SnowScan

User's Guide
Version 2.2

Drawing No#: 01-0254-03

subsurface imaging solutions

Sensors & Software Inc.
1040 Stacey Court
Mississauga, ON L4W 2X8 Canada

Tel: (905) 624-8909
Fax: (905) 624-9365

E-mail: sales@sensoft.ca
Website: www.sensoft.ca

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Sensors & Software Inc.
1040 Stacey Court
Mississauga, Ontario
Canada L4W 2X8
Tel:(905) 624-8909
Fax:(905) 624-9365
E-mail: radar@sensoft.ca

Table of Contents

1 General Overview

SnowScan is an integrated sensor using radar technology for displaying and recording snow depth information beneath the sensor.

The following manual covers the operation of the groomer mounted and the hand held SnowScan system. Setup of each system is different, however the operation and data acquisition of each system is the same.

Data acquisition with the two systems can be further broken down into the mapping system and the view only system. Both of these methods are covered in this manual.

The groomer mounted SnowScan is easily mounted on grooming machines and comes with a display that is mounted inside the cab. The hand held system is designed to cover the slopes by a person on skis.

The SnowScan system sends out signals through the snow below the unit. These signals bounce off the ground and are detected by the SnowScan sensor unit. The snow depth image is instantly displayed on the screen inside the groomer's cab or in front of the skier. In the mapping unit the data is combined with GPS (Global Positioning System) information and stored in the display unit (Digital Video Logger – DVL).

Please carefully read all the instructions below before proceeding.

2 Groomer Mount Installation

The groomer mounted SnowScan view only system comes with the following parts. Please ensure all parts are present before installation. Section 6 System Components on 21 contains photos of the parts indicated with +

1. ELEC0021 SnowScan groomer transducer. +
2. ELEC0017 SnowScan display unit (DVL). +
3. CABL0042 SnowScan to display unit cable. +
4. CABL0043 Power cable. +
5. HABR0021 DVL tray. +
6. HABR0030 Tray stand. +
7. MISC0061 Floor mount flange. +
8. HABR0037 Mounting brackets (See note below on brackets).
9. SOFT0039 SnowScan display (DVL) viewing firmware.
10. MANU0023 Manual

Three types of groomer mounting brackets are available. The bracket requires should be specified when ordering the system. Optional brackets can be purchased. The brackets are as follows:

1. HABR0037 Bombardier permanent mounting brackets. +
2. HABR0038 Pisten Bully temporary mounting brackets. +
3. HABR0039 Pisten Bully and generic permanent mounting brackets. +

The groomer mounted SnowScan mapping system comes with the following additional items.

1. SOFT0041 SnowScan display (DVL) mapping firmware.
2. MISC0063 GPS System.
3. SOFT0040 SnowScan PC Mapping Software.
4. CABL0029 DVL power supply cable. +
5. CABL0023 Transfer cable. +
6. SOFT0031 PC transfer software.
7. PSUP0018 Mains power supply. +

The style and body assemblies of grooming machines vary from manufacturer to manufacturer and in many cases from year to year within the same manufacturer. Installation of the unit may need to be customized depending on the grooming machine to be used.

The following are guidelines for the installation of SnowScan on late model Pisten Bully (i.e. PB300 and PB200) and late model Bombardier (i.e. BR2000 and MP plus) machines. Adaptation to other makes and models should be possible by following these guidelines.

The installation requires the following steps:

1. Mounting the sensor,
2. Mounting the display unit,
3. Wiring the system, and
4. GPS installation (optional).

2.1 Sensor Mounting

When mounting the sensor the installer should keep the following in mind.

1. Always try to keep the sensor oriented such that the connector faces the rear of the groomer. Better signals are obtained when the long axis of the box is in the direction of groomer movement.
2. Locate the sensor where there will be minimal possible damage, as a result of impacting stumps, rocks and/or other obstructions. The actual sensor is located within a sealed plastic housing inside the steel box.
3. There should be a clear path below the sensor as described in Figure 2-1.

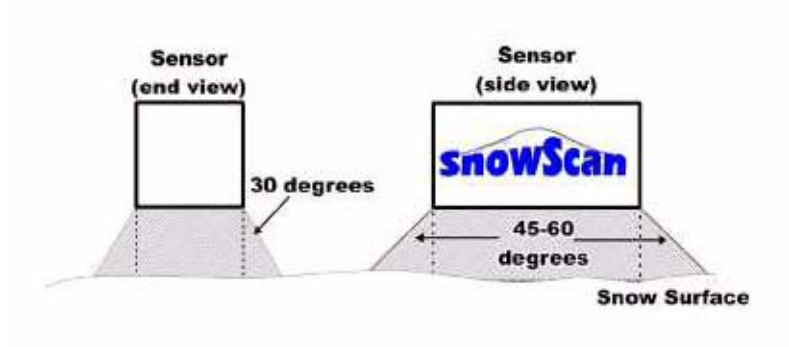


Figure: 2-1 Keep shaded area clear of obstructions

Pisten Bully

On late model Pisten Bully machines (i.e. PB200 and PB300) the ideal location to mount the sensor is in the center of the push frame. Mounting can be done using either temporary (HABR0038) or permanent brackets (HABR0039). When systems are shipped to Pisten Bully owners the temporary brackets are shipped. Please contact SnowScan to exchange these brackets if needed.

The two mounting options are shown below in Figure 2-2 and Figure 2-3.

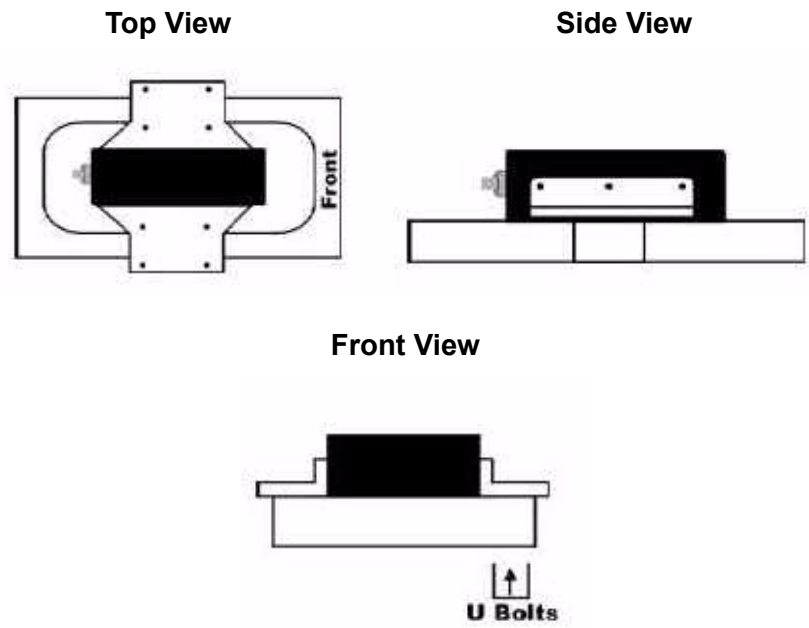


Figure: 2-2 Temporary mounting on Pisten Bully.

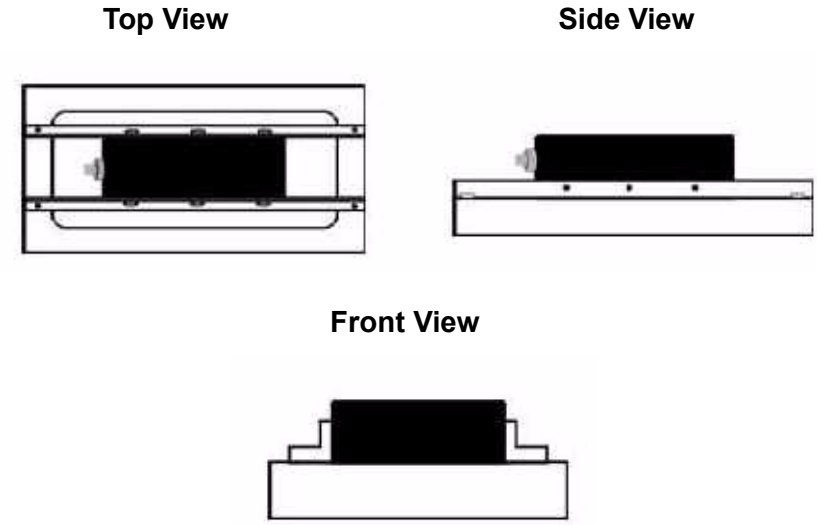


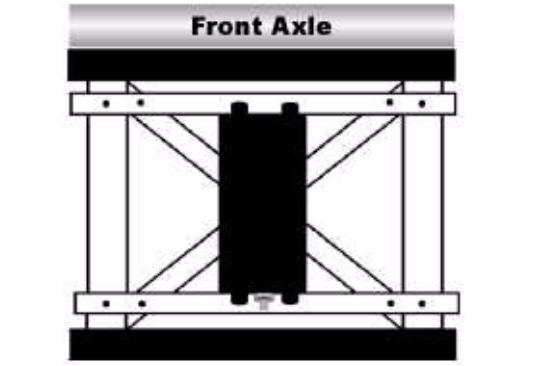
Figure: 2-3 Permanent mount on Pisten Bully. (Requires drill and tap of push frame.)

Bombardier

Since Bombardier machines contain hydraulic hoses and fittings in the center of the push frame, it is not possible to mount the SnowScan sensor within the push frame. For Bombardier machines, it is suggested that the sensor be located under the vehicle between the tracks and just behind the front axle.

The unit can be fastened to the main frame or, if present, to the cross braces using the supplied brackets (HABR0037). Holes must be drilled to support the unit and the owner should contact the Bombardier service agent if there are questions regarding the modification of the structural support. Caution should be exercised if drilling into the main frame as hoses often do exist inside these tube frames. See Figure 2-4 below for details.

Bottom View



Side View

Figure: 2-4

2.2 Display (DVL) Mounting

Groomer interiors vary with respect to layout. The groomer operator may have personal preferences regarding the mounting of the DVL. The installer must locate a suitable location to mount the display unit. This will probably be somewhere on the center console.

The system is shipped with a mounting tray (HABR0021), stand (HABR0030) and flange (MISC0061) to aid in the installation. The length of the stand can be cut to optimize the installation.

Depending on how permanent an installation is required, hook and loop (Velcro) could be used to fasten the unit. Caution should be exercised if hook and loop fasteners are employed such that the display does not come free and causes damage.

2.3 System Wiring

The wiring of the unit is quite simple. There are two cables. The 5 meter long cable (CABL0042) is used to connect the sensor to the display unit. The 1 meter long cable (CABL0043) is used to connect the display unit to a 12V-power source. Perform the following to install the cables:

1. Locate a suitable path to run the 5 m cable (CABL0042) through the cab to the outside sensor. Connect the large green Cannon connector to the back of the sensor and turn hand tight.
2. Tie down the cable to prevent it from touching any hot or moving parts.
3. Plug the 37-pin connector into the rear of the DVL. This is for communications to the sensor.
4. The second shorter cable coming from the 37-pin connector is used to supply power to the unit. This XLR connector should be plugged into the 1 metre power cable (CABL0043) after it has been attached to a power source.
5. Using the short power cable (CABL0043) locate a 12V power source (2A). Connect the power and plug this into the XLR socket.

2.4 GPS Mounting

If the optional mapping system has been purchased, a GPS system must be integrated into the system. The GPS antenna should be placed as high on the vehicle as possible, with an unobstructed view of the sky. The cables should safely run inside the cab and the 9-pin connector plugged into the rear of the DVL. Recommended power (using the correct polarity) should then be supplied to the GPS (see the GPS manual for further details).

3 Hand Held Assembly

The hand held SnowScan view only system comes with the following components. Please ensure all parts are present before installation. A photo of the Items marked with + can be found in Section 6 System Components on 21.

1. ELEC0016 SnowScan hand held transducer. +
2. ELEC0017 SnowScan display unit (DVL). +
3. SOFT0039 SnowScan display (DVL) viewing firmware.
4. CABL0040 Sensor to display unit cable. +
5. HABR0036 Hand held frame. +
6. HABR0021 Tray assembly. +
7. PSUP0012 12V waist belt power supply. +
8. PSUP0013 Power supply charger. +
9. MANU0023 Manual.

The hand held SnowScan mapping system comes with the following additional items.

1. SOFT0041 SnowScan display (DVL) mapping firmware.
2. MISC0063 GPS System.
3. SOFT0040 SnowScan PC Mapping Software.
4. CABL0029 DVL power supply cable. +
5. CABL0023 Data Transfer cable. +
6. SOFT0031 PC Data transfer software.
7. PSUP0018 Main power supply. +
8. PSUP0012 Extra 12V waist belt power supply. +
9. PSUP0013 Extra power supply charger. +

3.1 Sensor Mounting

The sensor (ELEC0016) is mounted to the hand held frame (HABR0036) using the 4 mounting posts located on the top of the unit. First, remove the 4 hitch pins located in the frame bottom. Next, slide the frame bottom over the 4 mounting posts and replace the hitch pins, locking the handle to the posts. Ensure that the connector for the cable is located closest to the upright shaft of the frame. For more details please refer to the Figure 3-1 below.

Figure: 3-1 Sensor Mounting on Hand Frame

A shoulder strap is provided to ensure the unit stays with the skier and also to allow the operator a hands free operation to control the display.

3.2 Display (DVL) Mounting

The display unit (DVL) is mounted on the tray assembly (HABR0021) which is fastened to the cross T of the handle (see Figure 3-2). Simply slide the DVL onto the tray and ensure that the connector in the front snaps into place, holding the DVL on firmly. The two screw knobs allow the user to loosen the tray assembly to adjust the handle angle to the particular user height. Please ensure the knobs are tight before starting.

Note: When the display is pushed completely back, the display will not come off since the release lever cannot be pushed down.

Figure: 3-2 DVL Mounting on Hand Frame

3.3 System Wiring

To wire the system, attach the 37 pin connector to the sensor and also one to the rear of the DVL. Make these connections hand tight (do not over tighten). Finally, plug the XLR connector (the other wire coming from the DVL connector) into the 12V battery belt.

3.4 GPS Mounting

If the optional mapping system has been purchased, the GPS system must be assembled and attached to the hand held frame (see Figure 3-3). If a Trimble system is being used, simply thread the antenna onto the stand provided near the front of the SnowScan sensor. Run the

cable up the pole and fasten it securely with cable ties. Plug the 9-pin connector into the rear of the DVL. Plug the GPS power into a second battery belt. Refer to the GPS manual and Section 4.2.6 COM Port Menu (Mapping Only) on 13 for further details on configuring the GPS.

Figure: 3-3 GPS Mounting on Hand Frame

4 System Operation

Once the systems have been fully assembled, the operation of the display unit (DVL) is the same for both the hand held and groomer operation. Systems equipped with mapping contain extra options and will be noted as such.

4.1 Starting the System

Once all the cable connections between the SnowScan sensor, the display unit, the power source, and optional GPS have been made, the system can be powered up by pressing any key on the front of the DVL. If the unit fails to power up, check the battery connection and make sure the groomer is turned on. If 12 Volts is properly supplied to the unit, the top red LED will be displayed on the DVL. Once the unit is powered up both LED's should be illuminated.

The front of the Display is shown in Figure 4-1.

Figure: 4-1 Display face

The water-resistant membrane key pad has a number of buttons that can be pressed to perform various tasks. Note that the buttons on the membrane key pad sometimes need to be pressed hard to register.

Menu Buttons: The yellow buttons labelled 1 to 8 correspond to menu choices that appear along the bottom of the screen and just above each button when the display is turned on.

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

Brightness: The yellow Up and Down arrow buttons beside the Brightness control are used to increase and decrease the screen brightness. For example, increasing the Bright-

ness setting may improve the visibility of the screen when outside on a sunny day. On a unit with a color display the Brightness control has little effect.

Contrast: The yellow up and down arrow buttons beside the Contrast control are used to increase and decrease the screen contrast. For example, increasing the Contrast setting may improve the visibility of weaker features on the screen. On a unit with a color display the Contrast control has little effect.

Once the display unit powers up, the menu below is displayed:

SNOWSCAN VIEWING

MAIN SCREEN

A – RUN SNOWSCAN

1 – SNOWSCAN SETUP

5 – POWER OFF

If the mapping option has been purchased then the title will read **SNOWSCAN MAPPING**. Please note that the mapping system can also operate as a viewing only system.

The battery voltage is displayed in the bottom left corner of the screen, along with the internal temperature of the display unit both in degrees Celsius and Fahrenheit.

Pressing the A button starts the SnowScan data acquisition program described in Section 4.3 Run SnowScan on 15.

Pressing Button 1 starts a setup program described in Section 4.2 SnowScan Setup on 11.

4.2 SnowScan Setup

The setup menu is activated by pressing the 1 button on the front panel while the main menu is shown. This setup menu allows for configuring the GPS, changing units (meters or feet), exporting data, setting the DVL time, etc.

Once the user has entered this menu, press the number corresponding to the item to be changed, then use the A and B button to change this item. Some items will bring up and additional sub menu.

4.2.1 Units

The SnowScan system can display all depths in metres or feet. This menu item allows the user to switch units. The default value is metres.

4.2.2 Unit Height

The SnowScan sensor measures the distance from the sensor to the ground below the snow. If the unit is groomer mounted, then the height the unit is above the snow must be recorded so that it is subtracted from the actual snow depth. This menu item allows the user to put this height in. The value entered should be the average distance between the bottom of the sensor and the top of the snow. The default value is zero. When using a hand held system please ensure this value is set to zero.

4.2.3 COM Usage (Mapping Only)

When the mapping option is purchased with SnowScan the user has a choice of storing the data into 1 of 8 files or sending the data out the serial port for storage in another device. This item sets the location where the data is stored.

When saving data to a file each time the save option is activated a new header is placed in the file with a time stamp. Data is always appended to the end of the file. To delete the file the user must go to the delete menu (see Section 4.2.7.4 Delete Files (Mapping only) on 14)

When data is sent to the serial port it is sent out in ASCII format. Each ASCII string is always followed by a CR and LF sequence. The user can output only the depth information or the depth and quality information.

4.2.4 Plotting (Mapping Only)

Quality

The SnowScan system must interpret which returned signal is the interface between the snow bottom and the ground surface. The quality number is an indication of how well the system believes it is tracking the correct interface. The higher the number the better it feels it is tracking the snow interface. This number can range from 1 - 32000. This option will place a dashed line on the display screen to indicate the quality. The bottom of the screen represents the lowest and the top of the screen represents the highest quality values.

Depth

As indicated above, the SnowScan system must interpret which returned signal is the interface between the snow bottom and the ground surface. When this item is activated the interpreted depth is displayed on the screen as a thick white line. This can be used as a check to see if the system is indeed tracking the snow-ground interface. Both this plot and the quality plot have no effect on the data itself.

4.2.5 Warning Level (Mapping Only)

When the unit is set to display a large depth number and not the raw data (see Section 4.3.2.5 Mode (Mapping Only) on 17), this number is the point at which the number appears inverted. This is a warning to the operator that the snow is getting thin.

4.2.6 COM Port Menu (Mapping Only)

This menu item allows the user to configure the serial port on the DVL. The serial port is used to either attach a GPS unit or output depth information during data collection. These values should match those set on your GPS system or external recording device.

4.2.6.1 Baud Rate (Mapping Only)

This sets the communication rate for the serial port. The port is capable of operating at 2400, 4800, 9600, and 19200 bits per second. The default value is 9600.

4.2.6.2 Stop Bits (Mapping Only)

This allows setting the number of stop bits. This can be set to 0 or 1. The default value is 1.

4.2.6.3 Data Bits (Mapping Only)

This allows setting the number of data bits. This can be set to 5, 6, 7, or 8. The default value is 8.

4.2.6.4 Parity (Mapping Only)

This allows setting the parity of the serial port. This can be set to odd, even, or none. The default setting is none.

4.2.6.5 Stop Label (Mapping Only)

When the system is hooked up to a GPS unit, the DVL will receive NMEA string information. The exact type of NMEA string information sent is dependant on the GPS unit and how it is configured. The unit may send a number of NMEA strings to the DVL. Each string starts with a particular ID code. The user must set this variable to the last ID code received in a group of NMEA strings. This last code can be determined by looking at the raw data (see Section 4.2.6.7 GPS Test (Mapping Only) on 13).

As a minimum the GPS unit must output the GSA and GGA string. These are the only two strings used by the SnowScan unit. Note: specifying too many output strings from the GPS may slow data acquisition.

4.2.6.6 Data Rate (Mapping Only)

The data rate controls how often data points are saved or sent to the serial port. The SnowScan system will collect approximately 10 readings per second. However, most GPS systems will only update at a rate of once per second. This option indicates on which scan interval a SnowScan and GPS value are stored. The default setting is 5.

4.2.6.7 GPS Test (Mapping Only)

This menu item allows testing the GPS system to ensure the communications are working. Selecting this item will bring up a submenu with 2 options. The first option (A), will display the raw NMEA string information on the screen. This is generally the recommended first step to ensure GPS communication is working correctly.

The second option (B), will plot the GPS location(s) on a plan view map on the screen. This can be used to look at the accuracy or drift of your GPS unit. Here the first GPS position is used as a reference and a line is draw between subsequent GPS readings on a plan view map. The clear button will clear the screen, keeping the 1st reading as the reference. The reset button will clear the screen and set the reference reading to the next GPS reading received. Zoom + and Zoom - will change the scale of the plot up and down.

4.2.7 Utility Menu

The utility menu contains several miscellaneous utility items. They are described below.

4.2.7.1 Set DVL Time

This item allows the user to set the time in the DVL. This has no impact on the view only system. However, in the mapping system the current time is logged to the start of every recorded section. This can be used to help identify when and thus where the data was collected.

4.2.7.2 Upgrade

The upgrade menu is used to install new firmware in the DVL. Instructions on installation would come with the new firmware package. Note: if the user should press this button by mistake, the units must be restarted by disconnecting the power.

4.2.7.3 Sensor Type

The SnowScan system has evolved over time. In order to maintain backwards compatibility this option allows switching between the older S type sensor to and the new Q type. Please note that the S and Q type also refer to the older and newer cables. In order to operate the new Q type sensor it must have a newer sensor and cable.

4.2.7.4 Delete Files (Mapping only)

This option will show the user which files have data in them and allows the user to select the particular file they wish to delete.

4.2.7.5 Export Files (Mapping only)

This item allows the user to export the data file(s) to a PC for plotting. The user must first install the transfer program PXFER22 or WIN_PXER on their PC. Next, they must hook up the transfer cable. Finally they must select the files to transfer.

PXFER22 is designed to work with Windows 98 and 95. WIN_PXFER is designed for all Windows operating systems.

4.2.7.6 View Files (Mapping only)

This item allows the user to look at the data stored in the data files.

4.3 Run SnowScan

Selecting the A button from the main menu will activate the data acquisition program. Once the 'A' button is pushed the system immediately looks for the sensor and configures it. If no system is attached an error will occur. If the sensor is not found, power the system off, check all connections and check the cables for damage. Then power it up again and retry starting. If this error does occur the complete system must be powered off before it will start again.

The SnowScan data acquisition screen is shown in Figure 4-2. It is divided into 2 sections. The top section contains the actual data and the bottom section contains the menu.

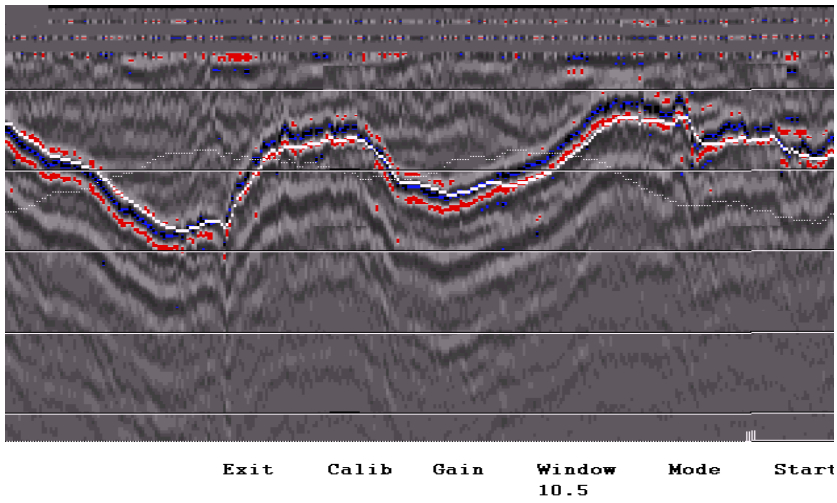


Figure: 4-2 SnowScan Data Screen

4.3.1 Section A - Data Display

This section contains the actual data collected. The section also contains the depth indicator lines, and any fiducial markers the user enters. See the sections below for more details.

4.3.1.1 Depth Lines

Depth lines are horizontal labeled lines indicating the estimated depth. They are very useful for getting snow depth estimates. These lines are located at an even multiple of 2 or 5. Check the total depth at the bottom of the screen to determine the interval.

Note that it is possible to change the depth units (see Section 4.2.1 Units on 11) to display meters or feet.

The depth line values are controlled by the snow type as well as the depth selected. The properties of the snow control the actual depth being scanned. The snow type is determined in the calibration menu (see Section 4.3.2.2 Calibration on 16). **It is the responsibility of the user to select the correct snow type in order to display the correct depth**.

4.3.1.2 Quality Plot (Mapping Only)

If the quality plot option is set to yes in the setup menu and the system is a mapping system a thin dotted line will appear on the screen. This value represented by this line shows how well the system believes it is mapping the snow ground interface. The closer the line is to the top of section A the better the quality of data.

4.3.1.3 Depth Plot (Mapping Only)

If the depth plot option is set to yes and the system is a mapping system, then a thick white line will appear on the screen. This line indicates where the system has determined the bottom of the snow is located and represents the snow thickness data that will be stored or exported.

Note: If the snow - ground interface is not being interpreted correctly then the operator can press the B button and the system will reset the estimation process.

4.3.2 Section B- Menu Items

The bottom section contains the user menu selection and current program settings. The menu selection is divided up into 6 sections before the system is started: Exit, Calibrate, Gain, Wind+, Wind-, and Start. Each of these options are addressed below.

Execution of a menu item is done by pressing the button immediately below the menu item. Pressing the button will change the setting for that menu item. For example, pressing the key below the Gain menu item will allow the user to cycle through the different gain settings available.

4.3.2.1 Exit

This button will terminate the program and return the user to main menu. The user can then run SnowScan again, change the setup parameters or shut the system down.

4.3.2.2 Calibration

The SnowScan sensor actually measures the time for the signals to travel from the unit to the ground (the base of the snow) and back again. The speed at which these signals travel depends on the type of snow beneath the sensor. The amount of moisture in the snow controls the speed at which the signals travel. In wet snow the signal will travel slower and in dry snow the signal will travel faster.

The horizontal scale lines on the screen indicate an apparent depth. Changing the snow type will change the location of these depth lines. In order for these line to be accurate, the operator needs to calibrate the system. The following steps need to be followed in order to calibrate the system.

1. Scan over a section of ground with a known snow depth. The depth of the snow should be at least 2-3 feet (1 metre). Usually a snow probe is used to determine the actual snow depth.
2. Pause the system and press the Calib button (Button 4).

3. Use the Up and Down buttons (1 and 2) to move the horizontal line to the top of the event at the location of the known depth.
4. Used the Snow+ and Snow- buttons (5 and 6) to adjust the depth to match the actual measured depth.
5. Press the return button (8). The system is now calibrated.

Snow type will generally vary from approximately 120 to 170 depending on the moisture content. The more water within the snow the lower the snow type will be.

4.3.2.3 Gain

The signals that the system collects from the ground can be very weak, especially through deep snow. To see these weak signals it is necessary to amplify or apply “gain” to them.

The Gain setting controls how much the signal is amplified. It varies from 1 to 9 with 1 being the lowest and 9 the highest. In general, if the snow is relatively shallow (1-2 meters) then a low gain setting can be used. If the snow is deeper increase the gain setting.

4.3.2.4 Window

This button will increase the depth which is displayed on the screen. There are 9 different depth settings. After the 9th setting, the screen will cycle back to the first section. The type of Snow affects the total apparent depth scanned. The user must calibrate the system correctly for the depth to be correct.

It is suggested the operator set the depth scale such that the average snow depth plots near the center of the display. This depth only represents the information displayed on the screen. With a mapping system, if the depth is calculated off the bottom of the screen then it is still stored in the file. Older S type sensors (see Section 4.2.7.3 Sensor Type on 14) are capable of scanning to a maximum depth of about 30 feet. The new Q type sensors are capable of approximately 50 feet.

4.3.2.5 Mode (Mapping Only)

The button toggles the screen between Chart Mode and Digital Depth Mode display.

4.3.2.6 Start

The Start button will begin the acquisition of data and displaying of data to the screen. After acquisition has started the Start button changes to a Pause button (used to halt acquisition). When the system is running the Exit and Calibration buttons are removed.

4.3.2.7 GPS and Mapping Options (Mapping Only)

If the system is a mapping system then additional information is displayed on the screen and buttons A and 1-4 all have a function.

On the far left of the screen three rows of information are provided. The first number represents the actual scan number. This gives the user an indication of how fast the system is scanning, enabling them to set the data rate (see Section 4.2.6.6 Data Rate (Mapping Only) on 13) correctly.

The next two numbers that appear are the calculated snow depth and quality number. These are the numbers which are stored in the files or exported through the serial port depending on the COM Usage setting (see Section 4.2.3 COM Usage (Mapping Only) on 12).

The bottom line indicates the current status of the GPS system. This status could have one of 6 settings.

1. `No Input` Indicates that no GPS data has been received.
2. `No GSA Input` Indicates that a GSA string was not received (see 4.2.6.5).
3. `No GGA Input` Indicates that a GGA string was not received (see 4.2.6.5).
4. `Fix Not Valid` Indicates data being received but data is not valid.
5. `Standard Fix` Indicates data received is standard GPS with no corrections.
6. `DGPS Fix` Indicates data received has been differentially corrected.

If a valid fix is being received from the GPS unit, the operator can activate data saving by pressing the A button. Data is only saved when valid GPS data is received. SnowScan can log data to 8 different files. The file which is being used is set in the setup menu (see Section 4.2.3 COM Usage (Mapping Only) on 12) and indicated on the screen. Each time the save mode is activated a new file indicator is placed in the file with the current date and time. Data is always appended to the end of the file. The user must delete the file to empty its contents.

When data is being logged to the file buttons 1 through 4 can be used as marker buttons. If one of these buttons are pressed then the next record sent to the file will contain this marker number. This is a good way to mark chair lift poles (1), snow guns (2), gun hydrants (3) or other features on the hill (4).

4.3.2.8 Data File Format (Mapping Only)

Data is saved to one of 8 different data files. When these files are exported to a PC they will have the names SSCAN01.SNO through SSCAN08.SNO. These files are ASCII text files with data in fixed columns. An example of the file is shown below.

The contents of each column are as follows:

1. GPS data type, either 1 for normal GPS data or 2 for DGPS.
2. GPS time.
3. Latitude defined as DD MM,MMMM (0-7 Decimal Places).
4. North or South.
5. Longitude defined as DDD MM,MMMM (0-7 Decimal Places).
6. West or East
7. Altitude.
8. PDOP.
9. Snow Depth in metres.

10. Quality Factor.
11. Trail Feature Marking
12. Velocity used to compute snow thickness.

```
**********   New File 12-18-2001 (MM-DD-YYYY) DVL time = 13:04:23   **********

 1 16:46:54.00   4338.1920000 N   7938.4353000 W 138.100000  2.60  0.12  10606 0   0.120

 1 16:46:54.00   4338.1920000 N   7938.4353000 W 138.100000  2.60  0.12   9912 0   0.120

 1 16:46:56.00   4338.1920000 N   7938.4352000 W 138.100000  2.60  0.11   9154 0   0.120

 1 16:46:56.00   4338.1920000 N   7938.4352000 W 138.100000  2.60  0.12   8677 0   0.120

 1 16:46:58.00   4338.1920000 N   7938.4352000 W 138.100000  2.60  0.14   8139 0   0.120

 1 16:46:58.00   4338.1920000 N   7938.4352000 W 138.100000  2.60  0.15   7555 0   0.120

 1 16:46:58.00   4338.1920000 N   7938.4352000 W 138.100000  2.60  0.16   7272 0   0.120

 1 16:47:00.00   4338.1921000 N   7938.4351000 W 138.200000  2.60  0.16   6972 0   0.120

 1 16:47:00.00   4338.1921000 N   7938.4351000 W 138.200000  2.60  0.18   6566 0   0.120

 1 16:47:02.00   4338.1921000 N   7938.4351000 W 138.300000  2.60  0.20   6205 0   0.120

 1 16:47:02.00   4338.1921000 N   7938.4351000 W 138.300000  2.60  0.21   5906 0   0.120

 1 16:47:02.00   4338.1921000 N   7938.4351000 W 138.300000  2.60  0.20   5575 0   0.120

 1 16:47:04.00   4338.1921000 N   7938.4351000 W 138.300000  2.60  0.20   5196 0   0.120

 1 16:47:04.00   4338.1921000 N   7938.4351000 W 138.300000  2.60  0.16   4898 0   0.120

 1 16:47:06.00   4338.1921000 N   7938.4351000 W 138.300000  2.60  0.16   4699 0   0.120

 1 16:47:06.00   4338.1921000 N   7938.4351000 W 138.300000  2.60  0.16   4499 0   0.120
```

5 Understanding the Data

The SnowScan system operates very similar to a bottom finder or fish finder on a boat. A signal is sent out from the sensor, this signal travels through the snow and bounces off the ground below. The returned signals are then plotted on the display unit (DVL).

The very top of the display represents the snow surface. The interface between the snow and ground is represented by a set of 2-3 lines generally moving up and down along the section. The operator is located at the very far right hand side of the screen. See Figure 5-1 below.

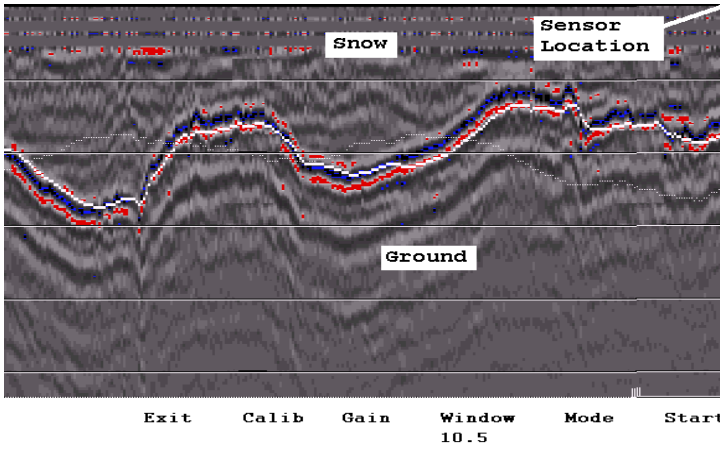


Figure: 5-1

The screen is easiest to understand if the operator is actually moving. A stationary operator will only produce horizontal lines since the distance to the ground (snow thickness) is not changing.

6 System Components

ELEC0016 ELEC0017 ELEC0021 CABL0042 CABL0043

HABR0021 HABR0030 MISC0061 PSUP0012 PSUP0013

HABR0037 HABR0038 HABR0039 HABR0036 CABL0040

CABL0029 CABL0023 PSUP0018

Appendix A Health & Safety Certification

Radio frequency electromagnetic fields may pose a health hazard when the fields are intense. Normal fields have been studied extensively over the past 30 years with no conclusive epidemiology relating electromagnetic fields to health problems. Detailed discussions on the subject are contained in the references 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 A-1.

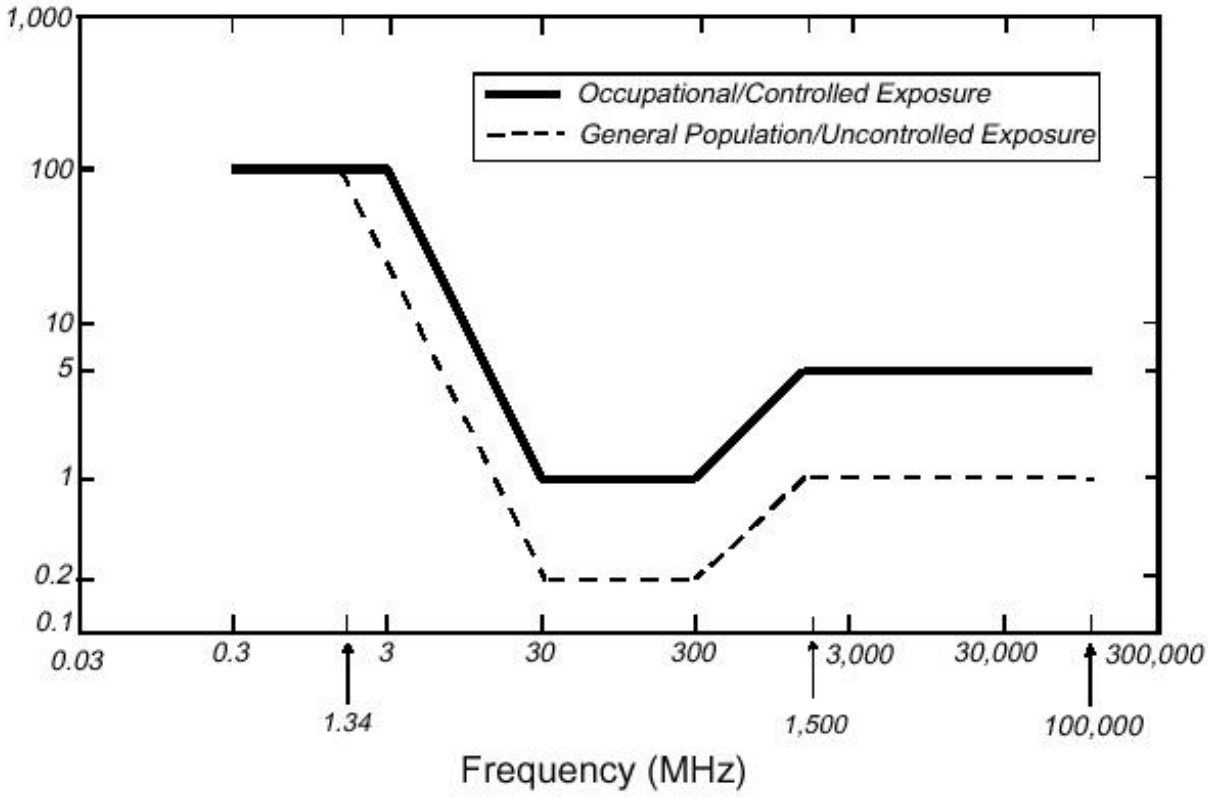


Figure A-1: FCC limits for maximum permissible exposure (MPE) plane-wave equivalent power density mW/cm^2.

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.

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)

Appendix B FCC Regulations

This device complies with Part 15 of the USA Federal Communications Commission (FCC) Rules. Operation in the USA is subject to the following two conditions:

(1) this device may not cause harmful interference and

(2) this device must accept any interference received, including interference that may cause undesired operation.

Part 15 – User Information

This equipment has been tested and found to comply with the limits for a Class A digital device, where applicable, and for an ultrawide bandwidth (UWB) device where applicable, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment 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 Operation Restrictions issued July 12, 2002
(FCC Order DA02-1658, paragraph 9)

The regulations contain restrictions on the parties that are eligible to operate imaging systems. [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

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

that the recent adoption of the UWB rules should disrupt the critical safety services that can be performed effectively only through the use of GPRs and wall imaging systems. We viewed these operating restrictions in the broadest of terms. For example, we believe that the limitation on the use of GPRs and wall imaging systems by construction companies encompasses the inspection of buildings, roadways, bridges and runways even if the inspection finds no damage to the structure and construction does not actually result from the inspection; the intended purpose of the operation of the UWB device is to determine if construction is required. We also believe that the GPRs and wall imaging systems may be operated for one of the purposes described in the regulations but need not be operated directly by one of the described parties. For example, a GPR may be operated by a private company investigating forensic evidence for a local police department.

FCC Permitted Mode of Usage

The GPR antenna must be kept on the surface to be in compliance with FCC regulations. Use of the antenna is not permitted if it is lifted off the surface. Use as a through-the-wall imaging device is prohibited.

GPR Use Coordination

FCC regulation 15.525(c) requires users of GPR equipment to coordinate the use of their GPR equipment as described 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.

FCC GROUND PENETRATING RADAR COORDINATION NOTICE

NAME:

ADDRESS:

CONTACT INFORMATION [CONTACT NAME AND PHONE NUMBER]:

AREA OF OPERATION [COUNTIES, STATES OR LARGER AREAS]:

FCC ID: [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 C Instrument Interference

Immunity regulations place the onus on instrument/apparatus/device manufacturers to assure that extraneous interference will not unduly cause an instrument/apparatus/device to stop functioning or to function in a faulty manner.

Based on independent testing house measurements, Sensors & Software Inc. systems comply with such regulations in Canada, USA, European Community and most other jurisdictions. GPR devices can sense electromagnetic fields. External sources of electromagnetic fields such as TV stations, radio stations and cell phones, can cause signals detectable by a GPR which may degrade the quality of the data that a GPR device records and displays.

Such interference is unavoidable but sensible survey practice and operation by an experienced GPR practitioner can minimize such problems. In some geographic areas emissions from external sources may be so large as to preclude useful measurements. Such conditions are readily recognized and accepted by the professional geophysical community as a fundamental limitation of geophysical survey practice. Such interference being present in the GPR recordings is not considered as an equipment fault or as a failure to comply with immunity regulations.

Appendix D Safety Around Explosive Devices

Concerns are expressed from time to time on the hazard of GPR products being used near blasting caps and unexploded ordnance (UXO). Experience with blasting caps indicates that the power of Sensors & Software Inc.'s GPR products are not sufficient to trigger blasting caps. Based on a conservative independent testing house analysis, we recommend keeping the GPR transmitters at least 5 feet (2m) from blasting cap leads as a precaution. Some customers do experimental trials with their particular blasting devices to confirm with safety. We strongly recommend that GPR users routinely working with explosive devices develop a systematic safety methodology in their work areas.

The UXO issue is more complex and standards on fuses do not exist for obvious reasons. To date, no problems have been reported with any geophysical instrument used for UXO. Since proximity and vibration are also critical for UXO, the best advice is to be cautious and understand the risks.