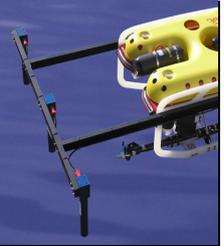




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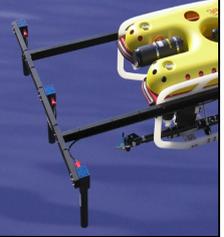
Section 5

SMARTSEARCH

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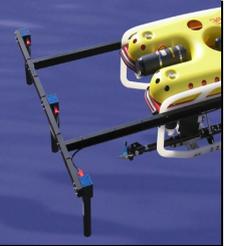
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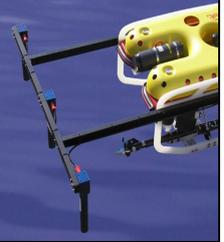
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SUPPORT INFORMATION

	Mail	Innovatum Ltd Units 11/12, Woodside Business Park Thetford Road, Ingham Bury St Edmunds IP31 1NR ENGLAND
	Telephone	+44 (0)1284 729123
	Email Web	support@innovatum.co.uk www.innovatum.co.uk



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SYMBOLS

The following symbols are used within these manuals



Important Note: items of particular importance.



Caution: items where care is required.



Danger: items where a hazard may exist.



ESD Hazard: items where ESD precautions may be required.

ERRORS and OMISSIONS



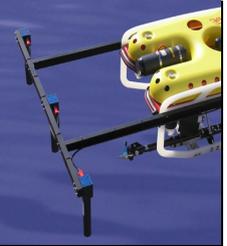
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5.1 Introduction

The "INNOVATUM" SMARTSEARCH is a magnetic mapping system for use on a variety of surface and underwater vehicles. It is capable of locating, and measuring the position of pipelines, cables, ferro-magnetic objects and debris, by means of their intrinsic magnetism and consequent distortion of the earth's magnetic field, or their permeability effect.

- SMARTSEARCH may be reconfigured to operate as a SMARTRAK unit for Passive Magnetic Survey of pipelines and cables.
- SMARTSEARCH may be supplied with a single sensor, up to a maximum of twelve sensors. If less than 12 sensors are supplied the systems may all be upgraded to the maximum number.
- The SMARTSEARCH system has a numeric suffix, indicating the maximum number of sensors it may have.
- The suffix "L" indicates the "Grad" sensors have a 60 cm gradiometer baseline.
- All systems are supplied with an altimeter.

SMARTSEARCH requires a navigation (positional) data input. This is normally provided by a combination of surface (above water) and subsurface underwater positioning devices. With a survey speed of up to 4 knots, and a data point acquired on each sensor around 6 to 10 times per second, SMARTSEARCH can map a survey area faster than any other current system. The real time data acquired is monitored by a "waterfall" display, which allows an immediate assessment of features of interest and simple tracking of linear features such as pipeline and cables. Array configuration, update rate and sensitivity may be selected on line. Positional data may be accepted from almost any survey positioning system. Data may be continuously logged for post processing and report generation.

SMARTSEARCH consists of three major elements:

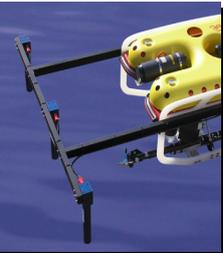
- a) The sensor array, consisting of high accuracy high sensitivity magnetic fluxgate gradiometers. The array is usually mounted on an Innovatum supplied frame.
- b) The subsea electronics package, known as the "Sensor Interface Pod" or SIP.
- e) The surface computer workstation and display, which may be any compatible "PC". A laptop is normally supplied.

The connections to the underwater vehicle are normally the responsibility of the vehicle operator, as is the provision of a suitable power supply. The following connections are required:



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- a) 18-36v D.C. power @ 850 mA continuous. (A wide range PSU to 72 volts DC may be supplied on request).
- b) A fully transparent data link to the surface unit, either RS485 via a "wired" umbilical, or RS232 via a vehicle multiplexer.
- c) An optional digital gyro input from the vehicle to the SMARTRAK via the surface interface unit.

The SMARTSEARCH provides serial data outputs at the surface computer for recording and further analysis purposes.

The system is normally supplied with spare sensor(s) to cover operational failures. A "remote location" spares package, containing additional items, will be supplied on request.

5.2 System Components

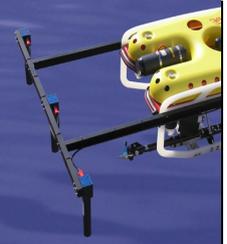
SMARTSEARCH is supplied in one or more specialist transit cases, designed to protect against environmental and transportation damage. The cases should always be used for system transportation and storage. The contents of the cases are as follows (SMARTSEARCH 12 only - other models may differ or have an additional case):

CASE 1

- 4 "Grads"
- 1 SIP (subsea can)
- 1 Interface & Overlay Unit
- 1 test cable, plus 1 RS485 test cable
- 1 test power supply
- 1 8-pin tail
- 4 sensor cables
- 1 Tritech PA 500 altimeter plus manual
- 1 altimeter cable
- 1 laptop computer
- 1 laptop PSU plus mains lead

CASE 2

- 10 "Grads"
- 8 sensor cables



5.2.1 “Grads” (Magnetic Fluxgate Gradiometers)

These devices measure total magnetic field (X,Y, and Z) in three axes and magnetic field gradient (dZ), in the vertical direction, using a 28 cm baseline. The total field “X” and “Y” values are used for setting the co-linearity of the Z elements and generating magnetic heading. Alternative sensors with a 60 cm baseline are available on request.



Grad

5.2.2 Sensor Interface Pod



Sensor Interface Pod (SIP)

The Sensor Interface Pod (SIP) is a “PC” based high specification data acquisition system. The SIP takes power and command signals from the surface, and sends sensor data and status information to the surface. Power for the sensors is generated within the SIP. The SIP connectors are shown in the table on the next page:



Label	Connector Type	Connect To...
ROV	8 Pin male	ROV
ALT	6 Pin Female	Tritech PA 500 Altimeter
1	8 Pin Female	#1 Fluxgate Gradiometer
2	8 Pin Female	#2 Fluxgate Gradiometer
3	8 Pin Female	#3 Fluxgate Gradiometer
4	8 Pin Female	#4 Fluxgate Gradiometer
5	8 Pin Female	#5 Fluxgate Gradiometer
6	8 Pin Female	#6 Fluxgate Gradiometer
7	8 Pin Female	#7 Fluxgate Gradiometer
8	8 Pin Female	#8 Fluxgate Gradiometer
9	8 Pin Female	#9 Fluxgate Gradiometer
10	8 Pin Female	#10 Fluxgate Gradiometer
11	8 Pin Female	#11 Fluxgate Gradiometer
12	8 Pin Female	#12 Fluxgate Gradiometer

If less sensors are used the leftmost sensor should always be connected to Port 1, the remaining sensors fitted in ascending order, and all unused Sensor ports fitted with a connector dummy plug.

5.2.3 Interface & Overlay Unit

The “Interface & Overlay” unit is used to route data signals to and from the surface computer. It contains USB to RS232 and USB to RS485 converters, plus a simple video overlay unit. It is powered by the computer USB port.

5.3 Physical Vehicle Mounting

5.4 Sensor Arrays Mounting

5.4.1 Sensor Array Selection

The SMARTSEARCH has array configurations ranging from 1 to 12 gradiometer sensors. The array set up required for the task should be carefully considered. The sensor spacing may be varied to suit the task, with a wide spacing (1m or more) when very large objects are to be located, reducing to as little as 30 cm when it is necessary to map small items. The required overlap between adjacent run lines should also be considered, as this is a function of the achievable



navigational accuracy.

Very large arrays may require a powerful ROV to overcome the hydrodynamic drag effects, and the array mounting frame may be collapsible for deployment and recovery operations.

5.4.2 Sensor Mounting Frames

The sensor array configuration is dependant on the object location task required. Sensor alignment accuracy is critical for accuracy of target positioning, and great care **MUST** be taken to ensure the sensors are set up properly. All sensors in the array should be mounted in the same vertical plane across the front of the vehicle with the sensor array plane at least 70 centimetres forward of the front of the vehicle, or the same distance aft in the case of rear sensors. All sensor cylindrical axes should be vertical.

The mounting frames for Innovatum gradiometer sensors must be fabricated using only non-ferrous metals (aluminium or 316/A4 grade stainless steel) and/or non-conducting composites (fibre-glass, plastics, wood etc.).

5.4.3 Folding Sensor Mounting Frames

The sensor array width of SMARTSEARCH may be more than 6 metres, often requiring a sensor mounting which may be folded or retracted for launch, recovery and other vehicle operations. Folding frames may be actuated by hydraulic or electrical means, and must be carefully designed to be rigid during SMARTSEARCH operation. The frame must also carry the sensors and associated cabling securely when retracted.

5.4.4 Fluxgate Gradiometer Mounting

The sensors must be mounted with equal sensor spacing, ideally symmetrical about the vehicle centreline, with all connectors at either at the top or all at the bottom, aligned with the cable exit in line with either the longitudinal or lateral axis of the vehicle. The bottoms of all Grads should be lined up closely so that they all lie on the same horizontal line across the front of the vehicle (+/- 1 mm).



Grads must only be mounted with the long axis vertical, and the cable exit either in the longitudinal or lateral axis direction of the vehicle. This orientation will be input into the system parameters menu. The flat plane on the connector opposite to the face where the cable emerges is the alignment reference plane for grads. (Be careful not to bend cables too sharply or apply too much tension to cables).



The sensors must be attached to the frame using non-magnetic bolts. Suitable materials are brass, titanium or SOME "A4" stainless steel bolts. All steel bolts **MUST** be tested for magnetic properties prior to use. Ensure the sensor mounting bolts are the correct length, and do not enter the sensor by more than 10mm. If washers are used these **MUST** also be totally non-magnetic. *If magnetic fastening components are used, the sensors will not operate correctly.*



After installing the mounting frame(s) and sensors on the vehicle it is necessary to accurately measure (to an accuracy of 1mm) and record the positions and alignments of the various sensors, for entry into the system menu after computer switch on.



The sensor array should, if possible, be mounted on the rear face of the ROV mounting frame to protect the sensors from damage in collisions, etc. It may be necessary to fabricate additional protection for the sensors.

Sensors are attached to the SIP (subsea can) in labelled positions. ALL sensors use identical connectors and pin allocations.

5.4.5 Sensor Interface Pod (SIP) Mounting

The SIP may be mounted only in either of two orientations. The long axis may be either horizontal (in line with the vehicle, or at right angles to the heading axis) or vertical (lid up). The arrow must point “up” when the long axis is horizontal. Care must be taken to ensure that there is no excessive tension or sharp bends in the sensor cables. Avoid clamps, etc. which might interfere with proper sealing of the can lid. This can may be placed in proximity to magnetic materials or low power A.C./D.C. power supplies on the ROV. A special SIP clamp is available from Innovatum Ltd.



Do not place SIP or connecting cables in close proximity to any high-power A.C. power cables, umbilical or termination boxes. Route all cables away from all other wires carrying high A.C. power. High power A.C. means voltages greater than 110 V.A.C.

5.5 Power and Signal Wiring on Vehicle

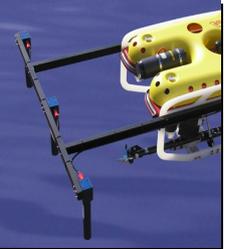
5.5.1 Vehicle Power Requirements

The vehicle power supply for the Innovatum subsea can (SIP) should be a regulated D.C. supply capable of supplying 850 milliamperes current at +16 to +72 volts. The SIP's internal power supplies are all isolated converter units. Vehicle power supplies must be able to supply sufficient start up current.

5.5.2 Vehicle Wiring to SIP

The 8-pin connector from ROV to Innovatum SIP has the following pin assignments:

- Pin 1** Serial data line through ROV umbilical (RS485 A or RS 232 uplink signal)
- Pin 2** Serial data line through ROV umbilical (RS485B, or RS232 common)
- Pin 3** Serial data line through ROV umbilical (or RS232 downlink signal)
- Pin 4** Not connected



- Pin 5** +16 to +36 volts D.C. with 1 amp current supply
- Pin 6** D.C. power common
- Pin 7** Not connected
- Pin 8** Not connected

5.5.3 Data Protocol Selection

It will be necessary to set the required data protocol in the SIP prior to installation. The selection switch is found internally on the "Protocol Converter PCB" circuit card, which is the top card in the SIP card stack.. Set the switch to the required position. The following protocols are available:

- RS485** (requires 2 shielded wires only, tested line length 1.2 Km)
- RS232** (requires 3 wires, only used for data link via vehicle multiplexer)

5.5.4 Signal Wiring – Topside

5.5.41 Wiring To PC and ROV Umbilical

There are several ways to connect the surface signals:

Interface & Overlay Unit Connection

Connect the "USB" connection on the Interface & Overlay Unit to a suitable USB port on the PC. If using RS485 signals connect this via PORT 4 on the Interface Unit using:

RS485 "A"	Pin 3
RS485 "B"	Pin 5

If Using RS232 signals:

Data UP	Pin 2
Data DOWN	Pin 3
Data COMMON	Pin 5

and connect to PORT 1.

Direct Connection

If using RS485 connect the 2 data lines from the ROV to the RS485 to USB adaptor, taking care that the "A" line goes to both the A Tx and A Rx terminals, and the "B" line goes to both the B Tx and B Rx terminals. If using RS232 the 3 data lines should be wired to a 9 pin "D" socket, wired as follows:

This D connector should be attached to PORT 1 on the Blue RS232 to USB adaptor.

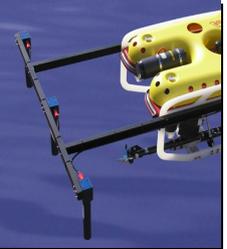
Multiplexer Connection

Use a 9 pin RS232 data cable to connect between the ROV multiplexer and the SMARTRAK PC at the Serial to USB adaptor.



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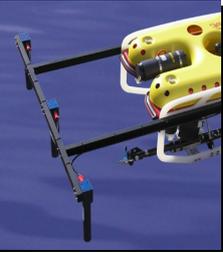


5.5.42 Additional Serial Data Inputs

Additional sensor inputs to SMARTSEARCH may be sent as RS232 data via the USB PORT 3 . Typical additional sensors are Gyros. Contact Innovatum Ltd for interfacing details

5.5.43 Data Transfer To Survey Computer

Data transfer from the SMARTSEARCH PC to another computer is accomplished via PORT 2 on the Interface adaptor box, or the RS232 port labelled COM2 on the USB to RS232 adaptor. This sends serial ASCII data to a second computer with a complete ASCII data string sent at the end of each update by the PC. The data is selectable by a choice of output string and baud rate.

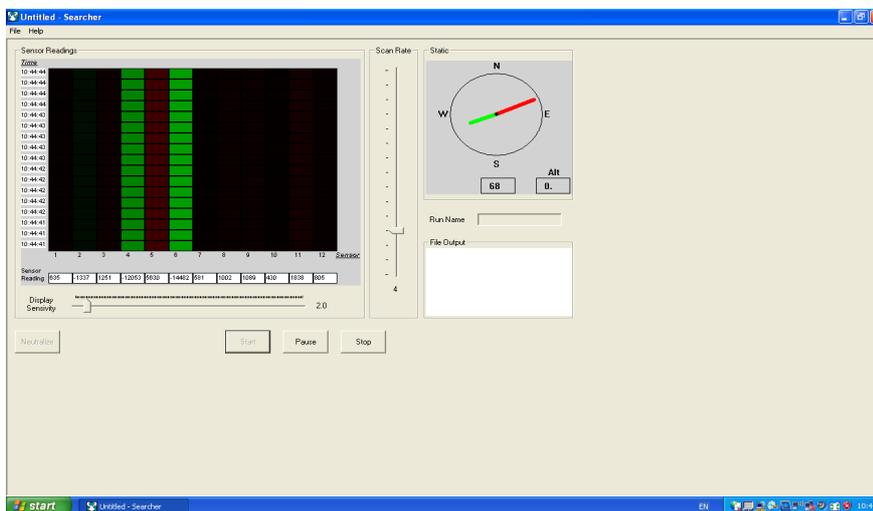


5.6 Software

5.6.1 Installing The Software

General Display

Below is the main display screen for Smartsearch. The Main Screen is split in to three sections:



Sensor readings

This shows the latest reading for each sensor along with the historical reading against time in waterfall-style display. A red or green box is displayed to represent the sensor polarity reading, with red positive (North Pole) or green negative (south Pole), and the intensity of the colour being adjusted according to the value of the sensor reading. The sensitivity of the colours can be adjusted

using the Display Sensitivity slider located at the bottom of the Sensor Readings display. The speed of the updated screen and file reading can be adjusted using the scan rate slider located on the right hand side of the Sensor Readings display. The picture above shows the system operational but when the system is stopped a red background is shown.

Display Sensitivity

This horizontal slider adjusts the sensitivity of the colour coding of the sensor values displayed on the water fall display. This has not effect on the values stored in the data file.

Scan Rate

This vertical slider adjusts the speed of the update rate of the screen and the data stored to file.

Heading Display

Shows the heading of the sensor array. The heading is calculated using the X and the Y axis magnetic flux gate reading taken from the No 1 Sensors. Also displayed is the altitude of the array measured in meters. The altimeter option must be enable for this function to work.



File Output

Shows the data string which is being saved to the text file.

Neutralize Button

This button takes average of all the sensor readings removing any local magnetic field. This function can only be run when the start button is not enabled. It is recommended that this function is done stationary if possible and on the same heading as the survey run line. Also as the Sip has some internal averaging it is best to run the system for a little while before neutralizing the system.

Start Button

This button starts the communications between the topside computer and the SIP also starts the on-line displays along with logging files and serial output strings

Stop Button

This button stops the communications between the topside computer and the SIP also stops the on-line displays along with closes the logging files and serial output strings

Pause Button

This pauses the logging data but communications between the topside computer and SIP remains running as well as the only line display.

Run Name this is the name given to the logging file. If left blank than the system will use the date and time to the nearest seconds as the file name.

Set Up Menu

Once a change has been made on the set-up menu it is recommended to press the **Apply** button as the option changed may allow changes to other menu options.

Positioning Set Up

Below is a example of that the Positioning Set up screen.

Positioning Device Connected

Enables and disables the survey input string to the Smartsearch software.

Comport set which serial port the survey string is being sent to.

Baud Rate adjusts the baud rate of the serial port selected in the above menu option.



Positioning Offset

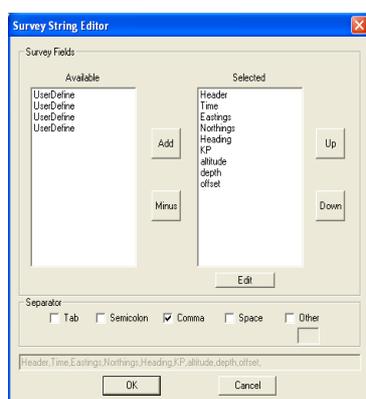
Allows an adjustment from the survey reference point to the Smartsearch reference point which is the middle of the Smartsearch sensor array.

Survey Device

Set the type of survey string being sent to the Smartsearch software.

Format Custom Survey String

Opens the survey string editor dialogue box as shown below:



Survey Fields

Allows the user to select the incoming fields using the add and minus buttons on the survey input string and set the order which they appear on the string using the up and down buttons. The user define fields once selected can be edited to change the field name using the edit button.

“The minimum fields that you must have is Time, Eastings and Northings”

The Survey String can only have a maximum of 12 fields

Time field must be in the following format “hh:mm:ss”

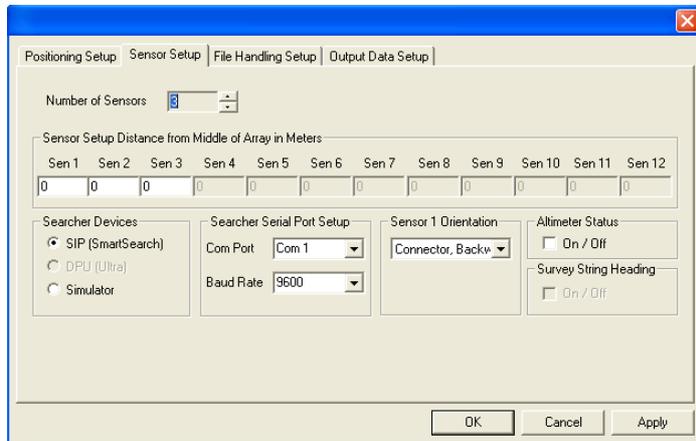
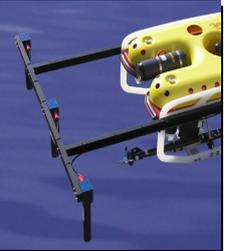
Separator

Allows the use to select the character that divides the fields this can be set to 1 or more different characters.

Along the bottom of the dialogue box is an example of the serial string is displayed.

Sensor Set Up

On the next page is a example of the Sensor Set up screen .



Number of Sensors

This set the number of sensors connected to the SIP

Sensor set up distance sets the distance from the Smartsearch reference point to the sensor in meters a negative number is to the left and a positive number is to the right of the reference point i.e. the middle of the Smartsearch sensor array.

Searcher Device

Selects the hardware type that is connected to the software

Searcher Serial Port Set

Up allows the user to select the serial port that the Smartsearch hardware is connected to. Along with the setting the baud rate on the serial port.

Sensor 1 Orientation

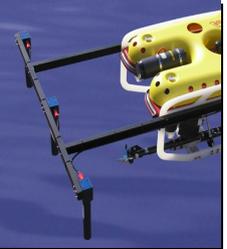
All sensors have a triaxial fluxgate sensor inside sensor port number 1 reads all three sensor readings which can be used for heading. It is important to put the orientation of the sensor in to make the correct for heading. We use the connector on the sensor for our directional reference.

Altimeter Status

This turns the altimeter data on and off. *Note that if turned off there is still power to the altimeter so it still runs but the data is not used*

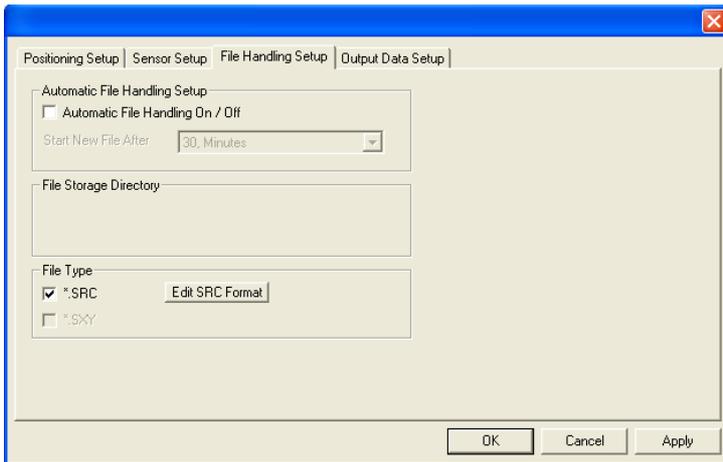
Survey String Heading

This allows the heading information from the survey string to be used instead of the fluxgate with in the sensor. *Note this option is only available from version 2.4 onwards*



File Handling Set-up

Below is an example of what the File Handling Set up screen looks like:



Automatic File Handling Set-up

This allows the software to automatically start a new file after a set time period that can be selected by the user. This is important to allow for regular backups of the files to be made and stops the file sizes getting too large. If a name has been placed in the run name box then a number will be appended to the name which slowly increments on each update. If the run name box is left empty then the date and time format on file creation is used.

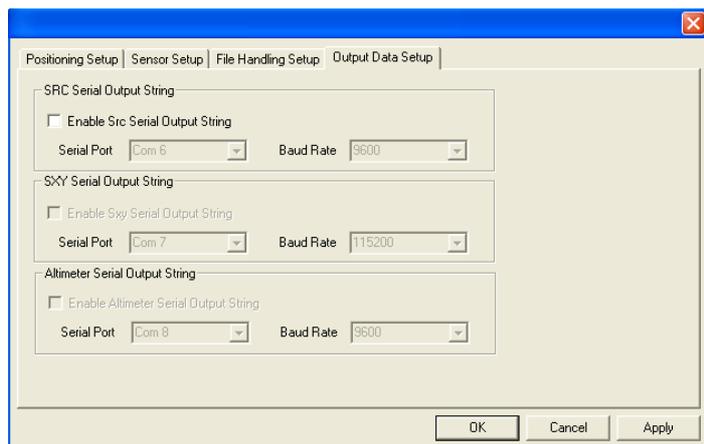
File Type

This allows the file type *.SRC or *.SXY to be created. The file types are described in the file storage section of the manual.



Output Data Set-up

Below is a example of the Output data Set up screen:



This menu section allows the different file types to be output via a serial output which can be used defined. Further information can be found in the Storage Files section of this manual

*Note that the *.SXY string is not recommended to output as serial string as there is far to much data but if used a high baud rate is needed.*

Storage Files

There are two types of storage files available with in Smartsearch *.SRC and *. SXY either of them can be enabled in the set up menu. Below is a description of the file format

*.SRC File

This is a normal text file which is created with either the name give in the run name box with a number added or if the run name box is left blank the date and time is used for the file name with the file extension src.

The default file comprises of the following fields:

Date (Formatted to DD/MM/YYYY)

Separator

Time (Formatted to HH:MM:SS)

Separator

Sensors readings (The reading is nT per foot. The number of readings will adjust according to the number of sensor enabled each reading is separated with a Separator)

Separator



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Heading	(The reading is in degrees)
Separator	(This will only appear if a survey string is present)
Eastings	(Raw value from survey string, this will only appear if a survey string is present)
Separator	(This will only appear if a survey string is present)
Northings	(Raw reads from survey string, this will only appear if a survey string is present)
Separator	(This will only appear if the altimeter is enabled)
Altimeter	(This value is the altimeter read in metres and is only present if the altimeter is enabled)

CR

LF

Example of the stored text with 4 sensors enabled, altimeter enabled and a survey string presents

“20/08/2008,14:32:51,1855,-944,387,330,576100.98,6224400.07,0.0000”

The file can also be user defined the default part of the string can not be changed but it does allow the separator to be changed and any additional fields which are read in from the survey string to be added to file.

***.SXY File**

This is a normal text file which can only be enabled if a survey serial string is present and is created with either the name give in the run name box with a number added or if the run name box is left blank the date and time is used for the file name with the file extension sxy. This file starts a new line for each sensor reading and the position given has had the sensor offsets applied.

The file comprises of the following fields

Date	(Formatted to DD/MM/YYYY)
Separator	
Time	(Formatted to HH:MM:SS)
Separator	
Sensors readings	(The reading is nT per foot.)
Separator	
Eastings	(value from survey string with sensor offset applied)
Separator	
Northings	(value from survey string with sensor offset applied)

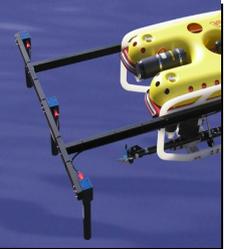
Example of the stored text:

“20/08/2008,15:07:27,-5597,576240.09,6224330.95”



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Serial Output Strings

SRC Serial Output String

This is ASCII output which is identical to the text being stored in the *.src file. This is described in storage files and *.src section of this manual. This can be enabled in the set up menu along with the serial port number and the baud rate.

SXY Serial Output String

This is ASCII output which is identical to the text being stored in the *.sxy file. This is described in storage files and *.sxy section of this manual. This can be enabled in the set up menu along with the serial port number and the baud rate.

Note: is recommended to run this serial output string with a high baud rate otherwise it will slow the system down.

Altimeter Serial Output String

To be issued