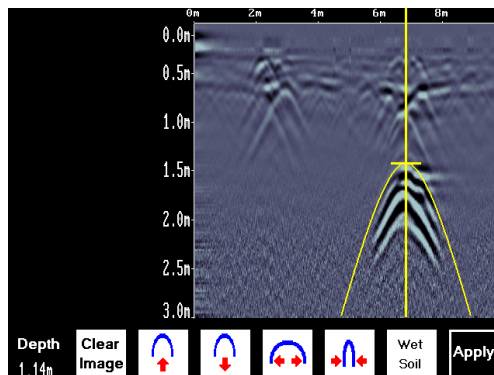
- 2) As you slow down and stop, the Indicator Arch will appear on the data image.



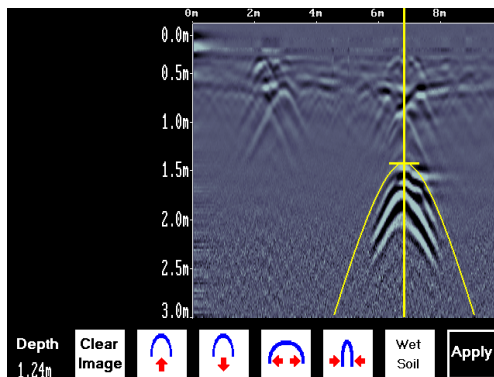
- 3) Use the Up and Down Arrows to move the Indicator Arch shallower or deeper in the GPR image respectively, until it lies overtop of the target arch.



- 4) Press the Soil Type button and toggle through the five different soil types to find the one that roughly fits the shape of the Indicator Arch to the shape of the Target Arch.



- 5) Use the Wide and Narrow Arch buttons to change the shape of the Indicator Arch to match the shape of the Target Arch on the GPR image. The depth of the target is indicated on the bottom left.



- 6) Press the Apply button to save the Soil Type and update the Depth Axis on the Scanning Screen. The Depth axis can now be used to estimate the depth of targets while scanning in the area.

11.3.2.2 Target at Known Depth

If there are no suitable arches visible in the image to perform the Target Arch Matching described above, there may be a target of known depth in the area being scanned.

To determine the Soil Type using a target at known depth:

- 1) With the target response visible on the image, use the Up and Down Arrows to move the Depth Indicator (and Indicator Arch) until it lies on top of the GPR response of the known target.
- 2) Use the Wide and Narrow Arch buttons to change the shape of the Indicator Arch until the depth of the target, displayed in red above the menu, is correct.

- 3) Once the depth is matched, save the Soil Type value by pressing the Save button.

11.3.2.3 Soil Moisture

If a good target arch or a target of known depth is not available, the user will have to estimate the Soil Type. The soil type is most strongly affected by water so the soil type options relate to the amount of water in the soil.

Change the soil type by pressing the Soil Moisture button until the option that best describes the soil in the area is displayed. The options are Very Dry, Dry, Moist, Wet and Very Wet Soil.

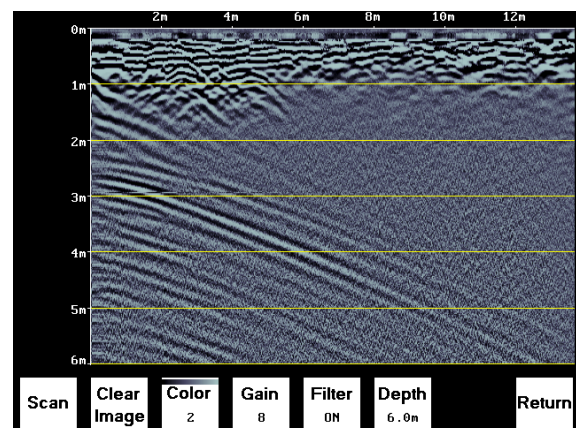
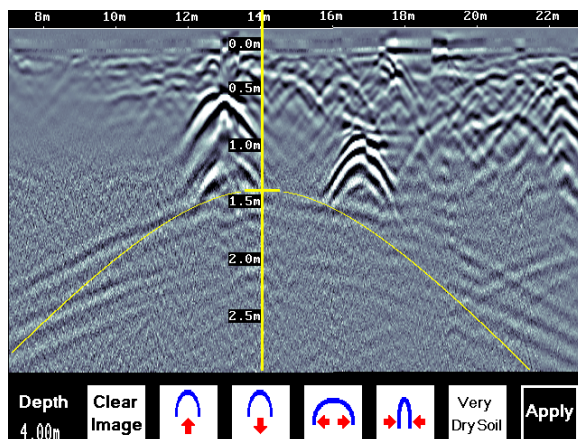
11.3.3 Identifying Air Wave Reflections

Some arches in the image can be caused by objects that are not in the subsurface, such as posts, fences, overhead wires and even trees.

An important part of understanding the data image is learning to recognize these unwanted "air" targets and differentiate them from the targets in the ground.

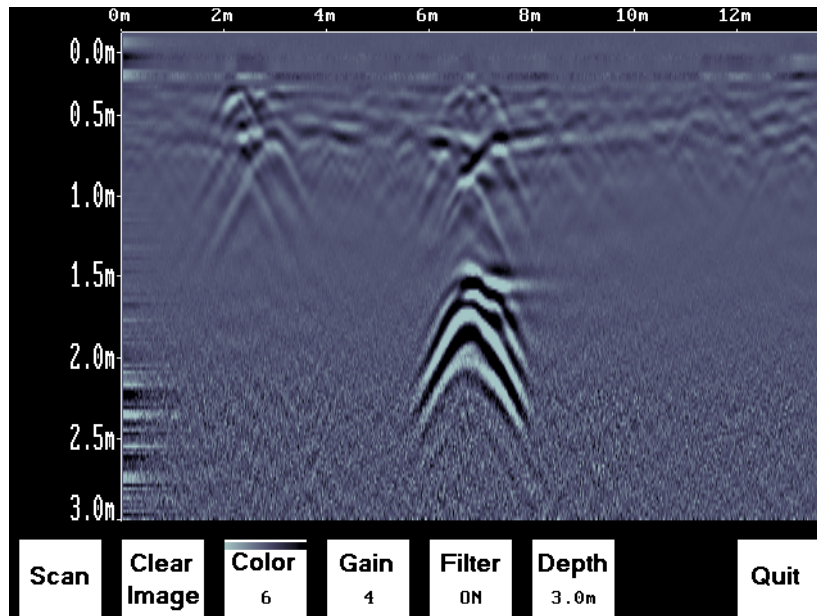
One way of identifying air reflections is to use the target arch method described above. However, arches from above-ground objects are wider than objects in the ground and out of the range of the maximum Soil Type.

Therefore, if the widest Indicator Arch is still not wide enough to match the target arch, the target arch is from an object in the air, not the ground.



11.4 Image Settings Screen

The Image Settings Screen is accessed by pressing the Pause (||) button while in the Scanning Screen or the Locating Screen. Menu options appear along the bottom of the screen:



11.4.1 Scan

To exit from the Image Settings Screen and resume Scanning, press the Scan button or the Pause (||) button again (to unPause). The Scanning Screen returns at the current location with the position information preserved.

If, while paused in the Image Settings Screen, the cart has moved more than a few centimeters, when scanning is restarted, a gap called a Position Break will appear in the image. The position break is also indicated by a message on the bottom of the screen and the Position Axis along the top of the data image resetting to zero.

