6.3 Noggin*plus* Setup

Pressing the number 1 on the main menu selects the Setup item. Setup lists the various parameters that can be edited. These parameters are organized under the following headings:

> **1 - System Parameters**
> **2 - Cart Parameters**
> **3 - Line Parameters**
> **4 - Grid Parameters**
> **5 – GPS Parameters**
> **6 – Set Defaults**

To select a setting to edit, press the corresponding number button. Then use the numbered buttons to select the new setting. It is also possible to change all the settings back to the factory default settings by pressing the 6 button (labelled Set Defaults).

The SETUP options are outlined below.

6.3.1 System Parameters

The System Parameters settings allow the user to view and modify settings specific to the data collection of the Noggin system. This includes the type of Noggin system, the desired depth of investigation, the velocity of the material being surveyed, the units of depth and position, the number of stacks and the amount of linear gain.

Depth

The depth setting is how deep the radar will try to probe in to the subsurface. It is important to realize that the depth setting is an estimated value that is dependent on the velocity of the material being probed.

Ground penetrating radar systems record the **time** for a radio wave to travel to a target and back. They do not measure the depth to that target directly. The depth to a target is calculated based on the velocity at which the wave travels to the target and back. It is calculated as:

$$D = V \times T/2$$

> Where   D is Depth (m)
> V is Velocity (m/ns)
> T is Two-way travel time (ns)

The Depth units can be changed to metres, feet or time in nanoseconds. For details, see Depth Units below in this section.

It is important to remember that just because the Depth setting is set to a certain value, it does not necessarily mean that the Noggin is able to penetrate to that depth and collect data. For example, if the Depth setting is 5 metres but the material penetration is only 3 metres the last 2 metres of the image will not contain subsurface information. Some materials will absorb the Noggin signal and limit penetration to less than the selected depth.

If the depth setting is deeper than the Noggin signals penetrate, the data in the lower part of the data screen will look blank or speckled rather than signal with continuity.

Velocity

The wave velocity depends on the properties of the material. The Noggin*plus* software allows the user to input a velocity, which changes the total time window collected by the system.

See Section 6.2.8 for a discussion about determining velocity.

A table of typical radar velocities in various materials is given below. If in doubt, use a value of 0.10 m/ns. This is a good average velocity that will provide a good estimate of depth in most situations.

Material	Velocity (m/ns)	(ft/ns)
Air	0.300	1.000
Ice	0.170	0.558
Dry Soil	0.130	0.427
Dry Rock	0.120	0.394
Soil	0.100	0.328
Wet Rock	0.100	0.328
Concrete	0.100	0.328
Pavement	0.100	0.328
Wet Soil	0.065	0.213
Water	0.033	0.108

If units are metres then velocities will appear in metres per nanosecond (m/ns). If units are feet then velocities will appear in feet per nanosecond (ft/ns). To change units see Section 6.3.1 – Depth Units.

The Noggin will accept units in metres/nanosecond or feet/nanosecond depending on the Depth Units setting.

Depth Units

This is the setting for the units of the horizontal depth lines that appear on the screen. The available settings are metres, feet or nanoseconds (ns). If nanoseconds are selected the "depth" lines (see Section 6.2.2) are actually time lines.

1. metres
2. feet
3. nanoseconds

Noggin System

The Noggin System should be set to the type of Noggin currently in use on the Smart System. The Noggins available are:

1. Noggin 250
2. Noggin 500
3. Noggin 1000

Stacks

Some materials tend to absorb radar signals and limit penetration. These materials are said to be lossy. When collecting data in lossy areas or areas with a lot of radio frequency noise, one way of increasing data quality is to collect more than one trace at each survey position, average them and save the averaged trace. This is known as "stacking". Data quality improves because the noise, which is usually random (like white noise on a TV screen with no station in the area), tends to zero when averaged. Consequently, the usable signal is easier to see. This is known as increasing the "signal-to-noise ratio".

The amount of Stacking can vary from 1 to 2048 by factors of 2.

While stacking improves data quality, it also forces the user to slow down survey production. The more stacks the longer it takes to collect data at each survey position. Therefore, it is important to find the lowest number of stacks that still reveal the target adequately. For most surveys, stacking 4 times is suitable.

See the warning in Section 6.2.7 about losing data if the Smart System is moving too quickly for the Noggin system to keep up.

Linear Time Gain

As described in Section 6.2.6, the weak signals must be amplified or "gained" to see them on the display. The Gain button described in Section 6.2.6 can be set to a value from 1 to 9 depending on the amount of gain required (1 is lowest gain, 9 is highest gain).

There is also a second level of gain available to the user and that is the Linear Gain setting. The default Linear Gain setting of 2.0 is usually adequate for most ground conditions, however, if advanced users find that they are surveying in areas where high Gain button settings are always required to see data, it may be advantageous to increase the Linear Gain setting. Conversely, if the user finds that low Gain button values work to see the data, it may be useful to decrease the Linear Gain setting.

For the experienced user, the setting indicates the gain increases per nanosecond.

The Linear Gain setting can vary from 0.0 to 5.0 in steps of 0.5.

Position Units

This is the setting for the position units used by the odometer. The available options are:

1. metres (default)
2. feet

6.3.2 Cart Parameters

The Cart Parameters settings allow the user to view and modify settings specific to the Smart Cart or Smart Handle system. This includes the direction the Noggin will move to collect data, whether or not the odometer is active and whether Auto Start is on or off.

Cart Direction

This setting determines whether data are collected as the Noggin is pushed forward or pulled in reverse. The back up arrow (see Section 6.2.7) will work in the direction opposite to this setting. The available options are:

1. Push (default)
2. Pull

Odometer Active

This setting determines whether the odometer is used to collect data. If no, then the system runs continuously.

1. Yes (use the odometer) (default)
2. No (operate continuously)

Auto Start

If the Auto Start option is set to ON (the default), after the user presses Run to collect a data line, the system will automatically boot up and be ready for data acquisition, rather than having the Start button appear. This prevents the user from having to press the Start button at the start of every new line. **This setting is especially useful when collecting numerous lines as occurs when collecting grid data.** If Auto Start is set to OFF the user must press the Start button to begin data acquisition for each line.

Arrow Offset

Section 6.2.7 describes the Back-up Arrow that appears when the Smart System is backed up. The Back-up Arrow allows the user to pinpoint the exact ground position corresponding to a target response on the data image. The Arrow Offset value is used to change the physical position that corresponds to the Back-up Arrow. If the Arrow Reference value is set to the default value of zero (0.0) metres, the Back-up arrow

position corresponds with the centre point of the Noggin.

However, the Arrow Offset value can be changed so that the Back-up Arrow corresponds to a position at any offset from the centre of the Noggin. For example, setting the Arrow Offset value to +0.25 metres moves the Back-up Arrow to line up with a position 25 centimetres in front of the Noggin centre point (on the Noggin 500 Smart Cart this roughly corresponds to the front axle). Setting the Arrow Reference value to -0.25 metres moves the Back-up Arrow to line up with a position 25 centimetres in behind the Noggin centre point (on the Noggin 500 Smart Cart this roughly corresponds to the back axle). In this way, the Arrow Offset value can be changed to correspond with any position desired by the user.

One reason the user may want to change the Arrow Offset value is to ensure that the Noggin does not cover the actual target location. This makes it easier to spray paint a mark or put a flag on the ground where the target occurs.

Positive values correspond to positions in front of the Noggin and negative values are positions behind the Noggin. Note that the Arrow Offset value is always expressed in metres regardless of the settings of the other units.

Trip Menu

The software records the total distance the cart has travelled. This value is displayed in Setup but cannot be changed.

The software also records a distance that can be reset by the user. To reset the distance counter, move to the Reset Counter option and press the Zero button.

Transfer Rate

Transfer Rate is a variable from 1 to 8 that corresponds to the speed of the data transfer from the Noggin to the DVL. A value of 8 provides the fastest transfer speed while a value of 1 is the slowest.

For standard Smart Systems like the Smart Cart system and Smart Handle system the Transfer Rate value must be set to 8.

The Transfer Rate value will only be decreased for systems with data cables longer than standard lengths. Please contact Sensors & Software before changing the Transfer Rate on your system.

Odometer Number

Noggin Smart Systems can take input from several different odometers.

It is very important that the user selects and calibrates the odometer appropriate for their Smart System.

When Odometer Number is selected, the user is prompted to select the odometer that is being used with the Smart System.

If a **Smart Cart System** is being used, select one of the two Smart Cart odometers (usually #1).

If a **Smart Handle system** is being used, select one of the two Smart Handle odometers (usually #1).

If the system is being towed behind a **vehicle** and using the transmission odometer to trigger the system, select one of the two Vehicle odometers (usually #1).

The odometers labelled **Other** are to be used in future configurations.

The number after the odometer is the current Odometer Calibration value for that odometer. To calibrate the odometer, see Section 6.5.2.

6.3.3 Line Parameters

The Line Parameters settings allow the user to view and modify settings specific to collecting data as individual lines, namely, the starting position of the line and line direction.

Start Position

The Start Position is the position value at the very beginning of a line. This will usually be set to zero (0.0). However, if the user wants a data file to start at a position other than zero, this value can be edited.

Line Direction

The Line Direction setting specifies which direction that line will be collected, either Forward or Reverse. Data are usually collected in a forward direction.

If data are collected in the Forward direction the position stepsize is positive, that is, the position value of each data collection point increments positively. For example, for a Noggin 250 system, if the Start Position is 10.0 and the Line Direction is Forward, the positions on the line will increment 10.00, 10.05, 10.10, 10.15 ….

If data are collected in the Reverse direction the position stepsize is negative, that is, the position value of each data collection point increments negatively. For example, for a Noggin 250 system, if the Start Position is 10.0 and the Line Direction is Reverse, the positions on the line will decrement 10.00, 9.95, 9.90, 9.85 ….
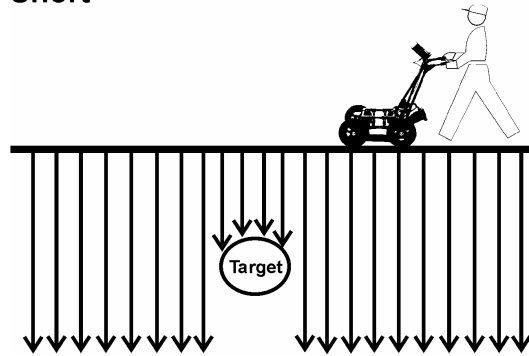
Station Interval

As Smart Systems moves, the odometer triggers the system to collect a data trace at fixed distance intervals. This interval is called the "station interval".

The station interval can be changed to allow a longer or shorter distance between traces. For a successful survey, it is important that several traces be collected over a

target. If the target is small, the user may want to shorten the station interval to ensure that data traces are collected over the target. Conversely, if the target is very large or is a flat-lying feature it is probably not necessary to collect a lot of traces over the target, in fact, sometimes this can make the target more difficult to see in the data. In this case it may be beneficial to increase the station interval.
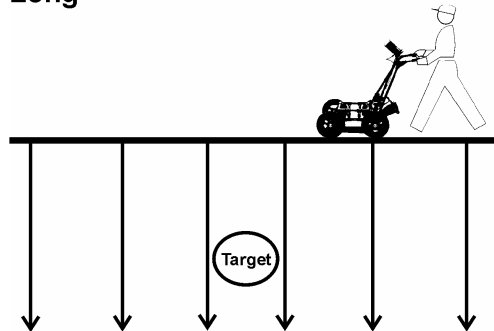
Short

Normal
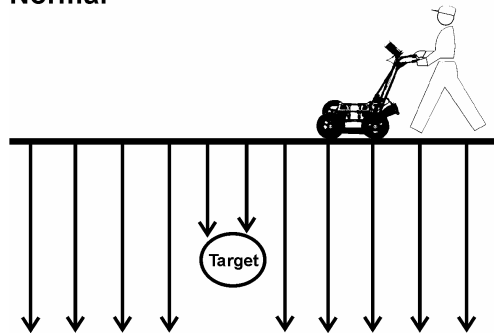
Long

Figure 6-5: The Station Interval is the distance between sample points on the ground. Be careful not to choose a Station Interval that is larger than the smallest target to be detected.

Note that decreasing the station interval increases the data volume and increasing the station interval reduces the data volume.

The choices available are:

1) Short
2) Normal
3) Long
4) X-Long
5) 10x Normal
6) 20x Normal
7) 40x Normal
8) 50x Normal
9) 100x Normal

Here is a chart showing the station interval for each system and setting. The choices available are:

Noggin 250 System

Setting	Station Interval	Data per Screen
Short	2.5 cm or 0.96 in	8 m or 25.6 ft
Normal	5.0 cm or 1.92 in	16 m or 51.2 ft
Long	10.0 cm or 3.84 in	32 m or 102.4 ft
X-Long	25.0 cm or 9.6 in	80 m or 256 ft
Norm x10	50.0 cm or 19.20 in	160 m or 512 ft
Norm x20	100.0 cm or 38.4 in	320 m or 1024 ft
Norm x40	200.0 cm or 76.8 in	640 m or 2048 ft
Norm x50	250.0 cm or 96.0 in	800 m or 2560 ft
Norm x100	500.0 cm or 192.0 in	1600 m or 5120 ft

Noggin 500 System

Setting	Station Interval	Data per Screen
Short	1.0 cm or 0.48 in	6.4 m or 25.6 ft
Normal	2.5 cm or 0.96 in	16 m or 51.2 ft
Long	5.0 cm or 1.92 in	32 m or 102.4 ft
X-Long	12.5 cm or 4.8 in	80 m or 256 ft
Norm x10	25 cm or 9.6 in	160 m or 512 ft
Norm x20	50 cm or 19.2 in	320 m or 1024 ft
Norm x40	100 cm or 38.4 in	640 m or 2048 ft
Norm x50	125 cm or 48.0 in	800 m or 2560 ft
Norm x100	250 cm or 96.0 in	1600 m or 5120 ft

Noggin 1000 System

Setting	Station Interval	Data per Screen
Short	0.5 cm or 0.24 in	3.2 m or 12.8 ft
Normal	1.0 cm or 0.48 in	6.4 m or 25.6 ft
Long	2.0 cm or 0.96 in	12.8 m or 51.2 ft
X-Long	5.0 cm or 2.4 in	32.0 m or 128 ft
Norm x10	10 cm or 4.8 in	64.0 m or 256 ft
Norm x20	20 cm or 9.6 in	128 m or 512 ft
Norm x40	40 cm or 19.2 in	256 m or 1024 ft
Norm x50	50 cm or 24.0 in	320 m or 1280 ft
Norm x100	100 cm or 48.0 in	640 m or 2560 ft

Note that Noggin 250 traces are plotted on the screen 2 pixels wide while traces from the Noggin 500 and 1000 are plotted on the screen 1 pixel wide (see Section 6.2.7).

6.3.4 Grid Parameters

The Grid Parameters settings allow the user to view and modify settings specific to collecting data in organized grids. This includes the grid dimensions, line spacing, grid type and survey format.

Data are normally collected on a grid if the user is interested in displaying the data as a 3D volume (using the EKKO_3D software) or as a plan map (using the EKKO_Mapper and/or EKKO_Pointer software). Producing accurate 3D volumes or plan maps is easier if the field survey is properly designed and data are collected correctly.

Positional accuracy of each line is vital if the user wants to be able to relocate targets of interest after the data have been processed.

For linear targets like pipes and utilities, the best GPR response occurs when the GPR survey line crosses the target at right angles. If possible, it is always best to run GPR survey lines perpendicular to the direction of linear targets.

Grid Type

The Grid Type asks specifically the way that the area of the grid is to be covered by the survey lines. Survey lines can be either a set of parallel lines in the X axis direction (Figure 6-6), a set of parallel lines in the Y axis direction (Figure 6-7), or, for complete coverage, parallel lines in both the X and Y direction (Figure 6-8).

X Lines Only - Forward

Set up a first-quadrant XY grid. Data lines run in the X direction, distance increasing from the Y axis baseline. Line numbers increase in the positive Y direction (see Figure 6-6). Lines must be equally spaced. It is not critical that all the lines are the same length. However, it does make processing easier if all the lines start at the same baseline position (usually defined as zero (0.0)).
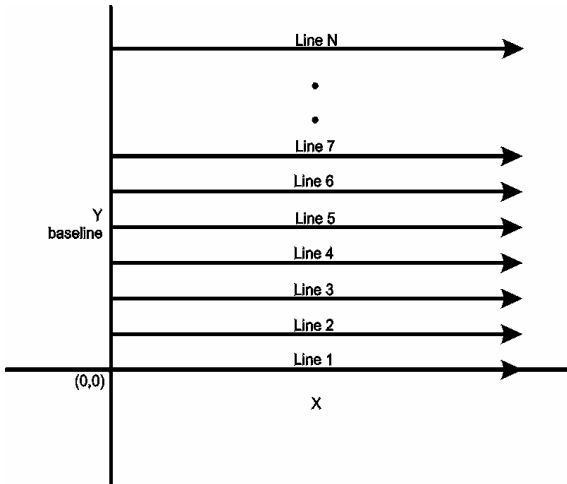
Figure 6-6: Proper X Line surveying pattern. Following this pattern and starting each line from the same baseline minimizes the data editing required to produce a spatially accurate map of GPR data.

Y Lines Only - Forward

Set up a first-quadrant XY grid. Data lines run in the Y direction, distance increasing from the X axis baseline. Line numbers increase in the positive X direction (see Figure 6-7). Lines must be equally spaced. It is not critical that all the lines are the same length. However, it does make processing easier if all the lines start at the same baseline position (usually defined as zero (0.0)).
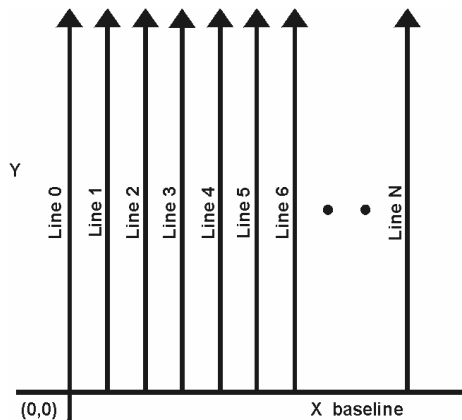

Figure 6-7: Proper Y Line surveying pattern. Following this pattern and starting each line from the same baseline minimizes the data editing required to produce a spatially accurate map of GPR data.

XY Lines - Forward

Set up a first-quadrant XY grid. X data lines run in the X direction, distance increasing from the Y axis baseline. Line numbers increase in the positive Y direction (see Figure 6-8). Lines must be equally spaced. Y data lines run in the Y direction, distance increasing from the X axis baseline. Line numbers increase in the positive X direction. Lines should be equally spaced. The line spacing of the X lines and Y lines can be different.

It is not critical that all the lines are the same lengths. However, it does make processing easier if all the lines start at the same baseline position (usually defined as zero (0.0)).
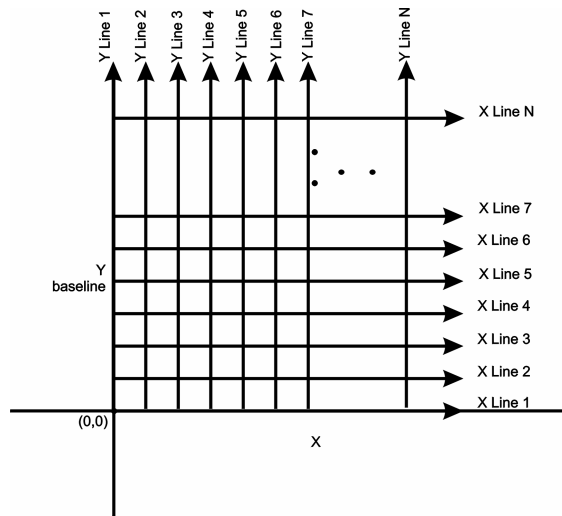
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Figure 6-8: Proper XY grid surveying pattern. Following this pattern and starting each line from the same baseline minimizes the data editing required to produce a spatially accurate map of GPR data

Survey Format

The Survey Format specifies how the lines will be collected. The lines shown in Figure 6-6, Figure 6-7, and Figure 6-8 are all collected in the Forward direction only. This means that each line starts at the X or Y baseline.

When the length of the survey lines are more than about 20 metres, data acquisition speed may be increased by collecting every second line in the reverse direction (Figure 6-9, Figure 6-10, and Figure 6-11). This is called a Forward and Reverse survey format.

Using forward and reverse format can speed acquisition but can lead to mapping artifacts called "herringbone" if there are positional errors. It is important that the odometer is calibrated (Section 6.5.2) and that the Grid Dimensions are correct (Section 6.3.4 – Grid Dimensions).

X Lines Only – Forward and Reverse

Using the Forward and Reverse survey format, X line data are collected in the pattern shown in Figure 6-9.
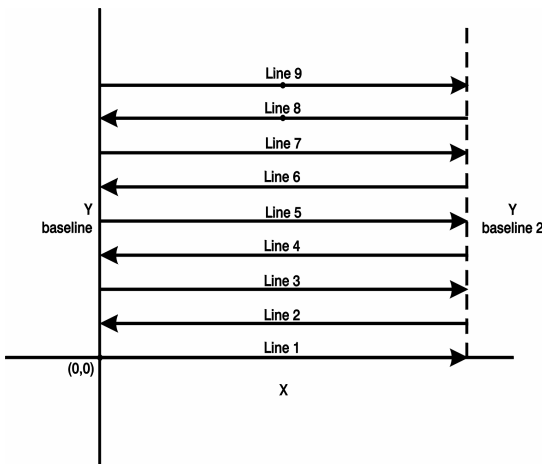

Figure 6-9: For collecting GPR data consisting of long data lines it makes more sense to follow a forward and reverse surveying pattern. For the final data to be spatially correct with a minimum of editing, data collected in this pattern should be on lines that extend completely from one baseline to the other.

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Y Lines Only – Forward and Reverse

Using the Forward and Reverse survey format, Y line data are collected in the pattern shown in Figure 6-10.

When data are collected like this, it is important that lines start and end on established baselines, otherwise, when lines are reversed to the correct orientation for the display, they may be offset from one another.
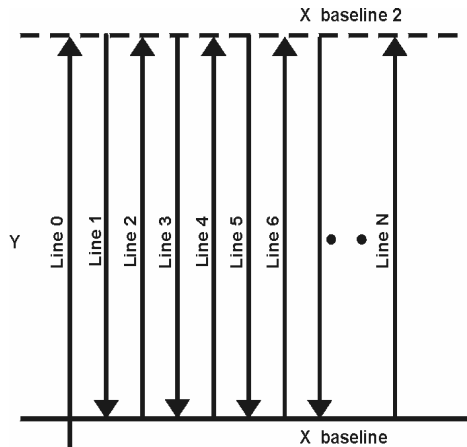

Figure 6-10: For collecting GPR data consisting of long data lines it makes more sense to follow a forward and reverse surveying pattern. For the final data to be spatially correct with a minimum of editing, data collected in this pattern should be on lines that extend completely from one baseline to the other.

XY Lines – Forward and Reverse

Using the Forward and Reverse survey format, XY line data are collected in the pattern shown in Figure 6-11.

When data are collected like this, it is important that lines start and end on established baselines, otherwise, when lines are reversed to the correct orientation for the display, they may be offset from one another.
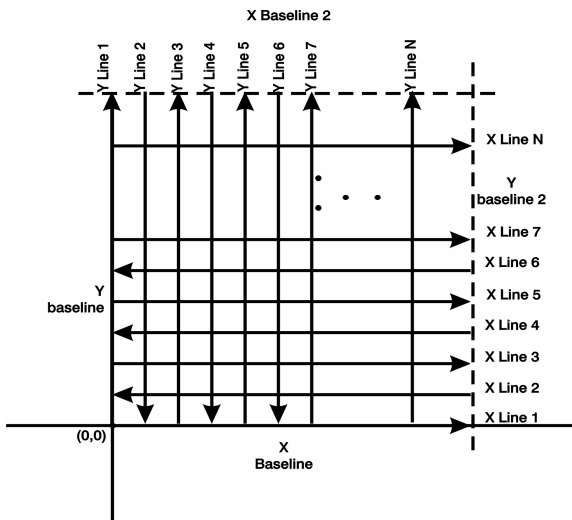

Figure 6-11: For collecting GPR data on a grid consisting of long data lines, it makes more sense to follow a forward and reverse surveying pattern. For the final data to be spatially correct with a minimum of editing, data collected in this pattern should be on lines that extend completely from one baseline to the other.

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Grid Dimensions

For grid data acquisition, the grid size needs to be specified. The user needs to input the length of the X dimension and the length of the Y dimension. The dimensions entered are assumed to be in the same units as the Position Units (see Section 6.3.1), i.e. metres or feet.

On this screen the user needs to highlight the dimension to be changed. The user can toggle between the X and Y fields by pressing the X/Y button.

The dimension value is incremented or decremented by pressing the +Line or –Line buttons. The dimension value will change by a value equal to the current Line Spacing in that dimension.

For example, if the Line Spacing (see below) in the X direction is 0.5 metres, the grid dimension in the X direction will increment or decrement in 0.5 metre intervals.

Note that the maximum number of lines that can be collected in each direction is 100. Therefore, the X and Y grid dimensions cannot be set to a value that will result in more than 100 lines being collected.

For example, if the Line Spacing between Y lines (defined as lines parallel to the Y axis) is set to 0.25 metres, the maximum X dimension is (100-1) X 0.25 = 24.75 metres. (One is subtracted because the first line is at position 0.0 metres.)

To increase the X dimension value, the Y line spacing must be increased. Using the example above, if the Y Line Spacing is increased to 0.30 metres then the maximum X dimension is (100-1) X 0.30 = 29.70 metres.

If the Grid Type is set to X Lines only or Y Lines only (see Section 6.3.4), the length of those lines are not restricted by the Line Spacing parameter of the opposite dimension. That is why if an X Lines only grid is selected, the X dimension can be input as a value rather than an increment of the Y Line Spacing. Similarly, if a Y Lines only grid is selected, the Y dimension can be input as a value rather than an increment of the X Line Spacing.

Line Spacing

For grid data acquisition, the distance between survey lines needs to be specified.

If the grid type is X Lines only (see Section 6.3.4) then the spacing between the X lines needs to be input.

If the grid type is Y Lines only (see Section 6.3.4) then the spacing between the Y lines needs to be input.

If the grid type is XY Lines (see Section 6.3.4) then the spacing between the X lines and Y lines need to be input. The line spacing can be different. The user can toggle between the X line spacing and Y line spacing fields by pressing the X/Y button.

Note that the maximum number of lines that can be collected in each direction is 100.

The calculation for determining an appropriate line spacing is complex. One has to consider system frequency, target size and practical considerations. In general, the Noggin 250 should have a line spacing of 0.5 metres or less, the Noggin 500 should have a line spacing of 0.25 metres or less and the Noggin 1000 should have a line spacing of 0.10 metres or less.

However, line spacing should really be determined by target size. In most cases the system must pass over a target to detect it. Therefore, the line spacing needs to be on the order of the size of the target or smaller, if practical. This can be adjusted to a larger spacing for larger targets or targets with a linear extent. As well, these rules may have to be bent for practical purposes like survey production rates. The fact is that a tighter line spacing takes longer to collect and this may not be economically possible in all circumstances.

6.3.5 GPS Parameters

The Global Positioning System (GPS) uses special satellites around the Earth to determine the position of a GPS receiver located at any position on the surface of the Earth. GPS receivers can be purchased from a number of manufacturers.

The DVL has a serial port on the back for attaching a GPS receiver. This port will accommodate any GPS receiver that has a standard serial port output.

This feature allows GPS information to be logged while collecting Noggin*plus* data. The GPS information may be useful for mapping where GPR surveys have been performed (see Reading per Trace mode below) or determining where a specific target of interest is located in GPS co-ordinates (see Fiducial Tagging mode below).

The DVL can be set up to read and log GPS information collected during data acquisition with the Noggin*plus* system. GPS information can be logged in two different ways: 1) for every trace collected by the Noggin*plus* system, or 2) every time the user adds a fiducial to the data by pressing the A button (see Section 6.2.4 – Fiducial Markers).

This feature provides a means of logging GPS information to an independent file. **Note that the GPS information is NOT automatically integrated with the Noggin*plus* data.** After data acquisition is complete, the data can be downloaded to a PC and the Win_EKKO_Pro software can be used to integrate the GPS data with the Noggin*plus* data.

In order for the DVL to read the GPS data string, the GPS settings for the specific GPS receiver being used must be input into this menu. There are 4 important items that must be specified correctly for the DVL to display the GPS strings. These items are Baud Rate, Stop Bits, Data Bits and Parity. These are discussed in more detail below. The default values listed below are the values that are typically used. Read the GPS Receiver User's Guide or experiment with the settings to find the correct ones.

Once these 4 items are set correctly you should be able to run System Test #1 and have GPS information written to the screen.

When the logging of GPS information is enabled, during data acquisition a message will appear in the bottom left-hand corner of the DVL screen indicating whether GPS data is successfully being received (see Section 6.2.4).

Mode

There are three GPS modes available:

1) **Off** mode means that a GPS receiver is not connected to the DVL so no GPS information is being logged. This should be the setting if you do not have a GPS receiver.

2) **Reading every x traces** mode means that every time the Noggin^{plus} collects a user-defined number of traces of GPR data, a data string of GPS information will be added to a file. This file has the same name as the data file i.e. LINE6, but with a GPS extension. This file can be accessed after transferring the GPR data files to an external PC (see Section 6.4.1).

   For example, if the number of traces is set to 1, the LINE6.GPS may look like this:

```
Trace #1
$GPGGA,134713.00,4338.221086,N,07938.421365,W,2,06,2.1,152.51,M,-35.09,M,5.0,0118*79
$GPVTG,34.0,T,,,001.4,N,002.5,K,D*70
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.6*36
Trace #2
$GPGGA,134713.00,4338.221086,N,07938.421365,W,2,06,2.1,152.51,M,-35.09,M,5.0,0118*79
$GPVTG,34.0,T,,,001.4,N,002.5,K,D*70
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.6*36
Trace #3
$GPGGA,134713.00,4338.221086,N,07938.421365,W,2,06,2.1,152.51,M,-35.09,M,5.0,0118*79
$GPVTG,34.0,T,,,001.4,N,002.5,K,D*70
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.6*36
Trace #4
$GPGGA,134713.00,4338.221086,N,07938.421365,W,2,06,2.1,152.51,M,-35.09,M,5.0,0118*79
$GPVTG,34.0,T,,,001.4,N,002.5,K,D*70
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.6*36
```

   Note that when the Reading per Trace option is on, it is still possible to add fiducial markers to the GPS file. These will appear as F1, F2 etc. between the trace numbers. For example, a portion of LINE6.GPS may look like this:

```
Trace #85
$GPGGA,134850.00,4338.204868,N,07938.429003,W,2,06,2.1,152.60,M,-35.09,M,4.2,0118*74
$GPVTG,152.6,T,,,002.3,N,004.3,K,D*43
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.7*37
F1
$GPGGA,134850.00,4338.204868,N,07938.429003,W,2,06,2.1,152.60,M,-35.09,M,4.2,0118*74
$GPVTG,152.6,T,,,002.3,N,004.3,K,D*43
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.7*37
Trace #86
$GPGGA,134851.00,4338.204362,N,07938.428362,W,2,06,2.1,152.40,M,-35.09,M,5.2,0118*72
$GPVTG,136.9,T,,,002.8,N,005.2,K,D*45
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.7*37
```

3) **Fuducial Tagging** mode means that whenever a fiducial marker (F1, F2 etc.) is added to the data (see Section 6.2.4), a data string of GPS information will be added to a file. This file has the same name as the data file i.e. LINE6, but with a GPS extension. This file can be accessed after transferring the GPR data files to an

external PC (see Section 6.4.1).
For example, LINE6.GPS may look like this:

```
F1
$GPGGA,134218.00,4338.190204,N,07938.438411,W,2,05,2.6,154.60,M,-35.09,M,4.0,0118*7B
$GPVTG,356.8,T,,,000.2,N,000.4,K,D*4B
$GPGSA,A,3,30,10,13,24,06,,,,,,,4.3,2.6,3.4*36
F2
$GPGGA,134219.00,4338.190294,N,07938.438409,W,2,05,2.6,154.45,M,-35.09,M,5.0,0118*7C
$GPVTG,1.3,T,,,000.4,N,000.7,K,D*44
$GPGSA,A,3,30,10,13,24,06,,,,,,,4.3,2.6,3.4*36
F3
$GPGGA,134221.00,4338.190261,N,07938.438285,W,2,05,2.6,154.05,M,-35.09,M,5.2,0118*79
$GPVTG,10.0,T,,,000.2,N,000.4,K,D*72
$GPGSA,A,3,30,10,13,24,06,,,,,,,4.3,2.6,3.4*36
F4
$GPGGA,134222.00,4338.190397,N,07938.438255,W,2,05,2.6,153.95,M,-35.09,M,5.0,0118*73
$GPVTG,9.8,T,,,000.3,N,000.5,K,D*42
$GPGSA,A,3,30,10,13,24,06,,,,,,,4.3,2.6,3.4*36
```

If the GPS mode is set to Reading per Trace or Fiducial Tagging AND the Noggin^{plus} is Run Without Saving Data (see Section 6.1.5), it is still possible to log GPS data strings. Every time a fiducial marker is added to the data (see Section 6.2.4), a data string of GPS information is added to a file. This file is called TAGGED.GPS and can be exported and/or deleted using the Noggin^{plus} File Management (see Section 6.4).

An example of a TAGGED.GPS file is shown below.

```
New File 09-18-2000  13:53:38
F1
$GPGGA,134227.00,4338.190520,N,07938.438280,W,2,05,2.6,153.98,M,-35.09,M,4.6,0118*7E
$GPVTG,347.7,T,,,000.3,N,000.5,K,D*44
$GPGSA,A,3,30,10,13,24,06,,,,,,,4.3,2.6,3.4*36
F2
$GPGGA,134228.00,4338.190238,N,07938.438286,W,2,05,2.6,153.87,M,-35.09,M,4.4,0118*75
$GPVTG,5.4,T,,,000.2,N,000.4,K,D*42
$GPGSA,A,3,30,10,13,24,06,,,,,,,4.3,2.6,3.4*36
F3
$GPGGA,134229.00,4338.190277,N,07938.438273,W,2,05,2.6,153.76,M,-35.09,M,5.4,0118*7A
$GPVTG,23.4,T,,,000.1,N,000.2,K,D*73
$GPGSA,A,3,30,10,13,24,06,,,,,,,4.3,2.6,3.4*36
F4
$GPGGA,134231.00,4338.190127,N,07938.438362,W,2,05,2.6,154.59,M,-35.09,M,5.0,0118*7A
$GPVTG,20.2,T,,,000.2,N,000.3,K,D*74
$GPGSA,A,3,30,10,13,24,06,,,,,,,4.3,2.6,3.4*36
****************************************************************************
New File 09-18-2000  13:55:36
F1
$GPGGA,134259.00,4338.192453,N,07938.449096,W,2,06,2.4,153.14,M,-35.09,M,5.4,0118*75
$GPVTG,310.9,T,,,000.5,N,001.0,K,D*4A
$GPGSA,A,3,04,30,10,13,24,06,,,,,,3.2,2.4,2.1*32
F2
$GPGGA,134301.00,4338.192559,N,07938.449176,W,2,06,2.4,153.17,M,-35.09,M,5.0,0118*7A
$GPVTG,314.4,T,,,000.6,N,001.1,K,D*41
$GPGSA,A,3,04,30,10,13,24,06,,,,,,3.2,2.4,2.1*32
F3
```

4) **GPR data out port** mode means that the GPR data stream will be output to the serial port of the DVL. This is for users who wish to read the GPR data into their own PC or other device. Contact Sensors & Software Inc. for more details if you want to use this option.

Note that this option slows down data acquisition speeds.

Baud Rate

The baud rate is the speed that data is sent from the GPS receiver to the serial port of the DVL. The available options are: 2400, 4800, 9600 (default) or 19200.

Stop Bits

The available settings for Stop Bits are: 1 (default) or 2.

Data Bits

The available settings for Data Bits are: 7 or 8 (default).

Parity

The available settings for Parity are: none (default), odd or even.

End String

The GPS receiver can be set up to send one or more types of data strings. These strings are called NMEA-0183 strings and each contains positional or other information in specific formats. Each type of string is specified by a 5-character prefix. There are numerous NMEA strings but examples of three different NMEA strings (GPGGA, GPVTG and GPGSA) are shown below.

```
$GPGGA,134713.00,4338.221086,N,07938.421365,W,2,06,2.1,152.51,M,-35.09,M,5.0,0118*79
$GPVTG,34.0,T,,,001.4,N,002.5,K,D*70
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.6*36
$GPGGA,134713.00,4338.221086,N,07938.421365,W,2,06,2.1,152.51,M,-35.09,M,5.0,0118*79
$GPVTG,34.0,T,,,001.4,N,002.5,K,D*70
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.6*36
$GPGGA,134713.00,4338.221086,N,07938.421365,W,2,06,2.1,152.51,M,-35.09,M,5.0,0118*79
$GPVTG,34.0,T,,,001.4,N,002.5,K,D*70
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.6*36
$GPGGA,134713.00,4338.221086,N,07938.421365,W,2,06,2.1,152.51,M,-35.09,M,5.0,0118*79
$GPVTG,34.0,T,,,001.4,N,002.5,K,D*70
$GPGSA,A,3,30,26,10,13,24,06,,,,,,,4.2,2.1,3.6*36
```

Before using the GPS with the Noggin*plus*, the DVL software needs to know the prefix of the LAST string being sent in each group. In the example above, three strings are being sent each time (GPGGA, GPVTG and GPGSA). Since GPGSA is the last one being sent in each group, the End String needs to be specified as GPGSA.

To see what the End String is for your particular GPS, run System Test #1 and note the first 5 characters on the last line after each series of strings is written to the screen. These are the 5 characters that need to be filled in under End String.

The End String option allows the user to fill in the 5 character GPS prefix. Use the Left and Right buttons to move left or right to different characters in the string. The currently selected character will have an "^" under it. To change the letter of the current character, use the Next button to change it to the next letter in the alphabet and the Previous button to change it to the previous letter in the alphabet. Using these keys all 5

characters can be filled in with the necessary GPS End String.

See the GPS Receiver User's Guide for details on how to set up the receiver to output specific NMEA strings or groups of NMEA strings.

System Test #1

After all the settings above have been input and the GPS receiver is attached to the serial port on the DVL, the user can test that the DVL is receiving the GPS output by using the Test option.

If the NMEA strings are successfully being read by the DVL they will appear on the DVL screen. This is a good time to note the prefix of the last NMEA string in the list and input it in the End String setting above.

If the NMEA strings do not appear, check that the port settings are correct. It is also possible that a crossover cable is required between the output cable of the GPS receiver and the serial port on the DVL.

System Test #2

Once the GPS system is running successfully, System Test #2 can be used to graphically display the GPS data. This screen displays the GPS Time, Latitude, Longitude and Altitude as well as other values indicating the accuracy of the GPS reading. The GPS position is also displayed in a square that can be Zoomed from 2 metres square to 16384 metres square.

6.3.6 Set Defaults

To reset all the parameter settings back to the factory default settings press the 6 button (labelled Set Defaults).

6.4 Noggin*plus* File Management

The File Management option is available by pressing 2 from the main Noggin*plus* menu. This option allows the user to export Noggin*plus* data or the TAGGED.GPS file (see Section 6.3.5) to an external computer using the parallel XFER cable. It is also here that the user can delete data from the DVL.

Before data export can take place, the DVL must be connected to the external computer using the parallel XFER cable that is supplied with the system. As well, the WinPXFER program must be installed and running on the external computer.

6.4.1 Transferring all Data Files to an External Computer using the WinPXFER Program

Connecting the Digital Video Logger to an External Computer

Smart Systems come with a separate cable called the parallel XFER cable. This cable is designed to connect the DVL to an external computer. Note that this is a special cable and standard 25 pin to 25 pin or Laplink cables will not work.
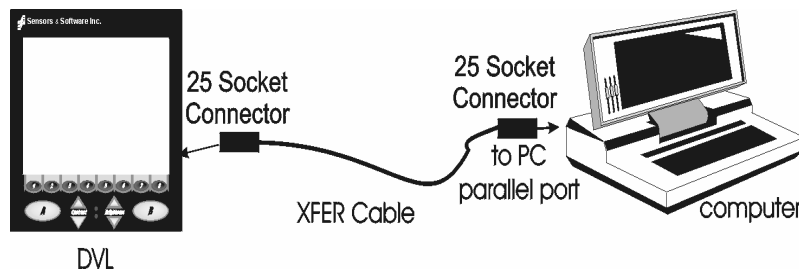

Figure 6-12: Parallel XFER cable connections

The 2 connections that must be made before attempting to transfer data are:

3) Attach the 25 socket parallel connector to the 25 socket parallel port on back of the Digital Video Logger, and
4) Attach the 25 socket parallel connector the parallel port of the external computer.

WARNING: To avoid damaging any of the components, turn off the DVL and computer before making any of these connections.

Installing the WinPXFER Program

The Smart system comes with a CD-ROM containing the WinPXFER program.

To install the WinPXFER program, follow the directions in the "Getting Started"

document that accompanies the CD. Basically, running the SETUP.EXE program from the WinPXFER folder on the CD will install WinPXFER on the computer.

Once the WinPXFER program has been installed on the computer and the user is ready to transfer data to the computer, the WinPXFER program needs to be run. This can be done using the WinPXFER shortcut on the Desktop, double-clicking the WinPXFER.EXE program in Windows Explorer or pressing Start – Programs – Sensors & Software GPR and finally WinPXFER.
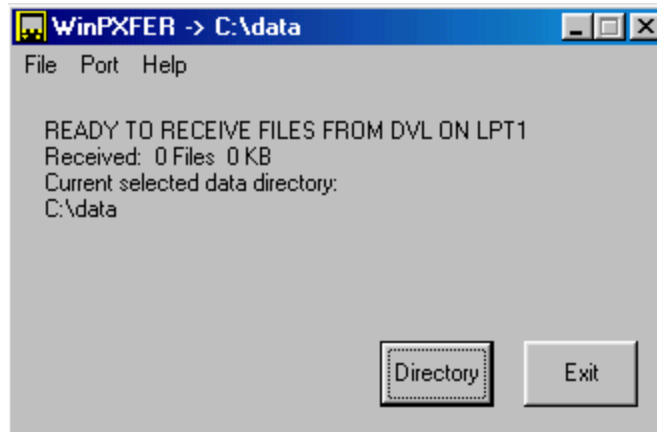

Figure 6-13: WinPXFER main screen

When the WinPXFER program has been run, it will display a screen as shown in Figure 6-13:

This means that it is ready to receive data transferred from the DVL to the LPT port number 1.

This command assumes that the data buffers are being transferred across Parallel Port 1 (LPT1). If using Parallel Port 2 (LPT2) or higher (LPT3, LPT4 etc.), specify the parallel port number under the Port menu item from WinPXFER.

The name of the folder (or directory) that the Noggin data will be transferred into is listed under the "Current selected data directory". In the example in Figure 6-13, the data will be transferred to the c:\data directory. The data directory can be changed by pressing the Directory button and choosing another directory.

Exporting Data to an External Computer

Once the parallel XFER cable is connected (see above) and the WinPXFER software is installed and running (see above), it is now possible to export data to the external computer.

All the data in one or more Line or Grid Projects or the TAGGED.GPS file (see Section 6.3.5) can be transferred to an external computer. From the main File Management menu, the user selects whether to export Line data, Grid data or the TAGGED.GPS file. If Line or Grid data is selected, the next screen lists the current projects.

One project can be highlighted and selected for export. Use the up and down arrows to highlight the project and then press the XFER button to transfer to the PC.

It is also possible to use the TAG button to select several projects and export them all at once. Use the up and down arrows to highlight the projects, the TAG button to tag each project and then press the XFER button to transfer all the projects to the PC.

The data will be transferred from the DVL to the computer and saved in a sub-folder from the current data directory indicated on the WinPXFER program, for example, \DATA\PROJECT2. The progress of the data transfer will be displayed on the DVL screen and the external computer.

When the data transfer is complete, exit from the WinPXFER program. Press any button on the DVL to return to the main menu.

Parallel Port not bi-directional Error

Sometimes, when attempting to transfer data to the PC, the error message "LPT1 is not bi-directional" may appear on the DVL screen. When transferring data from the DVL unit to a PC, the printer port is used. The WinPXFER program utilizes the functions of a bi-directional printer port for high-speed data transfer. A bi-directional port allows data to be sent in both directions over the data lines. Most modern ports are bi-directional; however, they may not be configured as such and may be configured as 'output only'.

There are a number of ways the port can be reconfigured depending on the type and manufacturer of your computer. Most computers configure the port using a BIOS setup program. Again, different manufactures have different ways to start this program. Some use the Delete key on boot up, some use the F1 or F2 key on boot up, some have a special key sequence and others use a program run through DOS or Windows. Often there is a line of text written to the screen during the boot-up sequence that indicates which key must be pressed to run Setup. This key MUST be pressed BEFORE Windows starts. If you miss pressing it, go into Windows, shut down, restart the computer and try again. Consult your owners' manual for details.

After the BIOS Setup program starts, the Parallel or Printer port configuration that needs to be changed is normally under the 'Peripheral' or "Advanced" setting heading. If you can't find it under these headings, look under the various headings for some setting like "Parallel Mode" or "Parallel Configuration". Take note of what the current setting is. The typical settings are Normal, ECP, EPP and bi-directional. It may require some experimentation to find the correct setting that works with the WinPXFER program. First, try changing the setting to bi-directional. Save the settings and exit the Setup program (usually there is a special key like F10 to do this). Then allow the computer to continue to boot up. Then, try transferring data again, as described above. If the "LPT1 is not bi-directional" error occurs again, reboot the PC, run the BIOS Setup program, change the Parallel port setting to EPP, save the settings and try again. The settings don't appear standard so no one particular setting will solve the error on all computers. Keep trying the different parallel port settings until one of them eliminates the error and allows data transfer.

Viewing Data Files on the External Computer

After transferring data files to the external computer the Noggin*plus* data files can be viewed, processed and plotted using the Win_EKKO, EKKO_3D, EKKO_Mapper or EKKO_Pointer software.

Appendix A contains details about the file format of Noggin*plus* data.

6.4.2 Deleting Data on the DVL

After data has been successfully transferred to an external computer or if the data is longer required, the whole Line or Grid project can be deleted from the DVL. From the File Management main menu, select Delete Line Project or Delete Grid Project. The next screen lists all the current projects.

To delete a project, use the up and down arrows to highlight it and then press the DEL button.

It is also possible to use the TAG button to select several projects and delete them all at once. Use the up and down arrows to highlight the projects, the TAG button to tag each project and then press the DEL button to delete the data from the DVL.

Before the project is deleted, the user is asked to confirm the deletion by pressing Yes or No. If the answer to the question is No, the project is not deleted.

This menu also allows the user to delete the TAGGED.GPS file.

6.5 Noggin^*plus* Utilities

Pressing the number 4 on the main menu selects Utilities. This menu has utility programs to change the date and time on the DVL and also calibrate the odometer.

6.5.1 Time and Date

The date and time are saved with the data files. The DVL date and time setting can be changed by moving to one or more of the appropriate fields and editing the current setting. The LEFT and RIGHT arrows are used to move between fields. To change any of the numbers or months, use the UP and DOWN arrows to increase or decrease the value. When the desired date and time are set, press ENTER to save the changes.

6.5.2 Odometer Calibration

The odometer should be calibrated periodically to ensure accuracy.

Noggin Smart Systems can take input from several different odometers.

It is very important that the user selects and calibrates the odometer appropriate for their Smart System.

When Odometer Calibration is selected, the user is prompted to select the odometer that is being used with the Smart System.

If a **Smart Cart System** is being used, select one of the two Smart Cart odometers (usually #1).

If a **Smart Handle system** is being used, select one of the two Smart Handle odometers (usually #1).

If the system is being towed behind a **vehicle** and using the transmission odometer to trigger the system, select one of the two Vehicle odometers (usually #1).

The odometers labelled **Other** are to be used in future configurations.

Once an odometer is selected, the user is prompted to either 1) manually enter the odometer calibration factor or 2) to actually calibrate the odometer over a known distance. To achieve the highest accuracy, it is recommended that the user choose option number 2 - Odometer Calibration.

When Odometer Calibration is selected, the user is prompted to select the length of the line to calibrate on. There are 8 different choices in metres and 8 choices in feet. To toggle the units between metres and feet, press the B button. Pressing the A button on this screen gives the additional option to select a user-defined value. The user-defined value can range from 0.01 to 5000 metres or 0.01 to 26400 feet.

When the calibration distance has been selected follow the directions on the screen:

4) Set cart at zero and press A
5) Move the cart the selected distance and press B
6) Press A to exit.

Odometer calibration values for the Smart Cart odometer should be around 4000. Odometer calibration values for the Smart Handle odometer should be around 1500. Odometer calibration values for the Vehicle odometer vary but may be around 50.

6.5.3 Upgrade

This option is used to upgrade the software on the DVL. DO NOT press this button until told to do so in the instructions accompanying the software upgrade.

6.5.4 System Information

This option can be used to list system information that may be useful to troubleshoot a problem with the Noggin. The information is intended for the use of Sensors & Software staff to assist in solving a problem with the Noggin system.

System information can be listed to the screen, printed directly to an attached printer or transferred to a PC.

To print the information to a printer, attach the printer to the parallel port of the DVL and then press the B button.

To transfer the information file to a PC, attach the parallel XFER cable from the parallel port of the PC to the parallel port of the DVL. Then run the WinPXFER program on the PC (see Section 6.4.1) and press the 1 button.

Sensors & Software technical staff may request that this information be sent to them. A printed copy of the information can be faxed to Sensors & Software Inc. If the data is transferred to a PC, the data file can be e-mailed to Sensors & Software Inc.

7   Troubleshooting

Noggin Smart Systems are designed to minimize user problems; however, all electronic devices are subject to possible failure. The following are troubleshooting hints in the likelihood of occurrence if your Smart System fails to operate.

7.1 Power Supply

The most common problem that can occur while trying to run a system is insufficient power. The battery may be dead or have a low voltage. If the system is being run from AC, there may be a problem with the AC power supply or adapter.

If there is enough power to run the DVL, the upper red LED on the front of the DVL will light up when the battery is plugged into the system. If this light is on and the DVL boots up, runs and displays the main menu, next check that the red light on the connector to the Noggin is on. If this light is off then there is a problem with the connection from the DVL to the Noggin. Check the connection and this part of the cable.

If the DVL is running but the Noggin system will not run, go to the main menu and check that battery voltage in the lower left corner (see Section 4) is above 10.5 volts. If not, the battery needs to be recharged or replaced for the Noggin to run (see below).

If the battery voltage is less than about 10.5 volts, the DVL may not turn on and the upper red LED will flash or not illuminate.

Check the battery voltage with a voltmeter. Try to do this while the system is still attached to the Smart System to get a true measure of the voltage while under load (it will be necessary to open the Smart Cart battery case and connect the voltmeter to the positive and negative battery terminals). If the battery has a low voltage or seems dead, try the system with another battery (if available), or give the battery a good 12-14 hour charge and try running the system again.

If the battery does not charge up to 12 Volts or more, it should be replaced.

Smart System batteries are fused to protect the system. For the Smart Cart system, open the battery case and check that the 10 Amp fuse is OK. If necessary, replace it with one of the spare fuses available inside the battery case. The smaller belt batteries available for the Smart Handle systems are also fused. Remove the battery from padded casing and check the 5 Amp fuse. Replace the fuse if necessary.

7.2 System Communications

If the system power supply is OK but the Noggin does not respond there may be a communication failure between the DVL and the Noggin. This type of failure is often indicated by a 10000 series error number like 10012.

If an error occurs, an error message will appear in the bottom left section of the Noggin screen. EXIT the program and turn off the Digital Video Logger. Disconnect the power source to completely shut down the system.

Make sure the cables are not damaged and that all cable connections are tightly secured. Sometimes vibrations cause the cable connections to loosen just a bit and break contact and this can cause errors. Disconnecting cables and reconnecting them may provide a better contact and solve the problem. Turn the Digital Video Logger back on and try running the system again.

If the power supply and cable are OK, the problem is likely a failure of the DVL. The DVL has no user-serviceable parts so it will have to be returned to Sensors & Software Inc for inspection and possible repair (see Section 7.6).

7.3 System Overheating

The Noggin systems are designed to operate to an *internal* temperature of 70 C or 158 F. In situations of high ambient temperatures or long exposure to direct sun, this maximum internal temperature may be exceeded and cause the system to fail. While the temperature displayed on the DVL in the lower left corner of the main menu indicates the internal temperature of the DVL and not the Noggin, this temperature should give an idea of whether the Noggin is overheating.

If you suspect that the Noggin system is overheating, shut it off and give it a chance to cool down in a shady location before trying to run it again. Placing a wet cloth on top of the Noggin may help in cooling it down.

If the situation is such that the high temperatures or direct sun cannot be avoided, it may be a good idea to put some sort of shade over the Noggin.

Contact Sensors & Software Inc. if the problem persists as there may be defective electronic components that need to be replaced (see Section 7.6).

7.4 DVL Problem

While the DVL has been ruggedized as much as possible, it should be handled in much the same way a notebook computer is. If the DVL does not power up and boot up, there may be a problem with the CPU or the storage media. If this occurs, contact Sensors & Software Inc. (see Section 7.6).

7.5 Noggin Problem

When the Smart System is powered up and the user selects data acquisition in Noggin or Noggin*plus* mode, the Noggin system goes through a self-calibration sequence. While the self-calibration is occurring the user sees the words "Booting Noggin" in the lower left corner of the DVL screen. These words are followed by a number that counts up from 1. Normally, once the count reaches 6 the text disappears and the Noggin is ready to collect data. Sometimes, however, this count goes beyond 6 and keeps going without stopping. This indicates an internal problem with the Noggin. No error message will be displayed on the screen and the only way to exit from the screen is to pull out the power connection.

If this error occurs, power the system down, power it up again and retry data acquisition. If the error persists, contact Sensors & Software Inc. (see Section 7.6).

7.6 Contacting Sensors & Software Inc.

If the Noggin system does not run, contact your agent or Sensors & Software Inc.

When contacting SSI, please have the following information available:

1) Noggin and/or DVL Serial Number.
2) Version number of the data acquisition software.
3) The error number or message appearing.
4) A brief description of when the error is happening and the operating conditions (temperature, humidity, sunshine, system and survey setup, etc.).
5) Sensors & Software Inc. technical staff may request a copy of the System Information file be sent to them by fax or e-mail. See Section 6.5.4 on how to view, print and download this file.

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8 Care and Maintenance

8.1 Battery Care

Smart Systems use 12-volt sealed lead acid batteries. They are fused with a 10 Amp fuse to protect them from short circuit damage.

The Smart Cart battery unit uses contains a 15 Amp-hour battery. The battery unit should run the Cart Noggin for 6-8 hours before recharging is necessary. If long days of data surveying are typical, a second battery unit may be a useful item.

The Smart Handle belt battery has a 7 Amp-hour battery. This battery should run the Smart Handle system for 2-3 hours before recharging is necessary. If long days of data surveying are typical, more belt batteries may be a useful item.

If batteries are maintained in a charged condition they will give long life and reliable service. Improper use and lack of maintenance will greatly reduce their life.

Sealed lead acid batteries should **<u>NEVER</u>** be left in a discharged condition for any period of time. Charge the batteries as soon as possible after use.

Charge batteries at room temperature whenever possible.

The Noggin and DVL contain a voltage monitoring circuit that will turn off the unit when the input voltage drops below 10.2 volts.

If a battery has been deeply discharged or left in a discharged condition for some period of time it may not accept charge immediately when it is connected to the charger (The fast charge LED will not light). If the fast charge light does not come on within 6 hours the battery should be considered damaged and should be discarded.

Do not assume that a battery that is still charging after 8 hours is nearing the end of its charge cycle. Typical charging time for an empty battery is 12-14 hours from start of fast charge.

Ensure that the batteries are fully charged before storing. If practical, store the batteries in a cool place, 10°c (a refrigerator is ideal), but make sure the temperature is not likely to drop below -30°C or the electrolyte may freeze and possibly split the case.

8.2 DVL Internal Battery

If the Smart System has not been powered up for an extended period of time, the internal battery will discharge. The dead battery causes the DVL time and date to reset to January 1, 1988 at 12:00 PM. To correct the time and date see Section 5.5.1 or 6.5.1.

To recharge the internal battery the Smart System must be powered up and left running for at least one hour and preferably longer.

8.3 Skid Pads

The bottom of the Noggin unit is covered with one large wear-resistant skid pad. The skid pad is designed to protrude from the bottom of the Noggin and take the majority of the abrasive wear. If the pad wears down enough, the less-resistant plastic housing may start to wear. If this occurs, it is best to replace the skid pad. It is easily removed with a Phillips screwdriver and a new one can be purchased from Sensors & Software Inc.

Appendix A   NOGGIN *PLUS* DATA FILE FORMAT

Noggin*plus* data consists of two files, a Header file and a Data file. The files have the same name but different extensions. The format details of these files are given below.

Header (.HD) File:

The header file, identified by the file extension .HD, is an ASCII file. An example is shown below. The heading identifies what each piece of information represents.

```
1234

Data Collected with Noggin Plus
12/10/2000
NUMBER OF TRACES   = 220
NUMBER OF PTS/TRC  = 156
TIMEZERO AT POINT  = 31
TOTAL TIME WINDOW  = 62
STARTING POSITION  = 0.0000
FINAL POSITION     = 10.9500
STEP SIZE USED     = 0.0500
POSITION UNITS     = m
NOMINAL FREQUENCY  = 250.00
ANTENNA SEPARATION = 0.3048
PULSER VOLTAGE (V) = 100
NUMBER OF STACKS   = 4
SURVEY MODE        = Reflection
```

This file can be read and/or printed using any Word Processor.

Data (.DT1) File:

The data file contains as many records as there are traces. Each record in turn consists of a header section and a data section. The header section consists of an array of 25 real*4 numbers and a string of 28 characters which is used for annotation. The 25 element real array contains the following information:

Item #	Description
1	Trace number
2	Position
3	Number of points per trace
4	Topographic data, if available
5	(not used)
6	# bytes/point (always 2 for Rev 3 firmware)
7	Time Window
8	# of stacks
9-10	reserved for GPS X position (double*8 number)
11-12	reserved for GPS Y position (double*8 number)
13-14	reserved for GPS Z position (double*8 number)

15	reserved for receiver x position
16	reserved for receiver y position
17	reserved for receiver z position
18	reserved for transmitter x position
19	reserved for transmitter y position
20	reserved for transmitter z position
21	timezero adjustment
	where:point(x)= point(x+adjustment)
22	Zero flag: 0 = data okay, 1=zero data
23	(not used)
24	Time of day data collected in seconds past midnight.
25	Comment flag: 1 = comment attached.
26 - 32	Comment

The data section consists of an array of two-byte integers, one value for every data point.

Appendix B   HEALTH AND SAFETY CERTIFICATION

Radio frequency electromagnetic fields can pose a health hazard when the fields are intense. Detailed discussions on the subject are contained in the references and the web sites listed below.

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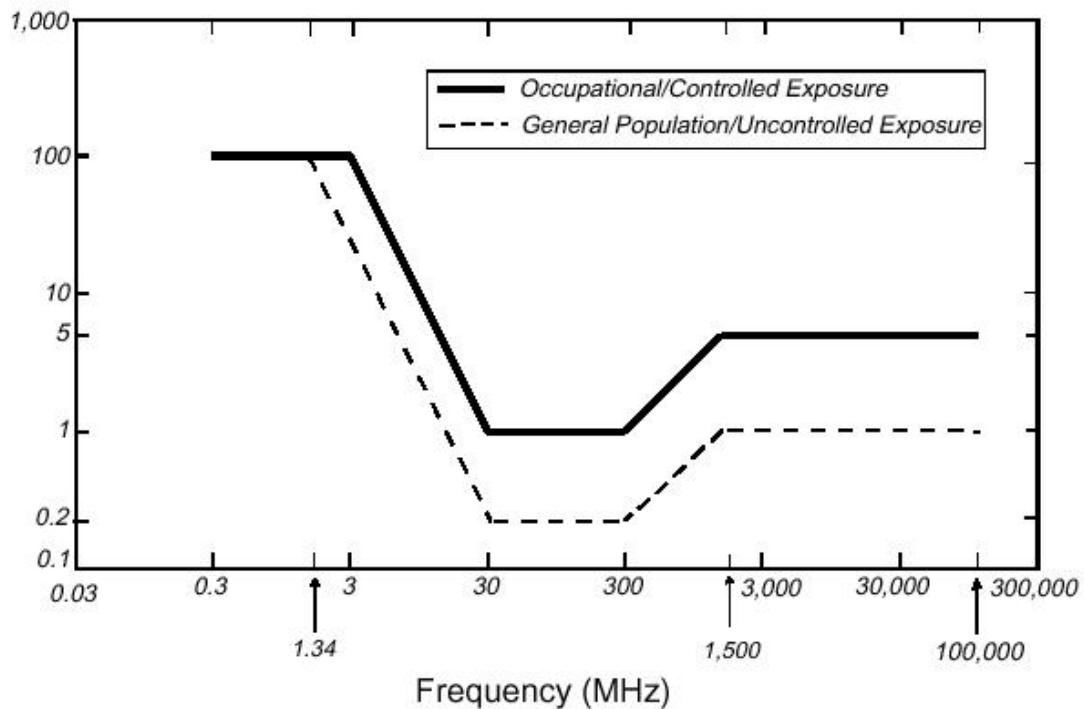

Figure 1:   FCC limits for maximum permissible exposure (MPE) plane-wave equivalent power density mW/cm^2.

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

Appendix C   FCC REGULATIONS

This device complies with Part 15 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.

FCC Class A Digital Device or Peripheral – User Information

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

WARNING

Changes or Modifications not expressly approved by Sensors & Software Inc. could void the user's authority to operate the equipment.

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

Operating Restrictions

Operation of this device is restricted to law enforcement, fire and rescue officials, scientific research institutes, commercial mining companies, and construction companies. Operation by any other party is a violation of 47 U.S.C. §301 and could subject the operator to serious legal penalties.

FCC Interpretation of this label issued July 12, 2002

The regulations contain restrictions on the parties that are eligible to operate imaging systems.[1] Under the new regulations, GPRs and wall imaging systems may be used only by law enforcement, fire and emergency rescue organizations, by scientific research institutes, by commercial mining companies, and by construction companies. Since the adoption of the *Order*, we have received several inquiries from the operators of GPRs and wall imaging systems noting that these devices often are not operated by the users listed in the regulations but are operated under contract by personnel specifically trained in the operation of these devices. We do not believe that the recent adoption of the UWB rules should disrupt the critical safety services that can be performed effectively only through the use of GPRs and wall imaging systems. We viewed these operating restrictions in the broadest of terms. For example, we believe that the limitation on the use of GPRs and wall imaging systems by construction companies encompasses the inspection of buildings, roadways, bridges and runways even if the inspection finds no damage to the structure and construction does not actually result from the inspection; the intended purpose of the operation of the UWB device is to determine if construction is required. We also believe that the GPRs and wall imaging systems may be operated for one of the purposes described in the regulations but need not be operated directly by one of the described parties. For example, a GPR may be operated by a private company investigating forensic evidence for a local police department.

FCC Permitted Mode of Usage

The GPR antenna must be kept on the surface to be in compliance with FCC regulations. Use of the antenna is not permitted if it is lifted off the surface.

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[1]   *See* 47 C.F.R. §§ 15.509(b), 15.511(b), and 15.513(b).

GPR Use Coordination

FCC regulation 15.525(c) requires users of GPR equipment to coordinate the use of their GPR equipment as decribed below:

      (a)   UWB imaging systems require coordination through the FCC before the equipment may be used. The operator shall comply with any constraints on equipment usage resulting from this coordination.

      (b) The users of UWB imaging devices shall supply detailed operational areas to the FCC Office of Engineering and Technology who shall coordinate this information with the Federal Government through the National Telecommunications and Information Administration. The information provided by the UWB operator shall include the name, address and other pertinent contact information of the user, the desired geographical area of operation, and the FCC ID number and other nomenclature of the UWB device. This material shall be submitted to the following address:

             Frequency Coordination Branch., OET
             Federal Communications Commission
             445 12th Street, SW
             Washington, D.C. 20554

             ATTN: UWB Coordination

The form given on the following page is a suggested format for performing the coordination.

GROUND PENETRATING RADAR COORDINATION NOTICE

NAME:

ADDRESS:

CONTACT INFORMATION [contact name and phone number]:

AREA OF OPERATION [counties, states or larger areas]:

FCC ID: [e.g. QJQ-NOGGIN250 for Noggin 250 system)]

EQUIPMENT NOMENCLATURE: [e.g. Noggin 250]

Send the information to:

Frequency Coordination Branch., OET

Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554

ATTN: UWB Coordination
Fax: 202-418-1944

INFORMATION PROVIDED IS DEEMED CONFIDENTIAL

FCC Shut Off Switch

FCC regulation 15.509(c) requires that a GPR system incorporate a manually operated switch that causes the transmitter to cease operation within 10 seconds of being released by the operator.

Sensors & Software GPR systems will only operate when triggered by the operator. If the system is not triggered by the operator it will cease transmitting within 10 seconds of releasing the trigger.

Appendix D   OPERATION OF SHUT OFF SWITCH

Sensors & Software Inc.'s GPR systems transmitters will not operate in the free run mode for more than 10 seconds without the shut off switch installed and depressed by the user.

Installation

To install the switch, plug the 25 pin male connector into the printer port of the DVL‑II or the controlling PC. Software will automatically detect the switch.

Operation

To operate the switch, hold the button in the closed position. Releasing the button for more than 10 seconds will cause the unit to stop functioning.

References

1. **Questions and answers about biological effects and potential hazards of radio-frequency electromagnetic field**
   USA Federal Communications Commission, Office of Engineering & Technology
   OET Bulletin 56
   (Contains many references and web sites)

2. **Evaluation Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.**
   USA Federal Communications Commission, Office of Engineering & Technology
   OET Bulletin 56
   (Contains many references and web sites)

3. **USA Occupational Safety and Health Administration regulations paragraph 1910.67 and 1910.263.**

Web Sites
www.fcc.gov/Bureau/EngineeringTechnlogy/Documents/bulletin
www.osha-slc.gov/SLTC **(see radio frequency)**