The SuperSting™ with Swift™

automatic resistivity and IP system

Instruction Manual

Instruction Manual

for

The SuperSting™ with Swift™ automatic resistivity and IP system

SuperSting R1/IP Release 01.01.38
SuperSting R8/IP Release 01.03.41

Advanced Geosciences, Inc.

January 2006

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1 Safety first

Every AGI instrument is designed with safety in mind. However, even the best design must rely on the user to employ safety precautions when using the instrument. Therefore review the following safety precautions to avoid injury and prevent damage to the equipment. To avoid potential hazard, use this product only as specified.

Since the geophysical resistivity method implies that an electric current is transmitted into the ground, it is necessary to use electrically energized ground stakes (up to 400 V using the internal transmitter, up to 3,000 V using the PowerSting external transmitter). It is therefore absolutely necessary that the survey line with its ground stakes and connections be monitored for the duration of the survey so that people, children and animals do not touch the electrode stakes.

- Always inspect the Swift cables and connecting cables for insulation damage or exposed wiring. Damaged cables should be replaced.

- Use good rubber sole shoes (or rubber boots) and rubber gloves when setting out the cable. Special high voltage electrical safety boots are included with PowerSting external transmitter shipments.

- Never work alone.

- Use a safe practice when setting up the survey line. First pound all stakes into the ground. Then lay out the electrode cable. Place the electrode switch/take-out on the stake, without touching any metal. Once the switch/take-out is in contact with the stake, attach the switch/take-out with the stainless steel spring. This procedure ensures that the electrode take-out is grounded as you attach the take-out to the stake.

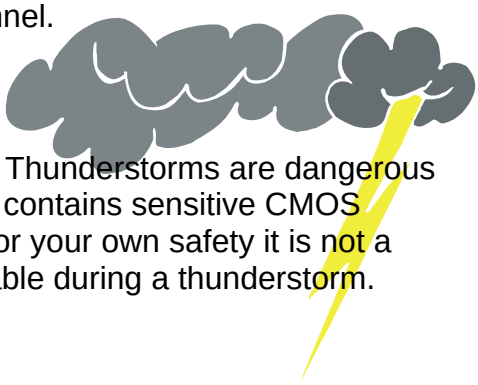
- The survey line should be sufficiently taped off with warning tapes.

- Use the “Electrode High Voltage Warning Covers” available from AGI. A warning cover should be placed on each electrode. Note that the warning covers do not protect from the high voltage, especially not when wet, but is a mere warning sign. The message “Danger high voltage” in English, Spanish and Chinese together with a self-explanatory picture is displayed on the cover.

- When setting up the instrument do not attach the electrode cables to the instrument until you are ready to start the survey.

Figure 1 Use the electrode warning covers

- Before starting the instrument, make sure that the survey line is clear and no one is touching the cable or electrode stakes.
- Use only the fuse type and rating specified for this product.
- Do not touch exposed connections and components when the system is energized.
- Do not operate with suspected failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.
- Do not operate in an explosive atmosphere.
- Do not operate during an approaching thunderstorm. Thunderstorms are dangerous both for you and the equipment. The instrumentation contains sensitive CMOS circuitry and can be destroyed by nearby lightning. For your own safety it is not a good idea to stand at the end of a long conductive cable during a thunderstorm.



2 Preface

2.1 Warranty

Advanced Geosciences, Inc. is not liable to Buyer or to any third party for consequential or incidental damages under any circumstances, whether due to defect in the product, due to delay or failure of delivery, due to a failure of the product to perform as specified, or for any other reason or cause. Buyer and Advanced Geosciences, Inc. agree that Buyer's sole remedy and Advanced Geosciences, Inc.'s sole liability to Buyer is limited to repair, replacement, or refund of the purchase price Damage due to corrosion, customer alterations, excessive dust, extreme environmental or electrical conditions, and/or misuse will be evaluated upon inspection. If inspection reveals that the cause of damage is not due to materials or workmanship, repair of the product will be treated on a non-warranty basis.

Each instrument manufactured by AGI is warranted to be free from defects in materials and workmanship. This warranty covers the servicing and adjusting of any defective parts (except for fuses, batteries and other consumables).The warranty is effective for 12 months after the date on which the instrument was shipped from the factory as set forth on the bill of lading, provided that the instrument is returned freight prepaid to AGI. If the fault has been caused by misuse or abnormal conditions, AGI will submit a cost proposal to the user prior to undertaking any repair work.

This warranty does not cover freight charges to or from AGI.

This warranty does not cover the costs of any steps that the purchaser takes or fails to take as the result of measurements made using our instrument or as the result of calculations carried out by the instrument or software.

If a fault occurs, contact AGI for instructions. Lethal voltages may be present inside the instrumentation even when the ac input voltage is disconnected. Only properly trained and qualified personnel should remove covers and access the inside of the power supply. Installation and service must be performed only by properly trained and qualified personnel who are aware of dealing with electrical hazards.

Advanced Geosciences, Inc. or any of the associated sales organizations cannot accept responsibility for personal injury, consequential injury, loss, or damage that results from improper use of the equipment and accessories.

2.2 Warranty registration

PRODUCT WARRANTY REGISTRATION CARD:

END USER'S NAME_____

COMPANY/ORGANIZATION_____

ADDRESS_____

_____

CITY_____STATE_____

COUNTRY_____

POSTAL CODE_____PHONE_____

FAX_____E-MAIL_____

NAME & SERIAL # OF INSTRUMENT_____

DATE OF PURCHASE_____

THIS WARRANTY REGISTRATION INFORMATION WILL HELP US TO KEEP OUR CUSTOMERS INFORMED OF UPDATES, CHANGES, AND NEW IMPLEMENTATIONS. PLEASE FAX THIS REGISTRATION CARD TO +1 512 258-9958 OR SEND IT VIA E-MAIL TO support@agiusa.com .

KEEP A COPY OF THIS REGISTRATION FORM FOR YOUR RECORDS.
THANK YOU FOR PURCHASING PRODUCTS FROM ADVANCED GEOSCIENCES, INC. FOR FURTHER INFORMATION, CONTACT OUR LOCAL REPRESENTATIVE OR ADVANCED GEOSCIENCES, INC., 12700 VOLENTE RD., AUSTIN, TEXAS, 78726, U.S.A., PH # +1 512 335-3338, FAX# +1 512 258-9958,
E-MAIL: agi@agiusa.com
Web page http://www.agiusa.com

2.3 Register in the AGI UserGroup

By registering, at our internet web site SuperSting User Group, you will get free software updates, helpful hints regarding the use of the SuperSting and the SuperSting automatic electrode system, latest news regarding the system and ready made command files.

Any SuperSting owner is eligible for joining our SuperSting User Group. To sign up, log in to our web page at http://www.agiusa.com and click on User Group Registration in the yellow left side bar. Fill in the registration information and within short time you will receive your registration password.

2.4 About this manual

This manual covers the following instruments:

- SuperSting R8/IP
- SuperSting R8/IP+28
- SuperSting R8/IP+56
- SuperSting R1/IP
- SuperSting R1/IP+28
- SuperSting R1/IP+56
- SuperSting R1/IP+84
- SuperSting R1/IP+112
- SuperSting Marine
- Swift dual mode automatic electrodes (patent 6,404,203) and accessories.

The manual uses the following conventions:

Example	Description
M6	Go to menu 6, by pressing the number 6-key
M7/F1	Go to menu 7, by pressing the number 7-key and then press the **F1** key

2.5 Unpacking the instrument

The following items should be enclosed in a standard SuperSting R8/IP shipment:

Item	Qty	Code	Description
1.1	1 1 1	951200 850002 850003	*SuperSting R8/ IP* instrument console or *SuperSting R8/ IP+28* instrument console or *SuperSting R8/ IP+56* instrument console
1.2	1	951001	Power supply for office use
1.3	1	911501	AC power cable
1.4	1	920009	Cable for communication *SuperSting*/Windows based computer
1.5	1	951016	Cable for loading firmware into the SuperSting
1.6	1	951010	Test box

1.7	1	951005	Main battery cable with boost battery take-out
1.8	1	938202	12 V power adapter cable for boost battery
1.9	1	933040S	Jumper cable, 2 meter, used to connect the Swift cable, a switch box or a test box to the SuperSting
1.10	1	951019	Test cable used to test the electrode switches
1.11	1	951018	Kit of fuses comprising: one 20 Amp, 1x1/4", one 1 Amp 250V 5x20 mm and one 2.5 Amp 250 V 5x20 mm fuses
1.12	1	920026	Allen wrench, 9/64"
1.13	1	951003	SuperSting Administrator, utility software
1.14	1	951004	Instruction manual

The following items should be enclosed in a standard SuperSting R1/IP shipment:

Item	Qty	Code	Description
1.1	1 1 1	870000 870001 870002	*SuperSting R1/IP* instrument console or *SuperSting R1/ IP+28* instrument console or *SuperSting R1/ IP+56* instrument console
1.2	1	951001	Power supply for office use
1.3	1	911501	AC power cable
1.4	1	920009	Cable for communication *SuperSting*/Windows based computer
1.5	1	951016	Cable for loading firmware into the SuperSting
1.6	1	870010	Test box
1.7	1	951005	Main battery cable with boost battery take-out
1.8	1	938202	12 V power adapter cable for boost battery
1.9	1	870030	Jumper cable, 2 meter, used to connect the Swift cable, a switch box or a test box to the SuperSting
1.10	1	851018	Kit of fuses comprising: one 20 Amp, 1x1/4", one 1 Amp 250V 5x20 mm and one 2 Amp 250 V 5x20 mm fuses
1.11	1	920026	Allen wrench, 9/64"
1.12	1	951003	SuperSting Administrator, utility software
1.13	1	951004	Instruction manual

The following items should be enclosed in a standard SuperSting Marine shipment:

Item	Qty	Code	Description
1.1	1	953100	*SuperSting Marine*
1.2	1	951001	Power supply for office use
1.3	1	911501	AC power cable
1.4	1	920009	Cable for communication *SuperSting*/Windows based computer
1.5	1	951016	Cable for loading firmware into the SuperSting
1.6	1	951010	Test box
1.7	1	951005	Main battery cable with boost battery take-out
1.8	1	938202	12 V power adapter cable for boost battery
1.9	1	933040S	Jumper cable, 2 meter, used to connect the Swift cable, a switch box, a marine streamer or a test box to the SuperSting

1.10	1	953013	GPS Lowrance LMS
1.11	1	953011	Lowrance serial communications cable
1.12	1	953012	SuperSting/GPS adapter cable
1.13	1	953114	Marine Log Manager software including the Administrator utility software and hardware key (dongle).
1.14	1	951019	Test cable used to test the electrode switches
1.15	1	951018	Kit of fuses comprising: one 20 Amp, 1x1/4", one 1 Amp 250V 5x20 mm and one 2.5 Amp 250 V 5x20 mm fuses
1.16	1	920026	Allen wrench, 9/64"
1.17	1	951004	Instruction manual

The following accessories may or may not be included in your shipment:

2	1	911903	Heavy duty carrying case for the *SuperSting*, protects the *SuperSting* during transportation
3	1	920034	Carry harness for the *SuperSting*, protects the instrument against dirt and scratches during measurement
4			Swift cable (active cable) with a number of patented "Dual Mode" electrodes for *SuperSting.*
4.1	1	SWITCHSERIAL#	Electrode switch serial number list
5			Switch box, if passive imaging cables are purchased
6			Set of passive imaging electrode cables
7	1		Electrode streamer for use with SuperSting Marine
8		920014	A number of stainless steel electrode stakes, length 18" by 3/8" diameter
9		920077	Electrode High Voltage Warning covers
10		920023	A number of non-polarisable electrodes
11		920219	A number of jumper cables to connect non-polarisable electrodes to the Dual Mode Swift electrodes
12	1		Kit for programming addresses into the programmable smart electrodes
13	1	951063	Serial/USB adapter, to be used with computers which only have USB port
14	1	951209	SuperSting Remote, for remote monitoring and scheduling of resistivity surveys over the internet.
15	1	944004	AGI EarthImager, resistivity/IP 2D inversion software.
16	1	944004	AGI EarthImager, resistivity/IP 3D inversion software.

2.6 The SuperSting

The SuperSting is available as an eight (SuperSting R8/IP) or single channel (SuperSting R1/IP) earth resistivity meter.

The single channel instrument has one receiver. Thus, for each current injection, the potential can only be measured between two electrodes. Therefore, when using a single channel instrument only four electrodes, two for current and two for potential, are used for each measurement.

The 8-channel instrument has eight receivers. Therefore, for each current injection the potential between nine electrodes can be measured simultaneously, thus speeding up the measurement process.

Both instruments are multi-electrode systems, entailing a large number of electrodes, typically 20 – 100 (virtually no upper limit on how many electrodes), be laid out and connected to the instrument.

There are two types of electrode switching systems; the distributed switching system and the central switching system.

In the distributed switching system, the actual switching happens at each electrode. The instrument assigns which electrode shall be the current and which shall be the potential. The advantage is that the cable, connecting all the electrodes, only needs to have two leads for signaling to the electrodes, two for the current electrodes, and one for each of the potential electrodes. In the distributed system the electronic detection and switching circuit is molded into special take-outs along the cable. This type of cable is also referred to as an active cable.

In the central switching system the electrode switching typically happens at the instrument. For this method, there is one lead for each electrode connected to the central switching unit. Central switching systems use cables which are similar to seismic type cables, but with different specification. These types of cables are referred to as passive cables.

The SuperSting can use both distributed and central switching systems.

The SuperSting instruments are mainly designed for resistivity imaging, using an active electrode cable with the automatic dual mode electrodes or using a switch box and passive electrode cable for resistivity imaging. Some SuperSting models has built-in electrode switching. The SuperSting can also be used as a standard resistivity IP instrument for profiling and sounding (VES) with four “manual” cable reels and electrode stakes.

The following models of SuperSting are available:

SuperSting R8/IP	Our basic 8-channel instrument
SuperSting R8/IP+28	Our basic 8-channel instrument with built-in central switching for 28 electrodes.
SuperSting R8/IP+56	Our basic 8-channel instrument with built-in central switching for 56 electrodes.
SuperSting Marine	Our 8-channel instrument specially adapted for continuous resistivity profiling (CRP) in water. This model can also be used on land like the SuperSting R8/IP.
SuperSting R1/IP	Our basic single-channel instrument
SuperSting R1/IP+28	Our basic single-channel instrument with built-in central switching for 28 electrodes.

SuperSting R1/IP+56 Our basic single-channel instrument with built-in central switching for 56 electrodes.

SuperSting R1/IP+84 Our basic single-channel instrument with built-in central switching for 84 electrodes.

SuperSting R1/IP+112 Our basic single-channel instrument with built-in central switching for 112 electrodes.

2.7 Swift the patented (patent 6,404,203) Dual Mode automatic electrode system

The Swift dual mode electrode system for SuperSting is an automatic distributed switching system, which comprises a number of electrode switches molded on to a special Swift SuperSting cable. The cable plugs directly into the SuperSting and no external switch box is needed.

The Swift system comes in two models, the Swift R1 for the single channel instrument and the Swift R8 for the 8-channel instrument. The two systems looks similar but the Swift R8 has a somewhat larger diameter cable, different internal switching and a different connector since it contains more leads.

The number of automatic electrodes which can be used with the SuperSting is virtually unlimited. Theoretically over 65000 electrodes can be addressed.

The Swift system is a distributed switching system in the sense that the actual switching of the electrodes happens at the electrode itself. Each electrode in the system has a unique number, or address, which is used by the SuperSting to control the operations of the electrodes. Therefore the SuperSting can set a certain electrode to be for example the A current electrode by addressing the switch by its number.

The unique advantage with the Swift, Automatic Dual Mode electrode system is:

1. Dual Mode capability makes it possible to use non-polarisable electrodes to measure voltage potential during automatic measurements. This is especially valuable for IP measurements. Since this feature is patented (patent 6,404,203), it is only available with AGI equipment.
2. All dual mode electrodes can have their addresses re-programmed without having to open them up. This is done with the Swift re-programming kit (for Swift R8 part #951010, for Swift R1 part #921001). This feature is important, for example, if one wants to use a Swift for SuperSting cable set from another user. The electrode addresses can then be re-programmed so that the electrode addresses are in consecutive order. Another case is if an electrode needs to be replaced by a spare electrode. The spare electrode is then quickly re-programmed and placed in the faulty electrodes position.

2.8 Switch box systems

The SuperSting can also be used with different size switch boxes and passive electrode cables.

The switch box system is a central switching system in the sense that the actual switching of the electrodes happens at a central location, i.e. at the switch box. Each electrode in the system has a specific lead in the cable attaching it to the switch box. The switch box can switch any electrode to any function, A, B, M or N.

The switch boxes currently come in the following electrode switching capability; 28, 56, 64, 84 and 112 electrodes. Several switch boxes can be daisy chained together for virtually infinite electrode switching capacity.

Note that switch boxes for SuperSting R8 and R1 are different. You can use an R1 switch box with a SuperSting R8 instrument, however the measurements will only be performed in single channel mode and thus be slower. An R8 switch box can not be used with a SuperSting R1 instrument.

SuperSting R1/IP+28, SuperSting R1/IP+56, SuperSting R8/IP+28 and R8/IP +56 has built-in switch capability for 28 respectively 56 electrodes. SuperSting +28 can be upgraded to SuperSting +56, but needs to be sent to AGI for the upgrade.

3 Quick start

This chapter presents information to help you get started quickly if you are already somewhat familiar with earth resistivity meters and methods.

The SuperSting can be used in two basic modes**.**

1. In automatic mode with the Swift for SuperSting automatic dual mode electrodes or with a switch box and passive cables. In this mode the SuperSting R8/IP can take up to 8 simultaneous readings for each current injection (1 reading/current injection for the SuperSting R1).
2. In manual mode with four cable reels and electrode stakes attached to the four banana connector terminals, marked A, B, M and N, on the front panel. In this mode the SuperSting R8/IP and R1/IP can take one reading for each current injection.

3.1 Automatic mode for resistivity/IP imaging surveying

The automatic mode is used to automatically record resistivity and IP data using a preprogrammed command file and the distributed Swift automatic multi-electrode system or the central switch box system with passive cable. The SuperSting system is used to collect large amounts of field data for resistivity and IP imaging. Below follows a complete step-by-step guide on how to collect and present resistivity/IP imaging data.

3.1.1 Treat the cables well and you will get good data

The Swift cables with the fixed cylindrical stainless steel switches as well as the passive cables are a sensitive part of the system. Therefore it is important to handle them carefully. Here are some rules handling the cables.

- Under no circumstances drag the cable on the ground. Bring the cable box along the profile alignment and lay out/take in the cable directly from/to the box.

- Carefully coil the cable into the box. Lay the cable coils down either with the cable end over the loop or under the loop, as the cable wants to lie.

- Make sure not to coil the cable in “tight turns”, since this will cause undue stress on the cable possibly breaking the seal to the switches or damaging the leads.

- Make sure that the connectors are always **clean and dry**. Always use the dust caps when the connectors are disconnected (dirty connectors is one of the main reasons for noisy data).

- Only special underwater cables can be used to be submerged in water (contact AGI for information on these cables).

3.1.2 How to set up the SuperSting system for an automatic field survey

The complete field system consists of:

1. The SuperSting instrument console.
2. Swift cables with a number of addressable dual mode switches or one or several switch boxes with passive electrode cables.
3. Stainless steel electrode stakes.
4. Electrode High Voltage Warning Covers.

The SuperSting uses one (normal mode, 100 Watt) or two (booster mode, 200 Watt) 12 V DC batteries. Make sure that the batteries are fully charged at the start of the day.

Note that you must be connected to a battery when you perform measurements. It does not work to try measurements with the office power supply. The reason is that the office power supply is not powerful enough to power the SuperSting transmitter.

3.1.2.1 Field preparation

- Start by stretching a tape measure along the profile line.
- Place the stainless steel electrode stakes in the ground at the predetermined spacing.
- Lay out the Swift cable (or the passive cable). Drop one switch (or take-out) at each stake. Note that the switches are numbered. The switch number is marked on the cable beside each electrode switch. If several cables are used, **it is important to lay out the cables in the correct order so that the switches (take-outs in the case of passive cables) are numbered consecutively** i.e. 1, 2, 3.....27, 28.....

- Using the stainless steel springs, fasten each switch/take-out to its electrode making sure that there is metallic connection between the switch and the electrode stake.
- Put the Electrode High Voltage Warning Covers over the electrode switch and secure with the Velcro straps.

Figure 2 Attach the electrode switch to the stake by using the stainless steel spring

3.1.2.2 Connecting the instrument

- The SuperSting is powered by either one or two 12 V DC external batteries attached to the connector marked “Power”. Note that the high power transmitter mode is only achieved if two external 12 V batteries are used.
- The system is now laid out and ready for measurement after the SuperSting has been set up.
- Turn the SuperSting on.
- After making sure that the electrode line is clear and under observation so that no humans or animals can come into contact with the electrodes. Attach the electrode

cable end connectors to the SuperSting (to the switch box or SuperSting with built in switching in case of passive cables) where marked "Connectors for Electrode Cables".

- When using the dual mode Swift system with the SuperSting, the instrument can be connected at either end of the cable lay-out; however it is preferred to connect the instrument in the middle. By connecting in the middle, the effect of voltage drop in the cables is minimized. When using the SuperSting with switch box and passive system it is necessary always to put the instrument with switch box in the middle of the electrode spread, except for passive systems with 28 electrodes, where the instrument is connected in either end of the electrode cable.

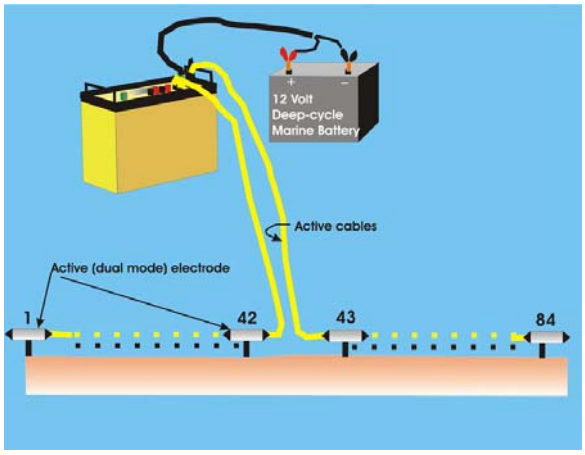


Figure 3 SuperSting set-up with active (dual mode) electrodes

3.1.2.3 Setting up the instrument for use with Swift dual mode electrodes

In the following we assume that an appropriate command file has been created and loaded into the SuperSting RAM memory. For information on how to load a command file into the SuperSting see section 6.4. We also assume that an accurate cable section table has been entered in menu 6/2, see section 5.1.6.2, this is important in case a roll-along survey will be performed.

- Select 1 from the main menu to prepare for an automatic survey.
- On Menu 1 select 2 Create data file.
- Press 1 to enter a name for the new file, maximum 8 characters. To enter letters select the first, second or third letter on the key by first pressing F1, F2 or F3. For example to enter the word STING press F1 1, F2 1, F3 9, F2 5, F1 9. Press Enter after the file name is spelled.
- Select the appropriate command file for the survey. Use + or – to scroll up and down in the list of command files.
- Select unit used, plus or minus key will select feet or meter.
- Enter Electrode spacing (Scaling factor). Note that if you have created the command file with electrode spacing=1 (default setting if you created the command file using the Administrator software), you shall at this point enter the electrode spacing you are actually using.
- Enter x-, y- and z-coordinates for the first electrode of the line. Note that the z-coordinate shall always be 0 unless it is placed underground. Exception is for electrodes placed on the bottom of a lake, where the z-coordinate is also entered as 0. Terrain elevation and water depth is entered in a separate file during the data processing stage.
- Enter Start command line=1. This simply means that the SuperSting will start at the first command line in the command file. If you would like to start at a point other than line 1 in the command file you can enter that line number here.
- Enter Y(es) or N(o) for Roll-along, using + for Yes and – for No. Roll-along is the survey technique where you advance forward along the measurement profile by moving your electrode cable sections in a leap-frog way. This method is used when

the survey line is longer than the electrode cable. When roll-along is selected, the instrument expects you to move the cable sections as specified on menu 6/2. Note that all data will end up in one continuous data file when performing roll-along surveys.

- Sometimes a line ends up against some obstacle, like a building or a fence etc. so that the last electrodes cannot be used. If this is the case, please enter the last electrode to be used at End address=
- Note that in case you enter erroneous x-, y-, z-coordinates, Start command line, Roll-along or End address, you can correct them later on menu 1 option 3. “Edit survey information” before you start the actual measurement.
- Press any key to get to continue.
- In case pole-pole or pole-dipole array is used, you will get a chance to enter the position of the infinite electrode at this point. If any other array, you will continue the setup. Again the z-coordinate is entered as 0 in all cases except when it is underground.
- Press ENTR to continue setup or press MEN to exit setup. The following setup is most likely from one survey line to another. Therefore if this is the second line the following setup has already been set and you can then exit by pressing the MEN key. If this is the first line press ENTR to continue setup.
- Select 1. Switch box if you are using switch box/boxes or built in switches and select 2. Distributed if you are using dual mode electrodes (smart electrodes).
- If you are using a SuperSting R8/IP, you will now get a choice of cables/switch boxes you are using. You can use R1 switch boxes and R1 dual mode electrodes with the SuperSting R8/IP, but you can not use R8 switch boxes and R8 dual mode electrodes with the SuperSting R1/IP.
- If you are using one or more switch boxes you will now get a chance to enter the type of switch box/boxes you are using. Press 1 to add a switch box and use plus or minus to scroll among the different switch boxes. When done press MEN to continue.
- At this point you need to enter the electrode cable sections used. For example, if you have a cable of 28 electrodes, which is divided into four sections with 7 electrodes each you should enter sections; 1-7, 8-14, 15-21 and 22-28.This cable address table is then used by the instrument to perform roll-along. When finished press the MEN key.
- Next setup is the measurement settings. For a reasonable good setting under most conditions, select the factory default setting by pressing the 9 key until the word FACTORY appears. Then press the MEN key.
- The contact resistance test menu will appear. Make sure that the Start and End address of the first and last electrode to be tested is entered. The test is started by pressing the F1 key.
- The instrument is now ready to start measuring. After once again having made sure that the line is clear press the MEA key to start the actual measurement.
- If the roll-along mode is selected the instrument will stop when ready and display the message “ENTR to continue roll-along”. When you press the ENTR key the instrument will display a short message “Shutting off power to move instrument and cables” for a few seconds and then power down.
- Move the appropriate electrode section and turn on the instrument when done. Press the 1-key for Automatic mode measurement and then press the MEA-key. The

instrument will now display “ENTR to continue roll-along”. Press ENTR to confirm that you still want to continue roll-along or press MEN to end the survey.

- The new Start coordinate for the first electrode will appear if you press ENTR. If this is the correct coordinate press ENTR. You will also have a chance to enter the address of the last electrode to be used in case your line ends up against some obstacle and all electrodes cannot be used. After you enter the last information the SuperSting will automatically start measuring.

3.1.2.4 Setting up the instrument for use with switch box and passive cables

When using a passive system, the instrument should, except for the 28 electrode passive system, always be placed in the middle of the electrode spread. When using a 28 electrode passive system, the instrument should be connected at either end of the electrode spread.

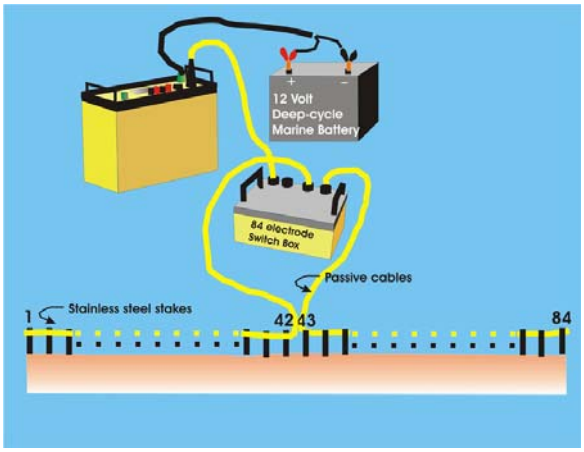


Figure 4 SuperSting set-up with external switch box and passive cables

- Select 1 “Automatic Mode” from the main menu to prepare for an automatic survey.
- On Menu 1 select 2 Create data file.
- Enter a name for the new file, maximum 8 characters. To enter letters select the first, second or third letter on the key by first pressing F1, F2 or F3. For example to enter the word STING press F1 1, F2 1, F3 9, F2 5, F1 9. Press Enter after the file name is spelled out.
- Select the appropriate command file for the survey. Use + or – to scroll up and down in the list of command files and press “ENTR” to select the command file.
- Select unit used, plus or minus key will select feet or meter.
- Enter Electrode spacing (Scaling factor). Note that if you have created the command file with electrode spacing=1 (default setting if you created the command file using the Administrator or the EarthImager software), you shall at this point enter the electrode spacing you are actually using.

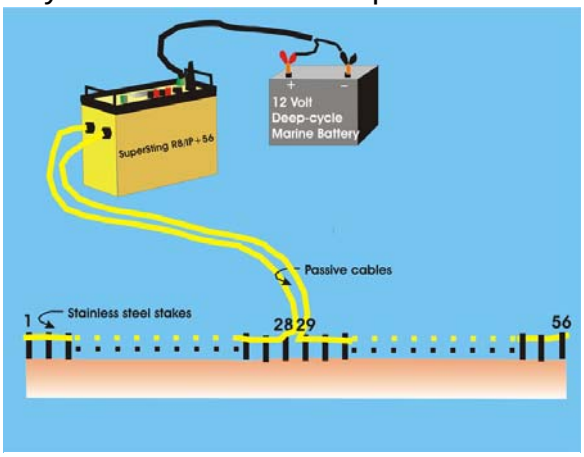


Figure 5 SuperSting set-up with built-in switch box and passive cables

- Enter x-, y- and z-coordinates for the first electrode of the line. Note that the z-coordinate shall always be 0 unless it is placed underground. Exception is for electrodes placed on the bottom of a lake, where the z-coordinate is also entered as 0. Terrain elevation and water depth is entered in a separate file during the data processing stage.
- Enter Start command line=1. This simply means that the SuperSting will start at the first command line in the command file. If you would like to start at a point other than

line 1 in the command file you can enter that line number here. The number after the /xxx indicates the total number of command lines in the selected command file.

- Enter Y(es) or N(o) for Roll-along, using + for Yes and – for No. Roll-along is the survey technique where you advance forward along the measurement profile by moving your electrode cable sections in a leap-frog way. This method is used when the survey line is longer than the electrode cable. When roll-along is selected, the instrument expects you to move the cable sections as specified on menu 6/2. Note that all data will end up in one continuous data file when performing roll-along surveys.
- Sometimes a line ends up against some obstacle, like a building or a fence etc. so that the last electrodes cannot be used. If this is the case, please enter the last electrode to be used at End address= . The SuperSting will not use the electrodes passed this address number and the electrodes can therefore safely be put to the side.
- Note that in case you enter erroneous x-, y-, z-coordinates, Start command line, Roll-along or End address, you can correct them later on menu 1 option 3. “Edit survey information” before you start the actual measurement.
- In case pole-pole or pole-dipole array is used, you will get a chance to enter the position of the infinite electrode at this point. If any other array, you will continue the setup. Again the z-coordinate is entered as 0 in all cases except when it is underground.
- Press ENTR to continue setup or press MEN to exit setup. The following setup is most likely the same from one survey line to another. Therefore if this is the second line the following setup has already been set and you can then exit by pressing the MEN key. If this is the first line press ENTR to continue setup.
- Select 1. Switch box if you are using switch box/boxes or built in switches.
- If you are using a SuperSting R8/IP, you will now get a choice of cables/switch boxes you are using, i.e. Eight Channel (R8) or Single Channel (R1). You can use R1 switch boxes and R1 dual mode electrodes with the SuperSting R8/IP, but you can not use R8 switch boxes and R8 dual mode electrodes with the SuperSting R1/IP.
- If you are using one or more switch boxes you will now get a chance to enter the type of switch box/boxes you are using. Press 1 to add a switch box and use plus or minus to scroll among the different switch boxes. When done press MEN to continue.
- At this point you need to enter the electrode cable sections used. For example, if you have a cable of 56 electrodes, which is divided into four sections with 14 electrodes each you should enter sections; 1-14, 15-28, 29-42 and 43-56.This cable address table is then used by the instrument to perform roll-along. When finished press the MEN key.
- Next setup is the measurement settings. For a reasonable good setting under most conditions, select the factory default setting by pressing the 9 key until the word FACTORY appears. Then press the MEN key.
- The contact resistance test menu will appear. Make sure that the Start and End address of the first and last electrode to be tested is entered. The test is started by pressing the F1 key. Press the MEN key when the contact resistance test is satisfactorily finished.

- The instrument is now ready to start measuring. After once again having made sure that the line is clear, press the MEA key to start the actual measurement.

3.1.2.4.1 Roll-along survey

At times the survey line is longer than the available electrode spread, i.e. number of electrodes less one, times the electrode spacing. If the electrode cable is divided into sections and each section has connectors in each end, the surveyed line, after the original data has been recorded, can be extended by moving the first electrode cable section and electrodes to the end of the cable. Data for each “roll” is then recorded and added to the previous data into one complete data file. This type of survey is called “roll-along survey”. By using this technique a survey line can be extended indefinitely.

Roll-along surveys can be performed using both passive and active electrode systems and can also be performed both in 2D and 3D surveys.

Note that when using active cables (dual mode electrodes) the instrument can be placed at any location along the line, even though it is to prefer to be near the middle of the line. This is so that the signal which decreases with distance from the instrument will have shortest possible distance to either end electrode.

However when using the passive electrode system with switch box or built-in switches, it is absolutely necessary to locate the instrument in the middle of the electrode spread. That is so that equal number of electrodes is on each side of the instrument. This rule is valid with one exception, when using a switch box for 28 electrodes the instrument has to be connected to one of the ends of the electrode cable.

3.1.2.4.1.1 Roll-along in 2D sureys

The order and number of electrodes to move during a roll-along survey is specified in the “Cable Addresses Setup” table on menu 6/2 in the SuperSting.

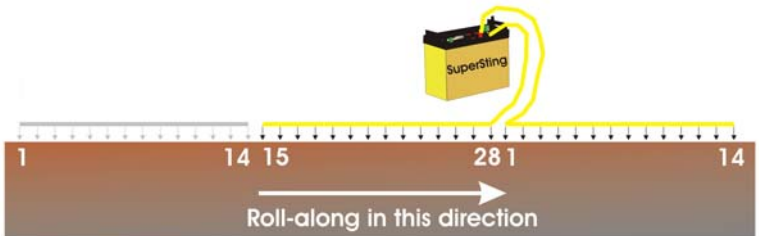


Figure 6 Data is first collected using cable section 1-14 and 15-28 to the left in the picture. After the initial data is recorded cable section 1-14 is moved to the right and connected to the SuperSting which also has been moved forward

- During the set-up prior to survey, the option to perform roll-along is selected. If the roll-along mode is selected the instrument will stop when ready and display the message “ENTR to continue roll-along”. When you press the ENTR key the instrument will display a short message “Shutting off power to move instrument and cables” for a few seconds and then power down.
- Move the appropriate electrode section and turn on the instrument when done. Press the 1-key for Automatic mode measurement and then press the MEA-key. The instrument will now display “ENTR to continue roll-along”. Press ENTR to confirm that you still want to continue roll-along or press MEN to end the survey.
- The new Start coordinate (physical location) of the first electrode will appear if you press ENTR. If this is the correct location press ENTR. You will also have a chance

to enter the address (electrode number) of the last electrode to be used in case your line ends up against some obstacle and all electrodes cannot be used. After you enter the last information the SuperSting will automatically start measuring.

3.1.2.4.1.2 Roll-along in 3D surveys

Roll-along surveys can also be performed during 3D surveys. However, roll-along can only be performed in the X-direction and the cable needs to be laid out back and forth in the Y-direction (see figure 7).

Note that the cable has to be laid out in such a way that the connectors allow roll-along with an even number of "electrode columns" at a time (i.e. 2, 4 etc.).

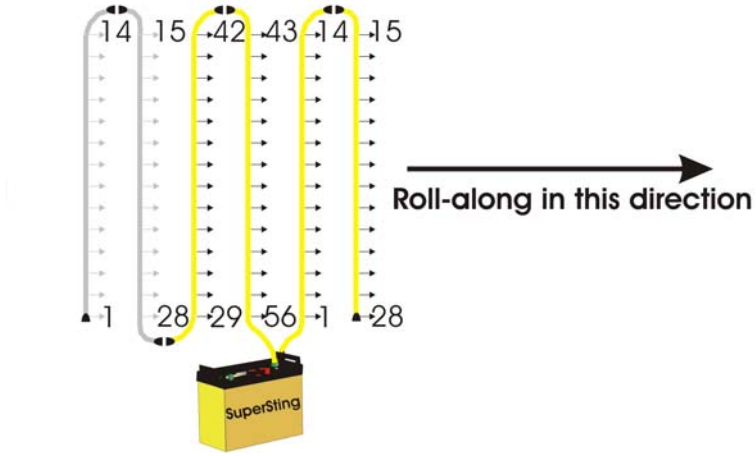


Figure 7 Data is first collected using cable section 1-28 and 29-56 to the left in the picture. After the initial data is recorded, cable section 1-28 is moved to the right and connected to the SuperSting which also has been moved forward

3.1.2.5 Downloading data

After the survey is done you can safely turn off the instrument and disconnect the external battery to transport it to a place where you can download the data.

To download the data:

- Connect the SuperSting to a Windows type computer using the "Cable for communication *SuperSting*/PC MS Windows type computer" (part number 951002).
- Connect the cable to the serial port on the computer and to the SuperSting front panel connector marked "PC SERIAL COM." On the SuperSting R1 marked "PC SERIAL COM 1".
  Note: If your computer only has USB ports, you will need an USB/serial adapter. We recommend the use of the Keyspan model USA-19HS. This adapter is available from AGI.
- Turn the instrument on.
- Press any key to get to the main menu. Note that you must be in the main menu or the first level submenu when connecting to the computer.
- Start the Administrator for SuperSting software.
- Under Window on the computer menu bar select the "SuperSting control center".
- Under Config on the computer menu bar select the appropriate COM port.
- Click on the "Connect" button. Green light, between the connect and disconnect buttons, will now indicate that the connection is established. Available command files and data files in the SuperSting will also be listed in the respective windows on the computer screen.
- In the "Data files" window select the data file to download by right clicking on the file name. Click on "Read File" and select where to save the file.

- When the transfer is finished a sign with the text “Selected measure file read from instrument. File set saved as: .....”. Click OK.
- Click on the Disconnect button to disconnect the SuperSting from the Administrator.

3.2 Manual mode for resistivity and IP surveying

The manual mode is used for recording data using four wire reels and four electrode stakes. The stakes are moved for each measurement.

Note that you must be connected to a battery when you perform measurements. It does not work to try measurements with the office power supply. The reason is that the office power supply is not powerful enough to power the SuperSting transmitter.

Proceed as follows:

Connect four ground electrode stakes to the current (A and B) and potential (M and N) terminals on the instrument front panel.

With a 12 V battery connected, turn the instrument on by flipping the ON/OFF (I/O) switch towards the ON (I) position. The instrument will come on and after a few seconds display the main menu.

Before you start measuring, you need to set a few parameters, which will stay the same for the whole survey.

1. Press the number 6 key for “System settings” and then the 1 key for measurement settings.
2. Press the number F2 key until FACTORY is displayed. All factory defaults are now set. Make any changes to the factory defaults as you wish.
3. After you have made your changes you can save your own default settings by pressing the F3 key.
4. When finished press the menu key twice to get back to the “Main menu”.
5. Press the number 2 key to get to the “Manual mode “menu. From the supported configurations, select the array type (electrode configuration) you are going to use. The chosen configuration will now remain in effect until changed.
6. Press the 2-key to create a data file to store the data in.
7. Press the 1 key to enter the file name. Letters or numbers can be used for the file name, maximum 8 characters.
8. Note that you can not change electrode configuration for the same data file. For example if your data file is named Sound1, you can not store both Schlumberger and Wenner soundings in the Sound1 data file, only one of them.
9. Enter the appropriate electrode geometry.
10. You are now ready to start measuring, check that the line is clear and no one is touching the stakes.
11. Press the MEA key to take the reading. The measurement result is displayed on the LCD screen.
12. Measured data will automatically be stored in the memory and can later be downloaded to a computer using the down load module of the Administrator software. If the displayed error σ is too large, you may want to repeat the measurement or you

may want to increase the output current (go to menu 6/1 to change the current) and measure again.

13. When the measurement is ready, move the stakes to a new location, enter the new geometry, check that the line is clear and press MEA again.

4 Your SuperSting, memory earth resistivity and IP instrument

The SuperSting is a rugged, weatherproof instrument for earth resistivity and induced polarization (IP) fieldwork. One or two external 12 V DC batteries power the SuperSting. The SuperSting R8/IP features a built in 8-channel receiver and a transmitter.

With the optional automatic multi-electrode system, the Swift, automatic measurement of any array type can be performed.

4.1 Getting to know the SuperSting

The SuperSting is a memory earth resistivity instrument. The controls, the display and the connectors are all located on the front panel.

Figure 8 SuperSting R8/IP front panel

1. Power connector.
2. Fuse holder.
3. O/I (OFF/ON).
4. Night light, used to illuminate the display during poor light conditions.
5. Connector for optional external transmitter (only on SuperSting R8/IP).
6. Indicator light for main and booster mode (on SuperSting R1 there is no indicator light for the booster mode).
7. Connectors for communication with optional external transmitter, also used for firmware upload (only on SuperSting R8/IP).
8. Liquid crystal display (LCD) window with 16 text lines of 30 characters each.
9. Keyboard.
10. Connectors for Swift cable 1 and 2 or to connect one or two switch boxes.
11. Positive and negative current terminals (A and B). For use with banana connectors or stripped wire.
12. Positive and negative potential terminals (M and N). For use with banana connectors or stripped wire.

13. Test terminal for use with banana connector or stripped wire (only on SuperSting R8/IP).
14. Connector used for serial communication with a PC, used for data download and command file upload.
15. On SuperSting R8/IP connector for future development. On SuperSting R1/IP connector for firmware upload.

4.1.1 Power connector

One or two external 12 V DC batteries power the instrument. The batteries are connected to the instrument front panel connector by the special power cable delivered with the instrument. The power cable has a pig-tail connector for the boost battery.

Main mode, the instrument is powered by one 12 V battery and the instrument operates in the range 0-100 Watt, the Main indicator light is on.

Boost mode, the instrument is powered by two 12 V batteries and the instrument operates in the range 0-200 Watt, the Main and Boost indicator light is on (there is no Boost indicator light on the SuperSting R1).

Office mode, when the instrument is used in an office environment it is powered by a Power Supply delivered with the instrument. The Power Supply is connected to the mains (100-250 V AC at 50-60 Hz input power) and the front panel connector marked “Power”. To turn the instrument on in this mode use the ON/OFF switch on the Power Supply. Note that the front panel ON/OFF switch will not work when the instrument is powered by the Power Supply.
In this mode the processor is working but the transmitter is unable to transmit any current and the instrument is therefore not able to take any readings. Downloading of data, uploading of command files and instrument firmware is possible in this mode.

Figure 9 Office power supply

4.1.2 Fuse holder

The main fuse holder is located on the front panel of the instrument. The fuse is a 20 Amp/32 V, 1 ¼”x ¼” fuse.

4.1.3 ON/OFF

When the battery is attached, turn the instrument on, by turning the I/O (On/Off) switch to the I (On) position. The following message will be displayed:

```
Advanced Geosciences, Inc.
        SuperSting

     Hardware initializing
```

After a short moment the main menu will replace the text.

The instrument can be turned off at any time and will keep its current settings until it is turned on again. Data in the memory will not be lost when the instrument is shut off or disconnected from the battery.

Note that the instrument, in order to save battery, as default will automatically shut off if no keyboard action has been detected for 5 minutes. The automatic shut off function will cause no loss of data or instrument setting. The automatic shut off function can be disabled or the time setting can be changed on menu 6/4/1. The shut off time can be set for any time between 1-60 minutes.

4.1.4 The Keyboard

Figure 10 The keyboard

The keyboard has 20 tactile keys.
Alphanumerical keys are used to enter letters and numbers and to select options on the different menus. To enter letters select the first, second or third letter on the key by first pressing F1, F2 or F3. For example to enter the word STING press, F1 1, F2 1,F3 9, F2 5 and F1 9.
The menu key is used to go up one step in the menu system.
The function keys, F1, F2 and F3 are used to select certain functions.
The measure key, marked MEA is used to start the measurements.
The combination contrast adjustment key and back space key is located in the top right corner of the keyboard. The LCD is sensitive for temperature and may turn pale or too dark with change of ambient temperature. To adjust the contrast to a suitable level, press the contrast key repeatedly.
The enter key is used to enter or select data.

4.2 The power supply

The power supply is used when the SuperSting is used in an office environment, for example connected to a PC for data download, command file upload or flash memory upload. The power supply was delivered with the instrument. It can handle 100-250 V AC at 50-60 Hz input power.

The power supply has an ON/OFF switch, which is used to turn on and off the SuperSting when the instrument is powered by the power supply. Note that the ON/OFF switch on the SuperSting front panel does not work when the instrument is powered in this manner.

4.3 SuperSting files

There are five types of files associated with the SuperSting.

1. The firmware software with extension .agi
2. The command files with extension .cmd
3. The data files with extension .stg
4. Calibration file with extension .cal
5. Contact resistance file with extension .crs
6. Binary file with extension .bin

5 Menu system and operational settings

When the instrument is powered up using the power supply it will display the following message:

```
Advanced Geosciences
Super Sting

Hardware Initializing

TRANSMITTER OFFLINE!!!
Press any key to continue
```

By pressing any key the instrument will display the Main menu.

5.1 Main menu

Enter a number from 1 to 7 in the "Select mode:" field to go to any of the seven sub-menus.

To return back to the main menu from any submenu, press the MEN key.

Notice that all submenus have the menu number in the upper left hand corner, for example M54 means submenu 4 of submenu 5.

```
       AGI SUPER STING
Date: 20050713 Time: 21:13:15

1. Automatic mode
2. Manual mode
3. Test mode
4. Log settings
5. File management
6. System settings
7. System information

Select mode:
Current method: RES
Battery voltage:
```

5.1.1 The Automatic mode menu

Press 1 on the main menu to perform an automatic resistivity survey.

5.1.1.1 Select data file

Press 1 to select data file. Then move the cursor, using the + and – key, among the available data files and press the ENTR key to make your selection.

If no data file is created the message "No data files available!!" will be displayed.

```
M1    Automatic Mode

1. Select data file
2. Create data file
3. Edit survey information

Command file:
Data file:
Scaling factor:
x=  0.0m  y=  0.0m  z=  0.0m
Command line #:1
Roll-along: Y

MEA: Start measurement

MEN: Up level
```

5.1.1.2 Create data file

Note that there has to be at least one command file available when a new data file is created. To see how to load command files see section 6.4.

Menu 1/2 is used to create a new data file. Type in a unique data file name with no more than 8 alphanumeric characters and then press the ENTR key.

To enter letters select the first, second or third letter on the key by first pressing F1, F2 or F3. For example to enter the word STING press, F1 1, F2 1,F3 9, F2 5 and F1 9.

After entering the file name, select and enter the command file to be used.

5.1.1.3 Edit survey information

This menu offers an opportunity to edit the survey information after they have been entered.

```
M13   Edit Survey Information

1. Start X=0.00   m
2. Start Y=0.00   m
3. Start Z=0.00   m
4. Start command line # :
               1     /25

5. Roll-along=Y
6. End address= OFF
7. Advance roll-along:
7. Advance roll-along

MEN: Up level
```

5.1.2 The Manual mode menu

The SuperSting currently supports the following manual electrode arrays: resistance, Schlumberger, Wenner, dipole-dipole, pole-dipole and pole-pole. The SuperSting R1 also supports SP Absolute and SP Gradient.

By selecting 2 on the main menu, the option to select any of these array types appear. Press any of the keys 1-6 (1-8 on SuperSting R1) to select the appropriate array.

Note that you must be connected to a battery when you perform measurements. It does not work to try measurements with the office power supply. The reason is that the office power supply is not powerful enough to power the SuperSting transmitter.

```
M2    Manual Mode

1. Resistance
2. Schlumberger
3. Wenner
4. Dipole-dipole
5. Pole-dipole
6. Pole-pole

Select array:

MEN: Up level
```

Before selecting an electrode array on menu 2 (options 1 – 6 for SuperSting R8) and (options 1 – 8 for SuperSting R1) you must create a data file on menu 1, 2 “Create data file". The reason is there must be a data file where the data can be stored. Note that you can not change method for the same data file. For example if your data file is named Sound1, you can not store both Schlumberger and Wenner soundings in the Sound1 data file, only one of them.

Settings like number of cycles, max current, measure time etc. is set up on menu 6/1 prior to starting the manual survey.

5.1.2.1 Resistance

When selecting the resistance array, the V/I value is measured and displayed. No correction for the electrode geometry is given and apparent resistivity is not calculated.

```
M21   RESISTANCE

1. Select data file:LINE1
2. Create data file
3. X =  0.000  m
4. Y =  0.000  m

Resistance:
Standard deviation:
Cycles:
Current:

MEA: Start measurement
MEN: Up level
```

There is an option to select the data file where the data is going to be stored, usually the same data file will be used for data from the same location, line etc.

A new data file can also be created using option #2. This is useful when the first measurement at a new location is taken.

Finally the x and y location of the measurement is entered. Pressing the MEA key starts the measurement.

5.1.2.2 Schlumberger

Enter Schlumberger configuration on Menu 2 by pressing 2. Select or create a data file the first time a new measurement is taken at for example a new sounding or a new line.

```
M22   SCHLUMBERGER

1. Select data file:LINE1
2. Create data file
3. AB/2 =  0.000  m
4. MN/2 =  0.000  m

Apparent res:
Vin:
Standard deviation:
Cycles:
Current:
MEA: Start measurement
MEN: Up level
```

The previously used AB/2 distance (half the distance between the current electrodes) and the previously used MN/2 distance (half the distance between the potential electrodes) is displayed. Type the new AB/2 value and press enter. If you like to keep the old MN/2 value just proceed to press the MEA key to start the measurement. If you would like to enter a new MN/2 distance just type the new value and press enter.

5.1.2.3 Wenner

Enter Wenner configuration on menu 2 by pressing 3. Select or create a data file the first time a new measurement is taken at for example a new sounding or a new line.

The previously used Wenner spacing a, the distance between the electrodes, is displayed. Type the new a-value and press enter. Proceed to press the MEA key to start the measurement.

```
M23   WENNER

1. Select data file:LINE1
2. Create data file
3. a =  100.0 m

Apparent res:
Vin:
Standard deviation:
Cycles:
Current:
MEA: Start measurement
MEN: Up level
```

5.1.2.4 Dipole-dipole

Enter dipole-dipole configuration on menu 2 by pressing 4. Select or create a data file the first time a new measurement is taken at for example a new sounding or a new line.

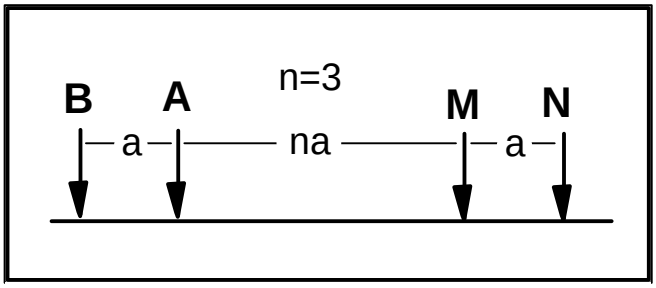


Figure 11 Dipole-dipole electrode array

The previously used parameters are displayed. Enter the new a, n and B_{pos} electrode position values. B_{pos} is the position of the B electrode along the survey line. If you want to keep for example the a and B_{pos} position values, just change the n value. Proceed to press the MEA key to start the measurement.

5.1.2.5 Pole-dipole

Enter pole-dipole configuration on menu 2 by pressing 5. Select or create a data file the first time a new measurement is taken at for example a new sounding or a new line.

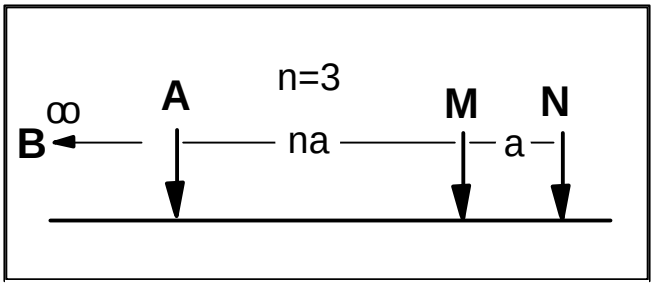


Figure 12 Pole-dipole electrode array

The previously used parameters are displayed. Enter the new a, n and AB distance values. If you want to keep for example the a and AB distance, just change the n value. Proceed to press the MEA key to start the measurement.

5.1.2.6 Pole-pole

Enter pole-pole configuration on menu 2 by pressing 6. Select or create a data file the first time a new measurement is taken at for example a new sounding or a new line.

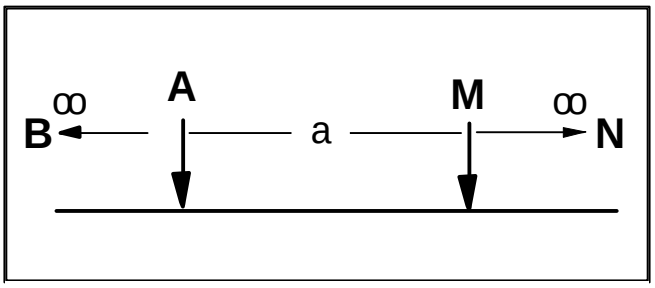


Figure 13 Pole-pole electrode array

The previously used parameters are displayed. Enter the new **a**, AN distance and AB distance values. If you want to keep for example the AN and AB distance, just change the **a-**value. Proceed to press the MEA key to start the measurement.

5.1.2.7 SP measurements

It is important to use non-polarisable electrodes when measuring SP.

Note that only the SuperSting R1/IP instrument model can measure SP, SuperSting R8/IP can not measure SP.

5.1.2.8 SP Absolute

The SP Absolute option is used when SP (self potential) shall be measured with one fixed base electrode. For each measurement enter the x- and y-coordinate for the moving non-polarisable electrode. This option is only available in the SuperSting R1/IP instrument.

5.1.2.9 SP Gradient

Use the SP Gradient option when the SP gradient (two moving non-polarisable electrodes) is measured. Enter a=electrode spacing when starting the survey and the x- and y-coordinate for the moving non-polarisable electrode array. This option is only available in the SuperSting R1/IP instrument.

5.1.3 The Test mode menu

The contact resistance test is used when performing automatic multi electrode surveys. It is always performed after the system is set up for survey and before the actual survey starts. It is performed to ensure that all electrodes are connected properly and the contact resistance reasonably low and even from electrode pair to electrode pair.

```
M3    Test Mode

1. Contact resistance test
2. Cable test
3. Receiver test
4. Relay test
5. Program address

MEN: Up level
```

The other tests are used to test specific parts of the system and are recommended to be used for example before and after a resistivity or IP project is started.

5.1.3.1 The contact resistance test

This test measures the contact resistance along the complete electrode cable layout. Enter the “Start address” (first electrode) and “End address” (last electrode) before starting the test by pressing F1.

When the test is started, the instrument will send out a current between the first two electrodes and at the same time measure the voltage between the same electrode stakes. Therefore, a value comprising of the contact resistance between the first stake and the ground, the resistance in the ground and the contact resistance between the ground and the second stake will be measured. This value is displayed on the instrument display and the test will continue between electrodes 2 and 3 and so on. If the electrode spacing is equidistant along the profile and near surface conditions are the same, one can expect similar ground/contact resistance along the profile. If near surface conditions change, for example from loose sand to moist clay, one can expect a change in contact resistance from higher values (loose sand) to lower values (moist clay) but values should stay similar within each unit.

Use this test to measure the contact resistance along the profile. If any of the measurements should show a significantly larger value, check that electrode pair to make sure it makes good contact to the ground and that the switch makes proper contact with the electrode stake. If the contact resistance is high because of local soil conditions, it usually helps to push the stake deeper into the ground and/or to pour some salt water on the ground where the electrode is planted. Be careful to avoid spilling water on the electrode switch or cable.

If the instrument stops, displaying an error code it typically means that the electrode switch is not connected to the stake (error code HVOVL) or that the stake is too loosely planted in the ground (error codes INOVL and TXOVL). In such cases the stake may seem to be properly planted but minute vibrations from traffic or wind may change the stake/ground contact resistance so that the error codes are issued.

After the electrode stakes have been inspected and corrected the contact resistance test is continued from where it was interrupted by pressing the F1 key. This will re-test the problem electrode pair; pressing F2 will skip the problem pair and continue.

5.1.3.2 The cable test

This test is only available for the SuperSting R8/IP instrument. Use this test to test the functioning of the Swift cable. The dual mode electrode switches comprises two parts. There is the large stainless steel take out used for current and potential measurement and there is the small banana jack take-out used for potential measurement (a small stainless steel cylinder take-out on the old style dual mode electrodes).

To test the large take-out on the cable:

- Connect the Swift cable to be tested to one of the two “ELECTRODE CABLE” connectors on the SuperSting front panel.

- Set the “Separate potential:” to OFF this will ensure that both current and potential are measured through the large take-out.
- Attach the test cable between the white banana connector on the SuperSting R8 front panel and clip the large test clamp over the large take-out of the first dual mode electrode to be tested. Do not connect the small banana plug (small test clamp for old type dual mode electrodes) and make sure to keep it away from any electrode switch.
- Press F1 to test the electrode.
- The SuperSting will issue a PASS or FAIL for each of the eight channels.
- Move the clamp to the next dual mode electrode and press F1 and so on.

To test the small take out on the cable:

- Set the “Separate potential:” to ON, this will ensure that current is injected through the large take out and potential is measured through the small take-out.
- Attach the test cable between the white banana connector on the SuperSting front panel and clip the large test clamp over the large take-out of the first dual mode electrode to be tested. Do not connect the small banana plug (small test clamp) and make sure to keep it away from any electrode switch.
- Press F1 to test the electrode.
- The SuperSting should now issue a FAIL for each of the eight channels. This indicates that the potential lines are not connected to the large take-out when the “Separate potential” option is set to ON.
- Now disconnect the large test clamp and make sure to keep it away from any electrode switch.
- Connect the small banana plug (small test clamp) to the small take-out.
- Press F1 to test the electrode.
- The SuperSting should now issue a PASS for each of the eight channels. This indicates that the potential lines are connected to the small take-out when the “Separate potential” option is set to ON.
- Disconnect the small test clamp and repeat the test on the next dual mode electrode.

5.1.3.3 The receiver test

This test is only available for the SuperSting R8/IP instrument. For this test, using the 2 meter jumper cable, connect the Test box, delivered with the instrument, to the left (male) connector of the two electrode cable connectors on the SuperSting front panel. **Do not connect the Swift cable**. Press the MEA key to start measuring. When the receivers work properly, the readings should be approximately 0.5 Ω.

Figure 14 The test box

To test the receiver in the SuperSting R1/IP, connect the test box as described above and perform a resistance measurement in manual mode (Menu2/1). The reading should be approximately 0.5 Ω.

5.1.3.4 The relay test

This test, tests the function of the relays in the Swift cable. Connect the Swift cable to be tested to one of the two “ELECTRODE CABLE” connectors on the SuperSting front panel. During the test the A and B relays (SuperSting R8/IP) are tested for each electrode switch along the cable. For SuperSting R1/IP the A, B, M and N relays are tested with this test.

5.1.3.5 Program address

This function is used to reprogram the addresses of the dual mode electrode switches. In order to reprogram a switch, the serial number of the switch must be known. A list of electrode switches and their serial number was supplied when the equipment was delivered. If the list of serial numbers has been lost, there is a Serial Number Scanner available see section 6.7.1.

To reprogram an electrode switch proceed as follows:

- Connect the electrode string with the dual mode switch to be re-addressed to the SuperSting R8/IP or SuperSting R1/IP.
- Power up and go to 3. Test mode.
- For SuperSting R1, select 4. Program address.
  For SuperSting R8, select 5. Program address.
- Select 1 to enter the new address.
- Select 2 to enter the serial number of the electrode switch to be reprogrammed.
- For SuperSting R1 press F1 to re-program the electrode switch.
  For SuperSting R8 press F3 to re-program the electrode switch.
- The electrode switch has now got the address specified above.

5.1.4 The Log settings menu

Select # 4 on the main menu to get to the time log menu. Set time increment in seconds to start the SuperSting to take 8 simultaneous readings. This function is used when the SuperSting is used to monitor a set of electrodes over a certain time period. Measurement cycle starts at the given interval. Enter 0 seconds to turn this function off.

```
M4    Log Settings

1. Log mode


MEN: Up Level
```

5.1.5 The File management menu

Select option 5 on the main menu.

```
M5   File Management

DATA FILE MANAGEMENT
1. Open data file
2. Delete data file
3. View data file
4. Format disk

COMMAND FILE MANAGEMENT
5. Delete command file
6. Delete all command files

MEN: Up level
```

5.1.5.1 Open data file

Select 1 to open a new data file. Use + and – to scroll through the data files, press enter to select the file.

5.1.5.2 Delete data file

Select a data file using + or – and delete by pressing enter. If the file has not been downloaded to a PC “Warning: File not dumped to PC Press . to confirm” will be displayed. By pressing the . (dot) key the deletion is confirmed and the file deleted.

5.1.5.3 View data file

Select number 3 to view data in the opened file.

5.1.5.4 Format disk

To format the virtual disk memory select 4 and then press 1. The message IN PROGRESS will appear. When formatting is finished the message DONE will be displayed. This function should only be used after replacing the back-up battery. The format function will only erase the data memory. Settings and command files will not be changed.

5.1.5.5 Delete command file

Select number 5 to delete a single command file. Select a command file using + or – and delete by pressing enter. The system will display “Press . to confirm” . By pressing the . (dot) key the deletion is confirmed and the file deleted. Note that the system will not allow that a command file, which has been used to record a data file that has not been downloaded to a PC, to be erased.

5.1.5.6 Delete all command files

Use this option to delete all command files.

5.1.6 The System settings menu

Under this menu all instrument settings are configured.

```
M6   System Settings

1. Measurement settings
2. Cable addresses set-up
3. Set time & date
4. General settings
5. Switch box settings
6. Skip electrode list set-up

MEN: Up Level
```

5.1.6.1 Measurement settings

Use option 1 – 9 and F1 to set the instrument measurement settings. Select option number, type the new setting and press enter.

Option F1 is used to save the current settings in a “User default” setting. This setting is recalled by pressing the 9-key.

5.1.6.1.1 Cycles

For each measurement station the instrument can be requested to take a number of readings. This procedure is also referred to as “stacking”. During the measurement the instrument will calculate the average and standard deviation of these readings and display on the screen. The maximum number of readings to take at each station is set under “cycles”. The default factory setting is 2 cycles. The number is increased by pressing the + key. The largest number of stack is 300.

```
M61 Measurement Settings

1. Cycles: 2
2. Max error: 2.0
3. Max repeat: 1
4. Max current:  1250mA
5. Measure time: 1.2s
6. Separate potential  OFF
7. Measure mode: RES
8. Use Address Table
9. Defaults:FACTORY
F1. Save user defaults

MEN: Up Level
```

5.1.6.1.2 Max error

The user can set a threshold value for the standard deviation. Then, if the standard deviation for all active channels is lower than the threshold value, the stacking procedure is interrupted prior to the set cycles has been reached. The default factory setting is 2.0 %.

5.1.6.1.3 Max repeat

If any of the channels receive the error message INOVL (meaning that the input amplifier for this channel has been overloaded during the measurement), the measurement at this station will be repeated for the channels which have received the INOVL message.

If the error message TXOVL (meaning that the transmitter amplifier has been overloaded during the measurement) is given during the measurement, the measurement will be repeated for all channels at this station.

If after the set number of cycles has been reached one or more channels have not reached a standard deviation which is lower than the set “Max error”, the instrument will repeat the measurement at this station for the channels with higher standard deviation than the set value. This function is only relevant in the SuperSting R8/IP instrument.

The default factory setting is 1.

5.1.6.1.4 Max current

To select the maximum current to be used for each measurement select # 4, scroll through the possible settings using the + and – key and then press enter. The default factory setting for the maximum current setting is 1,250 mA.

5.1.6.1.5 Measure time

To select the measure time to be used for each individual measurement select number 5, scroll through the possible settings using the + and – key and then press enter. Note that the measurement time is connected to the measure mode so that in the resistivity mode (RES, only resistivity is measured) the available times are 0.4 sec, 0.8 sec, 1.2 sec, 3.6 sec, 7.2 sec and 14.4 sec. In the resistivity/IP mode (RES/IP, resistivity and IP is measured simultaneously) the available times are 0.5 sec, 1 sec, 2 sec, 4 sec and 8 sec. The default factory setting is 1.2 seconds in RES mode and 0.5 seconds in RES/IP mode).

5.1.6.1.6 Separate potential

This function is only useful when non-polarisable electrodes are to be used with the dual mode Swift electrodes.

The patented dual mode Swift electrode switches has two “take outs”. In most cases it is sufficient to attach the switch to the stainless steel stake using the stainless steel spring. Current is then injected through the stainless steel stake into the ground and when the same unit is used for potential electrode the potential is measured through the stainless steel stake.

However, if the highest quality IP data is required you can connect a non-polarisable electrode a short distance to the side of the stainless steel stake and perpendicular to the survey line. The non-polarisable electrodes are connected to the small banana jack (small take-out on the old dual mode electrodes) at one side of the Dual Mode Smart Electrodes by a jumper cable.

If you are using just a stainless steel stake “Separate potential” should be set to OFF. If you are using a stainless steel electrode and a non-polarisable electrode “Separate potential” should be set to ON. Toggle between ON and OFF by pressing 6.

5.1.6.1.7 Measure mode

Press number 7 to toggle between RES or RES/IP mode. When the RES mode is selected, only resistivity is measured using the special measurement strategy developed for resistivity measurements. When the RES/IP method is selected, the special measurement strategy that has been adopted for IP measurements is used.

5.1.6.1.8 Use Address Table

By pressing the 8 you can toggle between Use Address Table/Use Command File Addresses.

The address table (chapter 5.1.6.2) is used by the instrument to calculate measuring commands when roll-along is used. The table simply shows how the cable is divided.

In some special situations, like for example if your electrodes have addresses 57-84 (the first electrode does not have address 1) and you want to use a command file with the actual addresses, i.e. 57-84, you must then turn off the address table function. Note that all command files created with the Administrator software start with address 1 and therefore you do not need to turn off the address table if the command files are created with the Administrator software.

The most common setting is to always have the User Address Table active.

5.1.6.1.9 Defaults

There are three default modes; FACTORY, USER and <none>. Toggle between modes by pressing the 9 key.

The factory default settings are as follows:

Cycles:	2
Max error:	2.0
Max repeat:	1
Max current:	1,250 mA
Measure time:	1.2 s in RES mode, 0.5 s in RES/IP mode
Separate potential	No default setting, the user setting will be kept at all times
Measure mode:	No default setting, the user setting will be kept at all times
Address Table:	Use Address Table

To set your own defaults, change any of the parameters 1 – 5 and 8, then press F1. Your default values are now stored and can be recalled by selecting USER by pressing the 9 key.

Note that if a change in settings is required, which is not covered by the FACTORY or USER defaults, the defaults option needs to be set to <none> by pressing the F2 key. This is because, if for example the FACTORY default is chosen and some setting is changed, this setting will automatically be changed back to the FACTORY setting when measurement begins.

5.1.6.2 Cable addresses set-up

This menu is used to enter information about your electrode cable. This information is used by the instrument to calculate the correct position of the electrodes when performing surveys using the roll-along technique.

Note that the cable address table is only to be <u>set up once before the survey starts</u>. Do not change the table during roll-along since this will ruin the data. Never change the address table during a survey unless a new cable configuration is desired.

```
M62 Cable Addresses Setup

1. New cable sections
2. Clear table

Addr Low:          High:
Section   AddrL    AddrH
1         1        14
2         15       28
3         29       42
4         43       56

+/- scroll ENTR:Edit  F3:Delete

MEN:Up level
```

An electrode cable typically consists of a number of cable strings, each cable string having a number of electrode switches (smart electrodes) or take-outs (passive cables). Each electrode switch or take-out has a unique address.

Note that command files created with the Administrator software allways has the electrodes in number sequence, starting with the first electrode as number 1. However, in reality your electrodes may have other numbers (i.e. starting with a number other than 1). The address table on menu 6/2 is used to map your physical electrodes to the electrodes in the command file.

To start entering information press the 1 key (to erase an existing cable table press the 2 key).

- Enter the lowest address of the first electrode string, in this example 1.
- Enter the highest address of the first electrode string, in this case 14.
- Press 1 for new cable section.
- Enter the lowest address of the second electrode string, in this example 15.
- Enter the highest address of the second electrode string, in this case 28.
- Press 1 for new cable section.
- Continue until all cable strings and their addresses have been entered.

With this set up, the instrument will calculate coordinates and addresses based on moving 14 electrodes at a time. In case you want to move another number of cables for each “roll” in this example maybe 7, you will need to clear the current table and enter a new table with four strings of 7 electrodes each.

Note that the number of electrodes in the command file **<u>must</u>** be the same as the number of electrodes in the cable address table.

The strings entered, do not need to have the same number of electrodes. However, the total number of electrodes entered in the table **<u>must</u>** be the same number as the number of electrodes in the command file used.

For ease of operation in the field, the strings are entered in consecutive number order. However, it is allowed to enter the strings in the table in any order, but then the strings must be laid out in this very same order when the survey starts in the field.

Also note that if you are using a switch box and passive cables, you must enter the correct number of strings, even if you are not going to use roll-along. For example; if you have a switch box/56, you can not enter just one string with start address=1 and end address=56. You must enter at least one string of 1-28 and another of 29-56.

5.1.6.2.1 Broken smart electrode

In case a cable section is damaged, the survey can continue without the broken section, but with fewer electrodes. To continue a survey, proceeds as follows:

- Create a new command file using the Administrator software. Make sure that this new command file has the same number of electrodes as you have working electrodes on the cable.
- Load this new command file into the SuperSting.
- Change the address list, see paragraph 5.1.6.2, not to include the addresses of the removed section.

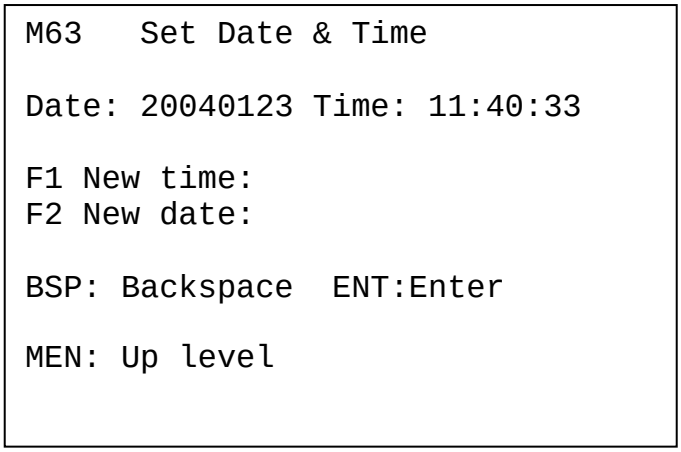
5.1.6.3 Set time & date

To set time:

- press the F1 key
- enter time as hhmmss
- press Enter

To set the date:

- press F2
- enter date as yymmdd
- press Enter.



5.1.6.4 General settings

5.1.6.4.1 Automatic shut off

Press the number 1 key to specify how long time in minutes, between 1-60, the instrument shall stay on after the last key-press. When this option is activated the instrument will automatically shut off after the keyboard has been inactive for user specified number of minutes. However, as long as the instrument is performing an automatic survey it will stay on. After the survey is ready, the instrument will stay on for specified time and then shuts off if the keyboard has not been used in this time. Use time=0 to deactivate this function, i.e. the instrument will stay on until you shut it off.

```
M64  General settings

1. Automatic shutoff:   ON
2. Start firmware update
3. Switch COM Delay: 60 ms
4. Set defaults
5. Commutate Delay:   100 ms
6. Sting/Swift Cable:OFF
7. HIVOLT:    384
8. Baud Rate: 38400
9. Show Apparent Res: OFF

MEN: Up Level
```

5.1.6.4.2 Start firmware update

This function is used when the firmware is being updated, see section 6.2.

5.1.6.4.3 Switch COM Delay

This is the time in milliseconds, used for connecting a certain electrode. Default value is 60 ms. SuperSting R8 with 8-channel cables and 8-channel switch boxes can use shorter time, for example 10 ms, but any time 1-channel cables or 1-channel switch boxes are used the setting should be at least 60 ms.

5.1.6.4.4 Set defaults

By pressing the # 4 key the default general settings are set. They are:
Automatic shutoff: No default setting, the user setting will be kept at all times
Switch COM delay: 60 ms
Commutate delay: 100 ms
Sting/Swift cable: OFF
HIVOLT: 400
Baud rate: 38400

5.1.6.4.5 Commutate delay

The delay during which the instrument will wait before starting measuring after the current has been commutated. This value can be set between 30-3000 milliseconds. Default value is 100 ms.

5.1.6.4.6 Sting/Swift cable

The single channel Swift cable or single channel switch box can be used with the SuperSting R8/IP when this setting is set to ON. Note that when using the single channel Swift cables the SuperSting R8/IP will only measure one channel for each current injection. The SuperSting R1/IP can only work with Swift R1 electrode cables.

In the SuperSting R1 this function is allways set to ON, in the SuperSting R8 this function default is OFF, i.e. the normal is to use 8-channel cables and switch boxes with the SuperSting R8.

5.1.6.4.7 HIVOLT

This value specifies the maximum voltage of the transmitter. It is set between 160 – 400 V. Note that the displayed value is an integer and the increments are in 1.6 V step, therefore the value you specify may change slightly when you hit ENTER. Default value is 400 V.

5.1.6.4.8 Baud rate

The # 8 key will scroll through the possible baud rate settings: 2400, 4800, 9600, 19200 and 38400. The default value is 38400 baud.

5.1.6.4.9 Show apparent resistivity

This function is used on the SuperSting R8 in order to be able to see more information. When the “Show apparent res” is set to OFF, the column for the apparent resistivity values is replaced by a column which displays the address of the first potential electrode in the command file for this channel. The idea is to be able to see approximately where the measurments are being taken along the line.
This function has no effect on the SuperSting R1, since both electrode coordinates and apparent resistivity fit on the screen.

5.1.6.5 Switch box settings

The SuperSting can be used with one or several switch boxes and passive cables. For the system to work properly the switch box type(s) used, needs to be entered into the system. Press the 1-key to add a switch box and then use the + or – key to scroll through the list of available switch boxes to select the appropriate box. The number displayed is the electrode switching capability of each box. Use the 2-key to clear the switch box list. Several boxes needs to be entered in case a number of boxes are used daisy chained together.

5.1.6.6 Skip electrode list set-up

This feature is used when an electrode position can not be used because some obstacle, i.e. pavement, a building, a pond etc., is occupying the station. Press the 1-key to add the address of the electrode to be skipped. Up to 8 electrode addresses may be entered into this list. Measurements which include any of the listed electrodes will be omitted.

Press the 2-key to clear the list of skip addresses. Selecting the “Set defaults” on menu 6/4 will also clear this list. The instrument will keep this list in memory even if the instrument is turned off.

Note 1 Any address entered in this list will be skipped during the survey. Therefore it is important to remember to clear this list for the survey of the next line.

Note 2 This function is not intended to be used to skip broken electrodes. In such case, remove the cable section with the broken electrode, create a new command file, using the Administrator software, with the number of working electrodes (i.e. the number of electrodes on the cable less the damaged electrode section) and load it into the SuperSting. Then modify the Address table, see paragraph 5.1.6.2, not to include the address(es) of the broken electrode cable section.

5.1.7 The System information menu

The system information menu gives you contact information to Advanced Geosciences, Inc., firmware version currently installed in the instrument and serial number of the instrument.

```
M7   System information

Advanced Geosciences, Inc.
12700 Volente Rd.
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Software version: 01.03.17
Serial #SS000626

MEN: Up level
```

6 The Administrator for SuperSting software

The Administrator for SuperSting software was delivered on a CD with your instrument. To install the software on your computer

- Insert the disk in your CD drive
- Using the Explorer double click on the file AGISSAdmin-1.3.2.171.exe (version no. will vary)

The Administrator for SuperSting software will now be installed.

The Administrator for SuperSting is used to:

- Load new firmware into the SuperSting RAM memory.
- Create new command files.
- Load command files into the RAM memory.
- Download data files from the SuperSting into your PC.
- Convert the data file so that it is formatted for other common software.
- Re-address the electrodes when using the re-addressing kit, see section 8.3.

The files are transferred in binary format; however the resulting file in the computer is a regular text file. The SuperSting file protocol used for communication is proprietary information and of no real use for the user.

The only way to up/download data is by using the Administrator for SuperSting software, which handles all aspects of establishing connection and transferring data.

Communications details:
Baud rate: 38200
Data bits: 8
Stop bits: 1
Parity: NONE

A common problem when running the Administrator for SuperSting on your computer is that you get an "Access denied" message, indicating that the port specified is already in use by some other application or some other function within our program.

In this case, check for other software running on the laptop that actually opens the port and keeps it opened. You have to locate that program and shut it down.

If you are using a Palm organizer with the HotSyncManager, chances are that the HotSyncManager is running (auto-starts every time you start the computer) and uses the COM1 port (keeps it open all the time).

Check if HotSyncManager is running by looking into the system tray down in lower right corner of your screen. If it is running there will be a small Red and Blue circular icon. Click on it and select Exit to stop it and then restart Administrator for SuperSting.

6.1 Connecting the SuperSting to a Computer which only has a USB Port

Many newer computers are delivered with a USB port instead of a serial port. In order to connect the SuperSting to a computer with USB port you will need a USB/Serial adapter (part number 951063). Note that this adapter will install itself as COM4 if the COM1 port is occupied by other devices. If more than four ports are occupied the USB/Serial adapter will install itself to the next higher COM port. For example if eight ports are occupied the adapter will install itself as COM9.

In order to find out what COM port the adapter is installed on, go to the computer "Device Manager". In Windows XP you have to go to the Control panel/System and look under the Hardware tab to find the "Device manager". In the Device Manager, look under Ports to find the one labeled Keyspan High Speed USB Serial Adapter (previous model of adapter ATEN USB to Serial Bridge). The COM port, the adapter installed itself on, will be listed there.

Make sure to go to the "Config" option on the menu bar of the Administrator software and select the same COM port, prior to establishing a connection between the SuperSting and the computer.

6.2 To load new firmware into the SuperSting Flash memory

From time to time new firmware for the SuperSting will be available at our UserGroup on our web site at http://www.agiusa.com . We recommend that you register as a SuperSting owner to get a password to access this site. This way you can download the new firmware and load it into the SuperSting flash memory. By doing this your SuperSting will always be up to the latest firmware standard.

SuperSting R1 and R8 have changed microprocessor type during year 2003. The new microprocessor needs a different firmware update file than the original microprocessor. So when updating the firmware you must be very careful to download the correct file for your instrument. The new SuperSting instruments use a CPU Model E and the corresponding firmware has been marked with an "E" identifier, for example version 1.3.41E. It is important that you use version 1.3.3.180 or later of the SuperSting Administrator to send firmware of "E" type into your instrument if the instrument is of the new "E" model. Earlier Administrator versions are not able to load firmware of "E" type into the SuperSting.

To find out which model you have, look at the current firmware version number on the SuperSting menu 7. If it ends with a letter "E" then you have the Model E type and you then need to make sure only to load firmware of "E" type.

In order to load a new firmware into the SuperSting proceed as follows:

- Make sure to use version 1.3.3.180 or later of the Administrator software if you install firmware of "E" type. Earlier versions of the Administrator can not install firmware of "E" type.

- Using the special cable for loading firmware into the SuperSting (do not mix up this cable with the data download cable) connect the SuperSting to the serial port of your computer. Connect the cable to the connector marked “Ext. TX. COM.” on the SuperSting R8/IP front panel (PC SERIAL COM2 on the SuperSting R1/IP). **Note** that for uploading of firmware only use a computer with serial port. Communication with a USB/Serial adapter is not working properly for this purpose.
- Turn on the SuperSting and go to the main menu.
- Start the Administrator for SuperSting software .
- Select the AGI SuperSting Firmware Updater under the Window option on the Administrator for SuperSting menu bar.
- Make sure to select the correct com port.
- Click on the “Load firmware” button and select the firmware update file (xxxxx.agi) you want to load.

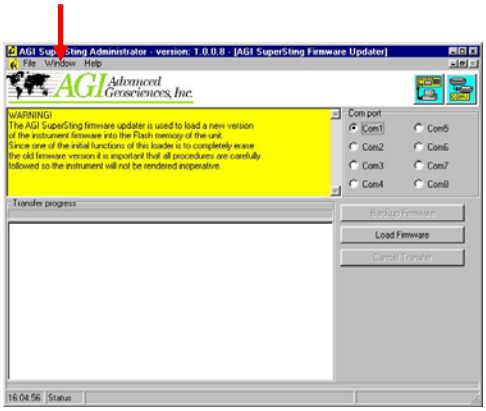


Figure 15 The SuperSting firmware update window

- In the Administrator Transfer progress window will now be displayed “Successfully loaded image file version x.x.x. Transferring start program to SuperSting. Start SuperSting in boot mode.”
- At this point, on the SuperSting, go to Menu 6 and select 4. General settings. Then press 2. Start firmware update.
- **The software is now being transferred to the SuperSting. This is a sensitive process, therefore make sure to leave the instrument and computer alone until the process is finished. This will take some 15 minutes.**
- When the uploading process is finished the progress window will display “Firmware transfer complete, restart SuperSting!”
- Restart the SuperSting.

6.3 To create a command file

When measuring, the SuperSting is controlled by command files stored in the instrument RAM memory. Command files are simple text files, which tell how the instrument shall perform the measurements. Command files can be manually made by the user, using a regular text editor, or automatically made using the “Command creator module” of the SuperSting Administrator.

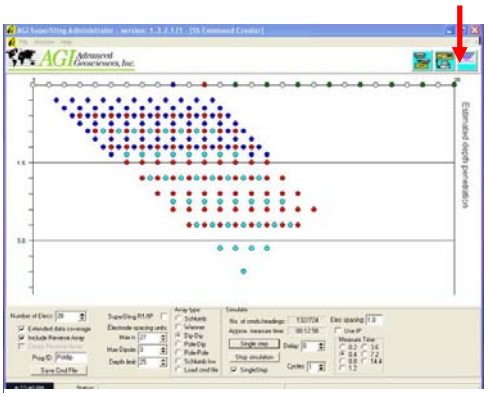


Figure 16 Use the command creator window to create a command file

To create a command file using the Administrator, proceed as follows:

- Click on the button for the SuperSting Command Creator module (top right corner of the Administrator).

- Make sure to check the box for SuperSting R1/IP if the command file is for a SuperSting R1/IP and to un-check the same box if the command file is for a SuperSting R8/IP.
- If the command file is for a SuperSting R8/IP we recommend you to check the "Create Reverse Array" box. This will in many cases speed up roll-along surveys when using the SuperSting R8/IP. For SuperSting R1/IP it does not matter if it is checked or not.
- Enter the number of electrodes you are using.
- The depth scale is estimated based on an electrode spacing of one unit. To get the correct estimate of the depth penetration for your survey, enter the intended electrode spacing in meters in the box for "Elec. Spacing". The depth scale will change only after you hit the "Simulate" button.
- Enter a program ID name in the Prog ID window. This is the ID you will see on the SuperSting display, when you select command file for a survey. It is also the default name for the command file name when you save the command file.
- Click for the array type of your choice.
- The following table gives recommended settings for the "Electrode Spacing Units". Numbers are entered in terms of "electrode spacings".

Schlumb	Max AB/MN	11	Keep the relationship AB/MN less than or equal to 11 gives a strong signal in most cases.
Wenner	N/A	N/A	All possible Wenner spacings are measured.
Dip-Dip	Max n Max Dipole	8 6	How far to separate the transmitter and receiver, 8 gives a strong enough signal in most cases. Depends on number of electrodes, for 28 set 3, for 56 set 6. To get all data just set a large number.
Pole-Dip	Max sep Max Dipole	20 3	20 gives a good enough signal strength in most cases. Depends on number of electrodes, for 28 set 2, for 56 set 3. To get all data just set a large number. Make sure to set the remote electrode at "infinity" approximately in line with the electrode line.
Pole-Pole	Max sep	55	Number of electrodes, less one. Make sure to set the remote electrode at "infinity" approximately in line with the electrode line.
Schlumb Inv	Max AB/MN	11	Keep the relationship AB/MN less than or equal to 11 gives a strong signal in most cases.

- Set "Depth limit" in meters to collect data down to your depth requirement. Make sure that you first have entered the "Electrode spacing" you are intending to use.
- Click on the Simulate button to see the measurement sequence in a graphical presentation. If the Single Step window is checked you can step through the measurement sequence one step at a time.
- Finally click on **Save CMD File** to save the command file.

For the dipole-dipole array there are a few additional settings.

Extended data coverage, means that the instrument will take overlapping readings in areas which are already covered by the normal measurement. This function is especially intended for the SuperSting R8, where there is not a large time difference in recording with or without extended data coverage. The additional information may help improving the data inversion process.

Include reverse array (includes reciprocal data), means that the instrument will first measure from left to right and then continue to measure from right to left, thereby creating a data file with two overlapping data sets. According to the rule of reciprocity a measurement made with AB and MN replacing each other, will be exactly the same as the original measurement. The EarthImager 2D software has an option to view the reciprocal data error distribution and to manually remove data with high error or to automatically “down weight” the influence of data with high error.

Create Reverse Array, this option only measures from right to left. This is especially valuable when using the SuperSting R8 for roll-along measurements, By measuring in this way, all 8 channels of this instrument can be better utilised and the survey will be faster. This setting is recommended to allways be used with the SuperSting R8.

In the **Simulate** section a number of entries are given to estimate the approximat time for a survey.
No. of cmds/readings indicates how many commands (i.e. current injections) and resistivity measurements there are in the actual command file.
Approx. measure time indicates the approximate time for a survey with this command file assuming the settings in the Simulate section. Note that this time is only approximate since there is no way of knowing how many repeat measurements there will be, caused by noise.
Use IP, check this check box in case you are going to perform an IP survey. This parameter is only used to calculate the approximate time for the survey.
Cycles, enter the number of measurement cycles (stacking) you are going to perform. This parameter is only used to calculate the approximate time for the survey.
Measure Time, check the measure time you are going to use. This parameter is only used to calculate the approximate time for the survey.
Delay, this is the time delay between measurements when performing a simulated survey on the screen. Note that this delay time has no influence on the real measurements, it is only used to speed up or slow down the measurement plot on the computer screen.
Simulate, click this button to simulate a survey on the computer screen.
Stop simulation, click on this button to stop an ongoing simulation.
Single step, check this box in case you want to step your way through the simulation one step at a time.
Single step, the Simulate button changes to Single step when you check the box for Single step. Use this button, to step one step forward in the simulation at a time.
Elec spacing, enter the real electrode spacing you are going to use in the field to get an approximate depth estimation on the depth scale. This parameter is only used in the computer to give correct depth estimation and has no influence on the actual measurements.

6.4 To load a command file into the SuperSting RAM memory

- Connect the SuperSting to a PC type computer using the “Cable for communication *SuperSting*/PC MS Windows type computer” (part number 951002). Connect the cable to the serial port on the computer and to the SuperSting front panel connector marked “PC SERIAL COM” (PC SERIAL COM1 on the SuperSting R1/IP).
- Turn the instrument on.
- Press any key to get to the main menu. Note that you must be in the main menu or the first level submenu when connecting to the computer.
- Start the Administrator for SuperSting software.
- Click on the SuperSting control center module button.
- Select the appropriate com port, found under the Config option on the menu bar.
- Click on the “Connect” button. Green light between the connect and disconnect buttons will now indicate that the connection is established. Available command files and data files in the SuperSting will also be listed in the respective windows on the computer screen.
- Under Command files on the Administrator menu bar, click on Send new command.
- Select the command file to send. The selected command file will now be transferred to the SuperSting RAM memory. After a short moment the file will be displayed in the Administrators Command files window indicating that the file is now residing in the SuperSting.
- Click on the Disconnect button to disconnect the SuperSting from the Administrator.

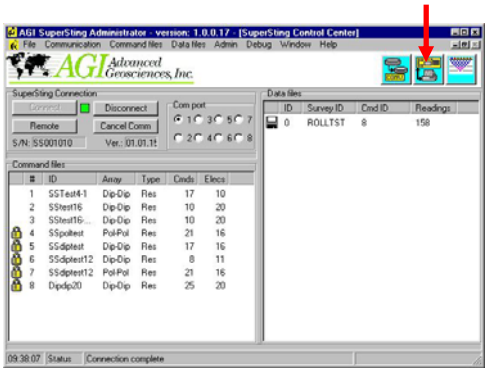


Figure 17 Use the command center window to upload command files and down-load data files

Note that a padlock at the command file on the Administrator screen indicates that this file is used by one or more data files still residing in the SuperSting memory. Since this command file is used when any of these data files are downloaded, it is locked in order not to be prematurely erased. As soon as all the corresponding data files has been downloaded and erased from the SuperSting memory, the padlock will be removed and it is possible to erase the command file.

To erase command files from the SuperSting memory, right click on the command file in the administrator window and then click on “Erase Command”.

6.5 To download SuperSting data to your PC

- Connect the SuperSting to a PC type computer using the “Cable for communication *SuperSting*/PC MS Windows type computer” (part number 951002).). Connect the cable to the serial port on the computer and to the SuperSting front panel connector marked “PC SERIAL COM” (PC SERIAL COM1 on the SuperSting R1/IP).
- Turn the instrument on.
- Press any key to get to the main menu. Note that you must be in the main menu or the first level submenu when connecting to the computer.
- Start the Administrator for SuperSting software.

- Click on the SuperSting control center module button.
- Select the appropriate com port, found under the Config option on the menu bar.
- Click on the “Connect” button. Green light between the connect and disconnect buttons will now indicate that the connection is established. Available command files and data files in the SuperSting will also be listed in the respective windows on the computer screen.
- In the “Data files” window select the data file to download by right clicking on the file name. Click on “Read File” and select where to save the file.
- When the transfer is finished a sign with the text “Selected measure file read from instrument. File set saved as: .....”. Click OK.
- Click on the Disconnect button to disconnect the SuperSting from the Administrator.

Note that a red cross will mark each data file in the Administrator window, which has not been downloaded to a computer. To erase a data file, right click on the data file in the Administrator window and then click on “Erase File”. If the selected data file is marked by a red cross, a warning will be issued before the data file can be erased.

6.6 To convert the SuperSting data for use in common software.

The AGI EarthImager resistivity and IP inversion software directly reads the SuperSting data files (.stg format). The EarthImager software also reads the common .dat format for resistivity imaging surveys.

6.6.1 Converting resistivity data

For other software than the EarthImager, use the Administrator conversion module to convert the SuperSting data for use in the Res2Dinv, the Res3Dinv, the Surfer for Windows and the Resix Plus software.

Note that if you have EarthImager 2D or EarthImager 3D software for inversion you do not need to convert the data. Just read the stg-files into the EarthImager.

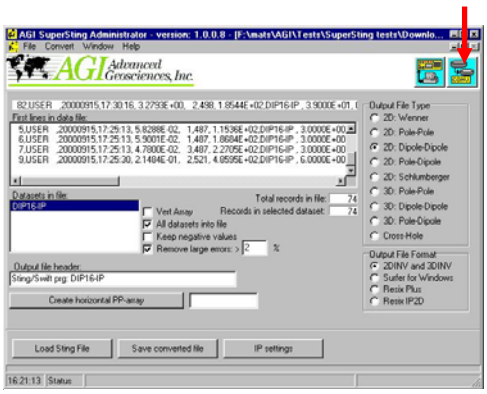


Figure 18 Use the Swift convert window to reformat data for other software

To convert for other software than EarthImager:

- Start the Administrator for SuperSting software.
- Under Window on the computer menu bar select the SuperSting data conversion.
- Under **Select Output File Type**, specify what type of data you have.
- Under **Select Output File Format**, specify to what software format you want to convert your data.
- Select **All Datasets Into Files** in case all data is going to be processed as one data set, as for example when performing a roll-along survey.
- Make sure that the **Keep Negative Values** box is **un**-checked.

- Check the **Remove Large Errors** box and specify at what % error data shall be omitted.
- Select data file to convert by clicking the **Load Sting File** button.
- Click on the **Save converted file** button to specify where to save the converted data.

6.6.2 Converting resistivity/IP data

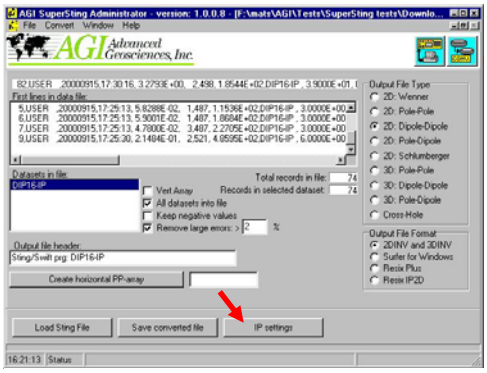


Figure 19 If IP data is present the "IP settings" button will appear

If your data contains IP data a new button will light up when loading the data into the software. To select the IP time windows to be included in the inversion, click on this button.

A new window will open where the IP data can be graphically inspected. A single IP curve or multiple curves can be displayed.

Records to plot, selects how many IP decay curves are going to be displayed for inspection at the same time. To display several curves at a time speeds up the inspection of the data set.

Starting window specifies the first IP window to be displayed and saved in the converted file.

Ending window specifies the last IP window to be displayed and saved in the converted file.

Scale, the up and down arrow are used to set the scale of the display window.

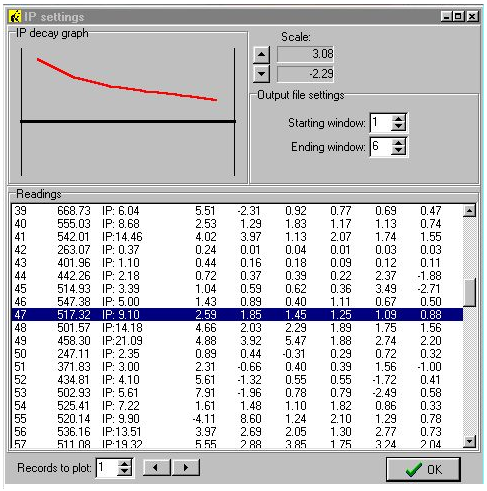


Figure 20 The IP decay curves can be inspected

The windows with data to invert are chosen after scrolling through the data and selecting the windows which displays the least amount of noise (jagged curve contour).

After your selection is made, click on **OK** and then click on the **Save Converted File** button to specify where to save the converted data file. The data set is now converted to selected

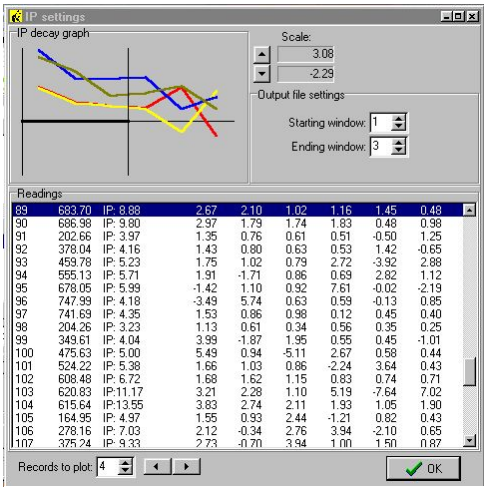


Figure 21 To speed up inspection, several decay curves can be displayed at the same time

format.

6.7 Re-programming electrode addresses

Electrode addresses can be re-programmed using the re-programming kit and the Administrator software. The procedure for re-programming dual mode electrode addresses and Switch box electrode addresses are slightly different.

The re-programming kit is only necessary for the dual mode electrode cable in case the electrode switch serial numbers have been lost. To re-program dual mode electrode addresses using the serial mumber of the dual mode electrode see section 5.1.3.5.

The re-programming kit is not necessary for re-programming electrode addresses in the Switch box.

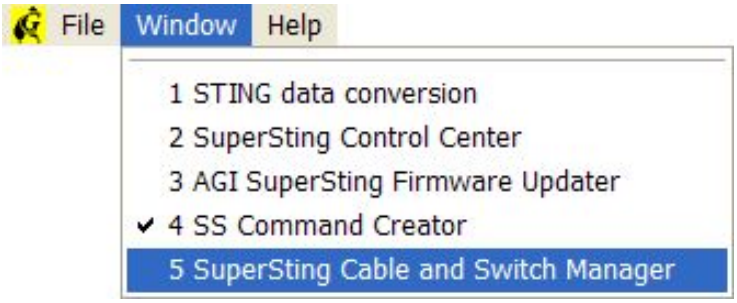
6.7.1 Re-programming cable electrode addresses

If the serial numbers of the electrode switches are known, the electrode addresses can be reprogrammed without the re-programming kit. The serial numbers for the electrode switches were delivered with the instrument. To re-program electrode switches when the serial number is known, see section 5.1.3.5

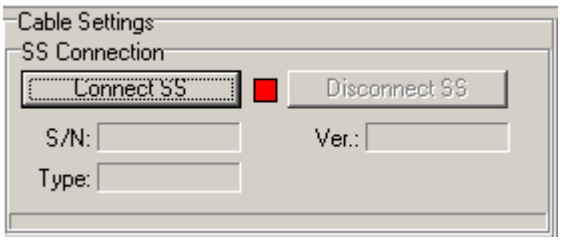
To re-program electrode addresses using the re-programming kit connect the re-programming box, the SuperSting, the computer and the cable to be re-addressed. Do not connect a complete cable, just the section of electrodes to be re-addressed.

1. Start the Administrator software on the computer.

2. After the Administrator software has started, open the “SuperSting Cable and Switch Manager” module by pressing the “Window” drop down menu in the top menu bar and select the “SuperSting Cable and Switch Manager”.

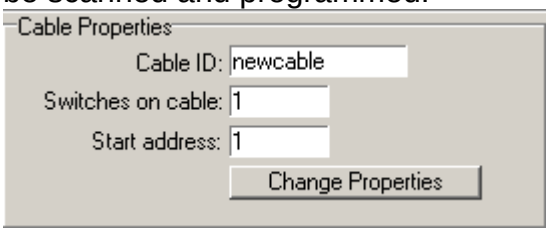


3. Turn on the SuperSting, then click on the “Connect SS” button on the computer screen to connect to the SuperSting.

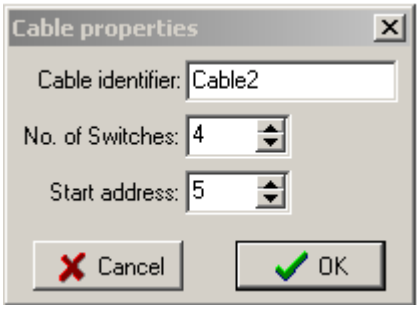


After pressing the “Connect SS” button the PC should connect to the SuperSting and all buttons and windows in the Administrator should become active.

4. If you are re-programming R1 electrode switches and are using a SuperSting R8/IP, you must check the box “Force 1-ch cable”.
5. Press the “Change Properties” button to edit the properties of the cable section to be scanned and programmed.

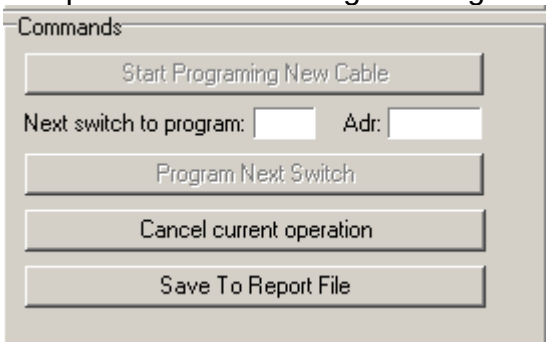


6. In the “Cable Identifier” box enter the serial number of the current cable section. Then in the “No. of Switches” box enter the number of switches on the cable section. Finally enter the Start address of the cable section, which is the lowest electrodes address on the cable section. The following shows the setup for a cable section of 4 electrodes with addresses 5 through 8.



Once the settings are entered press the “OK” button.

7. Use a cable with banana plug in one end and a large Mueller clip in the other end to connect the reprogramming box to the electrode switch to be re-programmed. The large Mueller clip should be clipped over the stainless steel tube of the electrode switch (over the larger stainless steel tube on the old type switces).
8. Next press the “Start Programming New Cable” button.



Once this button is pressed the software will begin to scan the serial number of the switch and program the switch with the corresponding address. If this is successful, it will return with a program address successful message.

9. Once the first electrode has been successfully programmed with the low address, clip the Mueller clip on to the next electrode to scan and press the “Program Next Switch” button.
10. Repeat the previous step until all electrodes on the cable section have been successfully programmed with their correct addresses.

6.7.2 Re-programming Switch box electrode addresses

The re-programming kit is not necessary when re-programming the Switch box electrode addresses.

Your Switch box contains a number of printed circuit boards. Each board is capable of switching 14 electrodes. Depending on the capability of your Switch box, there is different number of circuit boards in your Switch box.

The boards are numbered 1, 2, 3….. etc. The number 1 board always has the lowest number addresses, for example 1-14, the number two board the next fourteen addresses 15-28 etc.

To re-program addresses in your Switch box, proceed as follows:

- Connect the Switch box to the SuperSting. Note: only one Switch box is allowed to be connected when re-programming addresses, therefore no daisy-chaining of Switch boxes when re-programming addresses.
- Power up and go to menu 3. Test mode.
- For SuperSting R1, select 4. Program address.
  For SuperSting R8, select 6. Program address.
- Select 1 to enter the first address of the board to be programmed.
- Select 2 to enter the board number of the board to be re-programmed.
- For SuperSting R1 press F1 to re-program the board.
  For SuperSting R8 press F3 to re-program the board.
- The 14 electrodes, on that board, have now been re-programmed.
- Repeat for the next boards until all boards in the Switch box have been re-programmed.

Below is an example of a 56 electrode Switch box being reprogrammed from addresses 1-56 to 57-112.

Board number	Address before Re-programming	Re-programmed address
1	1-14	57-70
2	15-28	71-84
3	29-42	85-98
4	43-56	99-112

7 Data file formats

7.1 New file format

From SuperSting firmware version 01.03.03 and the Administrator for SuperSting version 1.3.1.108 electrode position defined by x, y and z coordinates (previously only x and y) is supported. This will make 3D surveys where electrodes are placed both on the surface and in bore holes more flexible.

7.2 SuperSting command files (.cmd)

Command files, with extension .cmd, are files which tells the SuperSting how to measure. The command files are ASCII files which are prepared in a PC and uploaded to the SuperSting using the ”Command Center” module of the Administrator software, see section 6.4.

The easiest way to make 2D command files is to use the “Command Creator” module of the Administrator software. For 3D command files use the “Command Creator” option in the EarthImager 3D software. It is also possible, but very tedious, to manually write a command file using a regular text editor.

Unfortunately if running Windows 2000, the operating software will consider all files with extension cmd as a program and is run by the batch processor cmd.exe. Therefore if you would like to open a command file, right click on the file name and use “Open with” or “Edit” to open the file.

When writing a command file, it is a good idea to use the unit spacing one between electrodes in the “Geometry” part of the command file. The reason is that this file can then be used for any electrode spacing by simply changing the scaling factor in the SuperSting when performing the survey. By having unit spacing one, the scaling factor simply reflects the new electrode spacing. This way there is only necessary to load one command file for each electrode array type used, even if different electrode spacings will be used later on.

SuperSting also has a built-in roll-along algorithm which uses the original command file, therefore no special command files are needed for roll-along surveys.

Below is a SuperSting R8/IP pole-pole command file for 50 electrodes. To the right are clarifying comments in red to each command file line.

;Automatically created command file	Semicolon indicates comment and is not used by the instrument.
:header	Header section starts here.
progID=polpol	This name will appear on the instrument LCD.
unit=meter	Unit used; meter or feet (default meter if no unit is given)
type=R	See type below.
arraytype=5	See arraytype below.
Binf=1	1 indicates B at infinity, otherwise use 0.
Ninf=1	1 indicates N at infinity, otherwise use 0.

MUX=2	See MUX below.
:geometry	Geometry section starts here. Each electrode address and its x and y coordinate is listed in this section. Use 1 as unit spacing is an advantage when loaded into the SuperSting, where a scaling factor is used to change the electrode spacing.
1,0.00,0.00	
2,1.00,0.00	
3,2.00,0.00	
4,3.00,0.00	
5,4.00,0.00	
6,5.00,0.00	
7,6.00,0.00	
8,7.00,0.00	
…….	
44,43.00,0.00	
45,44.00,0.00	
46,45.00,0.00	
47,46.00,0.00	
48,47.00,0.00	
49,48.00,0.00	
50,49.00,0.00	
:commands	Here starts the command section.
;A,B,P1,P2,P3,P4,P5,P6,P7,P8,P9,channels	This line describes the command format.
1,0,2,3,4,5,6,7,8,9,0,12345678	First command= first measurement
1,0,10,11,12,13,14,15,16,17,0,12345678	Second command= second measurement and so on.
1,0,18,19,20,21,22,23,24,25,0,12345678	A and B are the current electrode addresses specified in
1,0,26,27,28,29,30,31,32,33,0,12345678	the first column. Since Binf=1 (B at infinity) no automatic
1,0,34,35,36,37,38,39,40,41,0,12345678	switch is used for the B position here therefore write 0.
1,0,42,43,44,45,46,47,48,49,0,12345678	P1 to P9 are the incoming lines. It takes 9 lines to take 8
1,0,50,0,0,0,0,0,0,0,0,1	readings since it is the difference which is measured.
2,0,3,4,5,6,7,8,9,10,0,12345678	Each of the P-lines are separated by a comma.
2,0,11,12,13,14,15,16,17,18,0,12345678	At the end is a list of the receivers used. There are
2,0,19,20,21,22,23,24,25,26,0,12345678	eight receivers, in some measurements fewer receivers
……..	are used.
43,0,44,45,46,47,48,49,50,0,0,1234567	Here receivers 1, 2, 3, 4, 5, 6 are used for 44-45, 45-46,
44,0,45,46,47,48,49,50,0,0,0,123456	….49-50 and receiver 7 for 50-Ninf. (N infinity)
45,0,46,47,48,49,50,0,0,0,0,12345	
46,0,47,48,49,50,0,0,0,0,0,1234	
47,0,48,49,50,0,0,0,0,0,0,123	
48,0,49,50,0,0,0,0,0,0,0,12	Here receiver 1 is used for 49-50 and receiver 2 is used for 50-Ninf.

Below is an example of the corresponding command file for the SuperSting R1/IP.

```
;Automatically created command file
:header
progID=Test
unit=meter
type=R
arraytype=5
Binf=1
Ninf=1
MUX=1

:geometry
1,0.00,0.00
2,1.00,0.00
.
.
49,48.00,0.00
```

50,49.00,0.00

:commands
;A,B,P1,P2,P3,P4,P5,P6,P7,P8,P9,channels
50,0,49,0,0,0,0,0,0,0,0,1
50,0,48,0,0,0,0,0,0,0,0,1
50,0,47,0,0,0,0,0,0,0,0,1
50,0,46,0,0,0,0,0,0,0,0,1
.
.
4,0,1,0,0,0,0,0,0,0,0,1
3,0,2,0,0,0,0,0,0,0,0,1
3,0,1,0,0,0,0,0,0,0,0,1
2,0,1,0,0,0,0,0,0,0,0,1

type=R means resistance measurement, no other option is currently available.

arraytype, there are six arraytypes available. 0=undefined used when an out of standard array is used, 1=Schlumberger, 2=Wenner, 3=dipole-dipole, 4=pole-dipole and 5=pole-pole. This parameter is used to auto detect array type.

MUX, there are two possibilities. MUX=1 is used when the measurement is taken between lines P1-P2-P3-P4-P5-P6-P7-P8-P9. MUX=2 is used when the measurement is taken between P1-P9, P2-P9, P3-P9, P4-P9, P5-P9, P6-P9, P7-P9 and P8-P9

7.3 SuperSting result files (.stg)

SuperSting result files, with extension .stg, are the result of a resistivity measurement or the result of a resistivity/IP combination measurement.

The downloaded file is a comma delimited ASCII file. The first row contains information about the instrument used. The second row informs of which software version is installed in the instrument, the survey period of the data in the file and how many records the file contains. The third row informs whether the unit used was set for meter or feet at the time of downloading. The following rows contain one data point each. Below is the beginning of a downloaded SuperSting (stg) file:

```
Advanced Geosciences, Inc. SuperSting R8-IP Resistivity meter. S/N: SS001010
Software version: 01.01.15 Survey period: 20001121 Records: 450
Unit: meter
   1,USER   ,20001121,14:53:23, 1.8134E+00,   0,516, 6.8364E+01,ROLLTST  , 2.0000E+00, 0.0000E+00, 0.0000E+00, 0.0000E+00, 4.0000E+00, 0.0000E+00, 6.0000E+00, 0.0000E+00,IP:, 130, 1000, 4.1243E-
04, 2.2883E-04, 1.4102E-04, 1.0111E-04, 7.7164E-05, 6.6521E-05, 1.0271E-03
   2,USER   ,20001121,14:53:23, 6.4207E-01,   1,516, 9.6821E+01,ROLLTST  , 2.0000E+00, 0.0000E+00, 0.0000E+00, 0.0000E+00, 6.0000E+00, 0.0000E+00, 8.0000E+00, 0.0000E+00,IP:, 130, 1000, 1.3853E-
04, 6.0244E-06,-3.0113E-05,-3.6135E-05,-4.5170E-05, 3.4632E-04, 3.7946E-04
   3,USER   ,20001121,14:53:23, 2.8514E-01,   3,516, 1.0750E+02,ROLLTST  , 2.0000E+00, 0.0000E+00, 0.0000E+00, 0.0000E+00, 8.0000E+00, 0.0000E+00, 1.0000E+01, 0.0000E+00,IP:, 130, 1000,-1.2116E-
05,-4.4582E-05,-3.2622E-05,-4.1148E-05,-4.6275E-05,-3.9441E-05,-2.1618E-04
   4,USER   ,20001121,14:53:23, 1.7801E-01,   2,516, 1.3422E+02,ROLLTST  , 2.0000E+00, 0.0000E+00, 0.0000E+00, 0.0000E+00, 1.0000E+01, 0.0000E+00, 1.2000E+01, 0.0000E+00,IP:, 130, 1000,-3.9368E-
04,-7.2752E-04, 1.0765E-05,-3.2851E-04,-2.9050E-04,-2.8235E-04,-2.0118E-03
   5,USER   ,20001121,14:53:23, 1.2762E-01,   2,516, 1.6840E+02,ROLLTST  , 2.0000E+00, 0.0000E+00, 0.0000E+00, 0.0000E+00, 1.2000E+01, 0.0000E+00, 1.4000E+01, 0.0000E+00,IP:, 130, 1000,-4.6808E-
04,-3.3218E-04,-2.4534E-04,-1.9248E-04,-1.5095E-04,-1.3207E-04,-1.5211E-03
```

The example above shows the older data format where no z-coordinate was used.

The following data format is used:
A consecutive data record number, USER, date (YYYYMMDD), time (hh:mm:ss), V/I, error in tenths of percent, output current in mA, apparent resistivity in Ωm or Ωft, command file identifier, X-coordinate for the A-electrode, Y-coordinate for the A-electrode, Z-coordinate for the A-electrode, X-coordinate for the B-electrode, Y-coordinate for the B-electrode, Z-coordinate for the B-electrode, X-coordinate for the M-electrode, Y-coordinate for the M-electrode, Z-coordinate for the M-electrode, X-coordinate for the N-electrode, Y-coordinate for the N-electrode, Z-coordinate for the N-electrode.

If the Res/IP combination measurement has been performed, the record continues with: IP:, IP time slot in msec., IP time constant, IP reading in sec for the first time slot, IP reading in sec for the second time slot, IP reading in sec for the third time slot, IP reading in sec for the forth time slot, IP reading in sec for the fifth time slot, IP reading in sec for the sixth time slot, total IP reading in sec.

Note in the data file example above that each record wraps on two lines due to its length. It is actually one single line in the output data from Sting.

In order to avoid unnecessary number of zeros in the result, the values of the data fields are given in scientific notation. To read these values, simply move the decimal point to the right if the suffix is positive and to the left if the suffix is negative. For example: the value 2.5889e+02 is read 258.89 and the value 7.7424e-03 is read 0.0077424.

7.4 SuperSting contact resistance files (.crs)

During the measurement a resistance value for each pair of current electrodes used is collected and presented in the contact resistance file. This file may be a valuable piece of information in case of erroneous data. Below is the beginning of a downloaded SuperSting contact resistance (crs) file:

```
Advanced Geosciences, Inc. SuperSting R8-IP Resistivity meter. S/N: SS000228
Software version: 01.01.22 Survey period: 20010121 Records: 180
Unit: meter
Contact resistance readings (approximate)
RecNo, Vcode, Curr, Res, Date, Time of reading, AddrA, AddrB, Ax, Ay, Bx, By
   1,  23, 1.0320E-01, 3.5583E+02,20010121,17:38:27,   3,   1, 2.0000E+00, 0.0000E+00, 0.0000E+00, 0.0000E+00
   2,  19, 8.1560E-02, 3.6248E+02,20010121,17:38:41,   3,   1, 2.0000E+00, 0.0000E+00, 0.0000E+00, 0.0000E+00
   3,  29, 9.9093E-02, 4.6750E+02,20010121,17:38:58,   5,   3, 4.0000E+00, 0.0000E+00, 2.0000E+00, 0.0000E+00
   4,  26, 1.0701E-01, 3.8801E+02,20010121,17:39:14,   5,   1, 4.0000E+00, 0.0000E+00, 0.0000E+00, 0.0000E+00
   5,  28, 9.9097E-02, 4.5133E+02,20010121,17:39:31,   7,   5, 6.0000E+00, 0.0000E+00, 4.0000E+00, 0.0000E+00
   6,  28, 1.0399E-01, 4.3005E+02,20010121,17:39:48,   7,   3, 6.0000E+00, 0.0000E+00, 2.0000E+00, 0.0000E+00
```

The contact resistance file is automatically downloaded with the data file. The file is a comma delimited ASCII file. The first row contains information about the instrument used. The second row informs of which software version is installed in the instrument, the survey period of the data in the file and how many records the file contains. The third row informs whether the unit used was set for meter or feet at the time of downloading. The forth row states “Contact resistance readings (approximate)” indicating that the contact resistances are approximate. The next row indicates the content of each field of the data record. The following rows contain one data point each.

A consecutive data record number, the voltage code applied to drive the current into the ground, current in Ampere, contact resistance in Ω, date (YYYYMMDD), time (hh:mm:ss), address of the A electrode, address of the B electrode, X-coordinate for the A-electrode, Y-coordinate for the A-electrode, Z-coordinate for the A-electrode, X-coordinate for the B-electrode, Y-coordinate for the B-electrode, Z-coordinate for the B-electrode.

7.5 SuperSting binary files (.bin) and zip files

When data is transferred to a computer from the SuperSting, it is transferred in binary form. After the transfer is completed the Administrator software translates the binary file

into easy to read ASCII files. The binary file is valuable as a trouble shooting tool for AGI in case there has been a problem during the measurement.

When downloading the data there is also a zip-file is created. This file contains both the ASCII and the binary files with system information, which can help us analyze the data in case of a problem. It is named as the dataset (like PP564DF.zip).

Please e-mail the .zip file to Advanced Geosciences, Inc. (agi@agiusa.com) any time you have a question regarding the data or need our help to diagnose a problem.

7.6 SuperSting firmware files (.agi)

The SuperSting firmware can be updated by loading a new firmware file (.agi-file) into the SuperSting using the “Firmware updater” module of the Administrator software, see section 6.2.

The latest version of the SuperSting firmware is posted on the SuperSting UserGroup on the AGI web site at www.agiusa.com. Make sure to register for the SuperSting UserGroup in order to get your password.

8 Accessories

8.1 PowerSting series external high power transmitters for the SuperSting

Figure 21 The SGS generator, SuperSting R8 and a PowerSting makes up the system.

The PowerSting high power series external transmitters are designed for deep surveys and special applications. All PowerSting transmitters are equipped with wired or wireless communication to the SuperSting.

The different PowerSting transmitter models vary in specification but are operationally all the same.

Connection to the SuperSting can be either wired or wireless.

The PowerSting is a constant current source. If the load changes, the PowerSting will automatically switch to voltage mode in order to keep the current constant.

Two or more of same model PowerSting's can be daisy chained as master/slave to increase current output by current summation.

8.1.1 PowerSting HV 10 kW 3,000 V, 3.2 A

This transmitter is designed for high contact resistance conditions where there is a demand for high voltage output. This transmitter is ideally suited for dry and rocky areas with a thin overburden. The transmitter is tuned to operate at maximum specification, i.e. 3.2 A at 3,000 V, when the contact resistance is 937 Ohm.

8.1.2 PowerSting HC 10 kW 375 V, 27 A

This transmitter is designed for low contact resistance land or marine surveys where there is a demand for high current output at a relatively low voltage. This transmitter is

ideally suited for marine resistivity imaging on or under seawater or when the survey is performed on land in areas with moist ground and thick overburden. The transmitter is tuned to operate at maximum specification, i.e. 27 A at 375 V, when the contact resistance is 14 Ohm as is typical in a hyper-saline environment.

8.1.3 PowerSting 15 kW 1,500 V, 10 A

This transmitter is a good medium range transmitter for all around use. It is tuned to operate at maximum specification, i.e. 10 A at 1,500 V, when the contact resistance is 150 Ohm.

8.1.4 PowerSting 5 kW 1,000 V, 5 A

This transmitter is used together with off-the-shelf single phase generators, greater than 7.5 kW. The transmitter is tuned to operate at maximum specification, i.e. 5 A at 1,000 V, when the contact resistance is 200 Ohm.

8.1.5 PowerSting operation

The PowerSting is built into a shock absorbing, military spec instrument case that is stackable and includes removable caster wheels for easy shipping and transportation. No additional field box is needed.

Figure 22 The PowerSting with the red "kill switch" on the left side.

Note that the SuperSting needs to run a special firmware, currently 01.33.51E, in order to work with an external transmitter.

To set up the PowerSting, open the two hinged doors one on the front and one on the back of the PowerSting. The doors can be either removed by lifting the door of the hinges or folded to the side.

Before continuing, make sure that the large red 60 mm “kill switch” on the PowerSting front panel is pushed in (push for OFF and Twist or Pull for ON). This switch also works as a shut-off switch in case of emergency and will instantaneously shut off the PowerSting when pushed in.

Attach the PowerSting to the SGS generator using the generator power cable (1” thick black cable with two blue 3-phase connectors) connecting to the back of the PowerSting.

Figure 23 Caution: blocking ventilation will cause the PowerSting to overheat.

Connect the safety key to the “Peripheral Interface” connector beside the “kill” switch. Without this safety key it is not possible to turn on the PowerSting. Note that there are two different safety keys, one is for use when

SuperSting/PowerSting communication is performed by wired connection and the other one when the communication is performed wireless. The safety key for wired connection has an RS-232 connector attached to it.

If wired connection is used, connect the RS-232 cable between the SuperSting and the PowerSting.

Connect each of the A and B electrodes to the appropriate connector to the right of the PowerSting front panel. Make sure to use the appropriate current transmission cable. Use these minimum wire sizes for A and B transmitter cables:

- 8 AWG for 27A operation
- 18 AWG for 3.2A operation

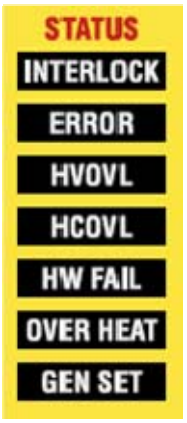
- Start the SGS generator to get power to the PowerSting.
- Start the SuperSting instrument and go to menu 6.4 and set the Baud rate to 19,200.
- If wireless communication is used, toggle the External Transmitter switch on the SuperSting front panel to the ON position so that the LED is on.
- If wired communication is used, toggle the External Transmitter switch on the SuperSting front panel, to the OFF position so that the LED is not on.
- On the SuperSting go to menu 2 and turn External Tx ON.
- On menu 2 continue and select 2. Sync Test. This will test the communication between the SuperSting and the PowerSting. The display will show PASS when the test is finished.
- On menu 2 select 3.Contact Resistance Test. This tests the contact resistance between the A and the B electrode. Set 1. Max Voltage and 2. Max Current to be used for the contact resistance test and then start the test by pressing F1.
- Go to Menu 1 and select Automatic Mode to start measurement.

8.1.5.1 PowerSting State Indicator lights

TRANSMIT lit, means that current is being sent through the A and B electrodes.

READY lit, means that the PowerSting is waiting to continue. No voltage to the A and B electrodes.

8.1.5.2 PowerSting Status Indicator lights



The STATUS lights indicate an error. When any of the STATUS lights comes on, the PowerSting stops and shuts off the power to the A and B electrode. To reset the PowerSting turn it OFF and then On again.

INTERLOCK is only used when two or more PowerSting are used together. INTERLOCK lit, means that the communication between the PowerSting's fails.
ERROR is a general error indication.
HVOVL a sudden change in voltage trips this light.

HCOVL a sudden change in current trips this light.
HW FAIL indicate power module hardware problem.
OVER HEAT the PowerSting is overheated, probably caused by blocked vents or a dirty air filter (see chapter 8.1.8 below).
GEN SET indicates that the incoming power is not sufficient to power the PowerSting.

8.1.5.3 Electrical safety working with the PowerSting

Caution: Lethal voltages may be present inside the PowerSting even when the A/C input voltage is disconnected. Only properly trained and qualified personnel should remove covers and access the inside of the PowerSting. Installation and service must be performed only by properly trained and qualified personnel who are aware of dealing with electrical hazards.

The A and B current connectors for the PowerSting are finger safe pin and sleeve high voltage isolated connectors.

The easily identifiable (red, 60 mm diameter switch on the PowerSting front panel) “kill” switch is used to instantaneously interrupt current transmission to the electrodes.

Three pairs of high voltage electrical safety boots are delivered with each PowerSting shipment. They are intended to be used by the PowerSting operator and the field assistant at one of the two current electrode stations. Electrical safety gloves (not included) should be worn too.

8.1.5.4 Transmitter electrode site preparation

It is important to reduce the contact resistance between the two A and B electrodes which are used to inject current into the ground. This is done by increasing the surface area and depth of each transmitter electrode. This can be achieved by using a number of, for example 10-20, stainless steel electrode stakes connected together and placed within a small area. This group of stakes then forms one large electrode. Another way is to dig a large hole and bury a sheet of aluminum foil and\or fill with salt water. Using a combination of these methods, the contact resistance may be reduced to the 20-50 Ohm range.

8.1.6 Wired communication SuperSting/PowerSting

The communication between the PowerSting transmitter and the SuperSting receiver is accomplished with a RS-232 cable. The wired safety key with the RS-232 connector is needed for wired communication.

8.1.7 Wireless communication SuperSting/PowerSting

The wireless communication between the PowerSting and the SuperSting is based on the international open bands 900 GHz or 2.4 GHz depending on region.

The wireless function is only available to be used with SuperSting with wireless option installed. SuperSting instruments with wireless option installed have the symbol displayed on the front panel.

Typical reach for the wireless system is 500 meter. This distance can be increased by placing a number of repeaters every 400 meter.

No set-up is necessary. A repeater battery may work for 12 hours of continuous operation. Charging takes approximately 90 minutes. The repeater has a built in 2,300 mAh Li-Ion battery.

Figure 24 The SuperSting wireless repeater is placed high on a tripod.

8.1.8 PowerSting maintenance

Blocking ventilation or running the PowerSting with a dirty air filter will cause the PowerSting to overheat and shut down. Therefore make sure to clean the air filter as soon as it gets dirty, this is important especially after using the PowerSting in a dusty environment.

The PowerSting uses a K&N high performance air filter model number K&N 33-2877. This is a washable and cleanable filter. The K&N washing and cleaning instruction are available online at this link: http://www.knfilters.com/cleaning.htm

The air filter is located on the right side of the front panel.

The K&N filter can be washed and re-oiled up to 100 times. This filter was originally designed for the 1991-2002 Mercedes Benz® SL600 V12 automobile and a replacement is therefore easily available from a Mercedes automobile dealer ship.

K&N filter cleaning accessories can be found at this link: http://www.knfilters.com/clningacc.htm

8.1.9 SGS (Sting Generator Set)

- The SGS (Sting Generator Set) consists of a Honda GX-670 V-Twin gasoline powered motor mated to a Mecc Alte SPA ECO 3-2LN/2 generator head. http://www.honda-engines.com/engines/gx670.htm
- The Honda GX-670 produces 15.3kW (20.5hp) at 3600 rpm.

Figure 25 The Sting Generator Set is a compact power unit.

- Operation manual for the Honda GX-670 V-Twin gasoline motor is attached with this manual.
- Recommended fuel for the Honda GX-670 V-Twin engine is pump octane rating 86 or higher.
- The generator head is a maintenance free, 3600 rpm, wired for 208V and 3-phase, 21KVA, Mecc Alte S.P.A. generator head (model number: ECO 3-2LN/2)
- The SGS requires a 12V battery with at least 145 CCA (cold cranking amps) (size: 7 5/8" W x 5" H x 6 1/4" L)

8.2 SuperSting electrode switch box

In some applications it is not economically feasible to use the intelligent smart electrodes, in such cases AGI has a number of electrode switch boxes available to be used with passive cables and electrodes to form a central switching system. When using the switch box any cable can be used to connect to the electrode stakes.

Figure 26 The switch box is available in 28, 56, 64, 84 and 112 electrode capability and for both the SuperSting R8 and the SuperSting R1

The switch boxes are available in 28, 56, 64, 84 and 112 electrode switching capability both for the SuperSting R8/IP and the SuperSting R1/IP.

SuperSting R8/IP is available with built-in switch box for 28 and 56 electrodes (model name SuperSting R8/IP+28 resp. SuperSting R8/IP+56).

SuperSting R1/IP is available with built-in switch box for 28, 56, 84 and 112 electrodes (model name SuperStingR1/IP+28 etc.).

The switch box has two Amphenol (male and female) connectors (black plastic type) and two female MS3476L18-32S connectors (metal type). On the SuperSting models with built in switch capacity the MS3476L18-32S connectors are placed on the right side of the instrument enclosure. The Amphenol connectors are used to connect the switch box to the SuperSting instrument or daisy-chaining to other switch boxes in order to control more electrodes.

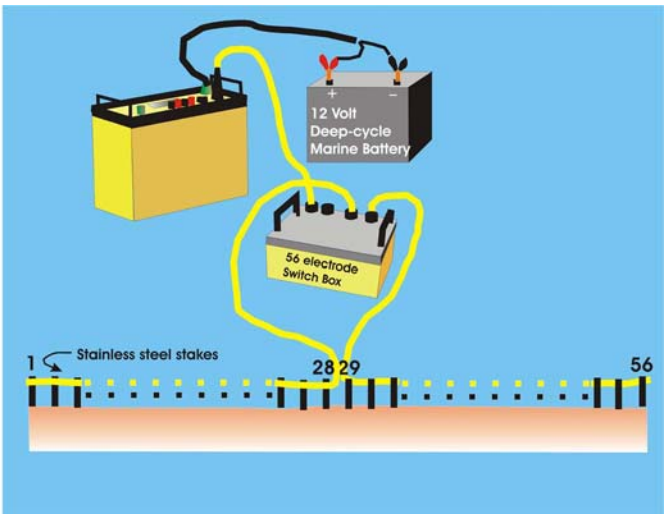


Figure 27 SuperSting/Switch box connection

The MS3476L18-32S are used to connect the electrodes to the instrument, use mating connector MS3476L18-32P. The connector marked “Low address cable” is used to address electrodes 1-28. Pin 1 of the connector should be connected to electrode 1, pin 2 to electrode 2 and so on.

The connector marked “High address cable” is used to address electrodes 28-54. Pin 1 of the connector should be connected to electrode 28, pin 2 to electrode 29 and so on.

An adapter is delivered with the switch box, for connecting the female connector of a passive cable to the female connector of the switch box.

For the SuperSting to control the switch box a regular command file can be used. For information on how to create a command file see section 6.3.

WARNING 1: The switch box contains sensitive CMOS circuitry, therefore make sure that the electrodes are not exposed to high voltage (over 15 V). Specially make sure that the electrodes are not touching each other so that an electrode which currently is a current electrode is not in contact with an electrode which is currently a potential electrode. Approaching thunderstorms can cause high voltage between electrodes, therefore interrupt any survey when the first thunder can be heard. Also be aware of electric fences.

8.2.1 What cable to use

It is not advisable to use any unshielded cable to connect to the electrode stakes. Crosstalk between members of the cable may be a serious problem causing coherent noise in the data. Since the noise is coherent it is impossible to distinguish from real data.

It is not advisable to use “seismic cables” to connect to the electrode stakes. The reason is that a seismic cable is not designed to transmit electrical current but to transmit a small voltage signal in the millivolt range. Since the signal voltage in the seismic application is low there is no reason to protect the wires from cross talk between members. In the electrical resistivity application current are driven into the ground with up to 400 V and at the same time the response is measured on other cable members in the millivolt range.

There are several types of passive cables available from AGI. There are land cables for resistivity imaging purpose on the surface, there are special underwater cables for measurements on the bottom of ponds, lakes, rivers and in the sea. There are also special borehole cables used in resistivity tomography measurements (ERT). Contact AGI for information on cables for your special application.

8.3 The AGI EarthImager 2D and 3D resistivity and IP inversion software

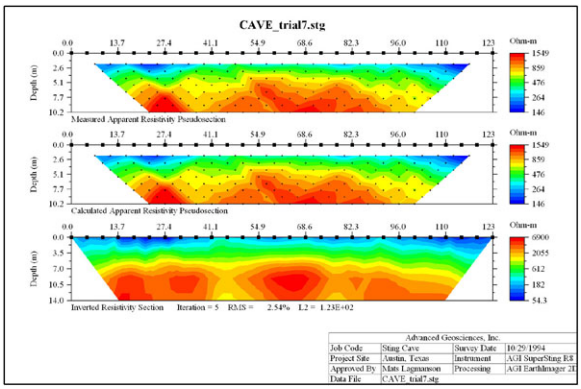


Figure 28 The EarthImager report ready plat style print-out

The EarthImager software directly reads SuperSting data files and inverts resistivity and IP data into images in color. Some of the highlights of the software are:

- Inverts both 2D and 3D data
- Inverts surface, underwater and borehole to borehole data
- Time lapse option for resistivity monitoring
- Includes a survey planner for pre-survey modeling
- Includes command file creator for borehole to borehole surveys
- High definition report quality plat style print-out
- Topographic correction
- A priori information input

8.4 Address re-programming kit

With the instrument was delivered a list of electrode switch serial numbers. By going to the SuperSting menu 3/6 you can re-address an electrode switch using the known serial numbers of that switch. If the serial numbers has been lost it is possible to scan the electrodes for the serial numbers, using the “Switch address re-programming kit.”
The re-programming kit comes in two versions, for SuperSting R1/IP (part number 951131) and for SuperSting R8/IP (part number 951031), only the connectors for the electrode cable differs. Make sure to specify model when ordering.

The re-programming kit comes with two cables, one to connect to the electrode switch and one to connect the re-programming box to the computer. To connect the re-programming box to the SuperSting the jumper cable delivered with the instrument is needed. To connect the re-programming box communication to the SuperSting the download cable delivered with the instrument is also needed.

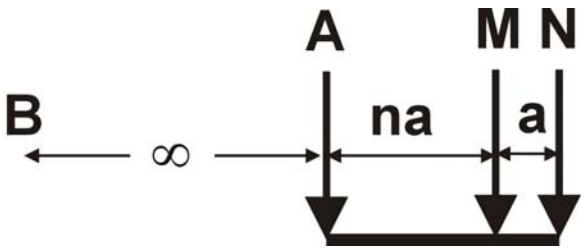
Figure 29 Address re-programming kit

8.5 Infinity adapters

Figure 30 The infinity adapters are available both for the SuperSting R8 and the SuperSting R1

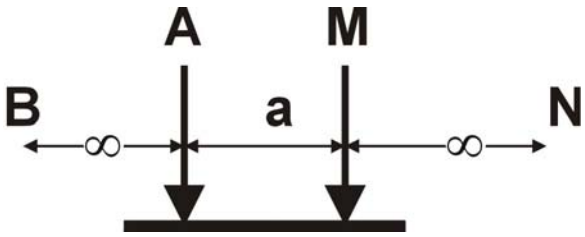
When performing surveys like pole-dipole and pole-pole it is necessary to place one or two electrodes at “infinity”. To make it easier to attach the infinity electrodes when using the Swift dual mode electrodes there are two infinity adapters available. The adapters plug in at the ends of the Swift electrode cable, the SuperSting is connected somewhere in the middle of the cable.

The adapter for the B electrode plugs into the “low address end” of the cable, and the adapter for the N electrode plugs into the “high address end” of the cable. Each adapter has a banana jack where a single lead wire with banana plug can be connected. The single lead wire leads to the infinite electrode. The adapters are marked “Infinity Elec. (N)” and “Infinity Elec. (B)” respectively.



The infinity adapters are not possible to use with the passive electrode system. In case of passive electrode system attach the infinity current electrode to the B terminal on the instrument front panel and the potential electrode to the N terminal.

When performing pole-dipole surveys, try to place the B electrode at 10 times the largest expected (**na**+**a**) distance away from the survey site.



When performing pole-pole surveys, try to place the B and the N electrodes at opposite sides of the survey area and at 10 times the largest expected **a** away from the survey site.

There are adapters available both for the SuperSting R1/IP and the SuperSting R8/IP.

8.6 SuperSting booster box

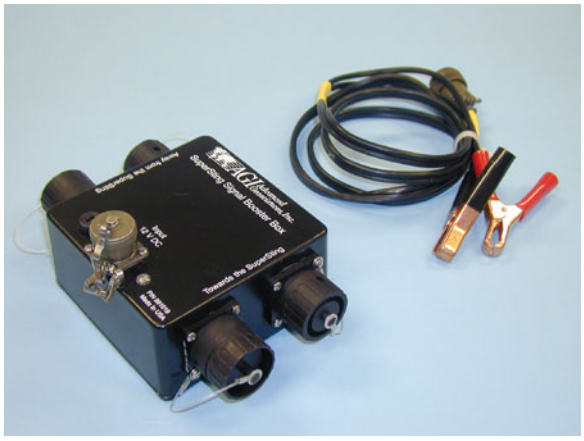


Figure 31 The booster box is available both for the SuperSting R8 and the SuperSting R1

When performing large surveys with many electrodes, the power supply and the signal level to the electrode switches get more attenuated the further you go from the SuperSting. At a certain distance from the SuperSting the electrode switches will not function correctly any longer, resulting in erratic data. The distance where this

occurs depends on how many electrodes and what electrode spacing is used.

In order to take care of this problem, one or several booster boxes needs to be installed along the line. As a rule of the thumb place the SuperSting in the middle of the electrode cable lay-out if you have less than 100 electrodes.

If you are using more than 100 electrodes, place the SuperSting between electrode 50 and 51, and use a booster box for every 50 electrodes. For example, if you are using 200 electrodes place the SuperSting between electrodes 50 and 51, a booster box between 100-101 and 150-151. Of course these are not exact addresses, place the SuperSting and the booster boxes at the nearest connector to these addresses along the line.

The booster box is placed in the line in such a way that the side which is marked “Towards the SuperSting” is connected to the Swift cable going directly towards the SuperSting.

Power the booster box with a 12 V type lawn mower battery.

There is a booster box available both for the Swift R1 and the Swift R8 electrode cables.

Figure 32 The short manual cable set

8.7 Manual cable set

There are three different manual cable set available from AGI, all with four plastic reels. The short cable set with two current cables 150 m/each and two potential cables with 50 meter each.

The medium cable set with two current cables 400 m/each and two potential cables with 135 meter each.

There is also a long cable set with two current cables 400 m/each and two potential cables with 135 meter each.

Figure 33 The medium size manual cable set

8.8 Laboratory measurement of soil samples

The resistivity of any material is defined as the resistance in ohms (Ω) between opposite faces of a unit cube of that material. If R is the resistance of a block of conductive material having length (L), in a cross-sectional area (A), then the resistivity (ρ) is expressed by the formula:

$$\rho = \frac{RxA}{L}$$

Resistivity, being a fundamental property of material, is independent of the volume. The unit for resistivity is Ohmmeter.

Resistance, however, depends upon the shape and the size of the specimen. The unit for resistance is Ohm (Ω).

Our soil resistivity test box is designed so that the readings shall be multiplied by a factor 101 to give result in Ωcm

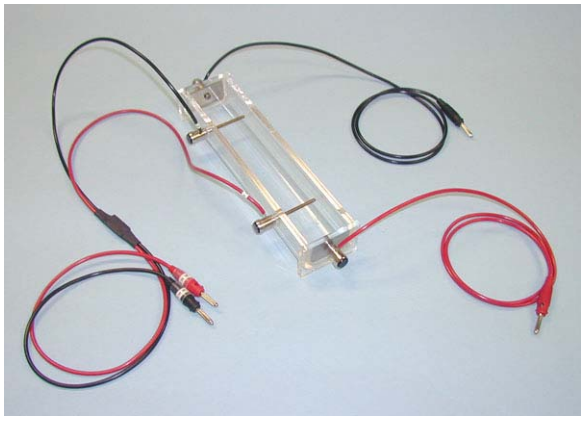


Figure 34 Test box for soil samples.

8.8.1 Equipment

The equipment required for the measurement of the resistivity of soil samples in the laboratory are:

1. the SuperSting, earth resistivity meter
2. a soil resistivity test box with cables and voltage divider
3. a straight edge
4. four insulated test leads
5. water (tap and distilled)

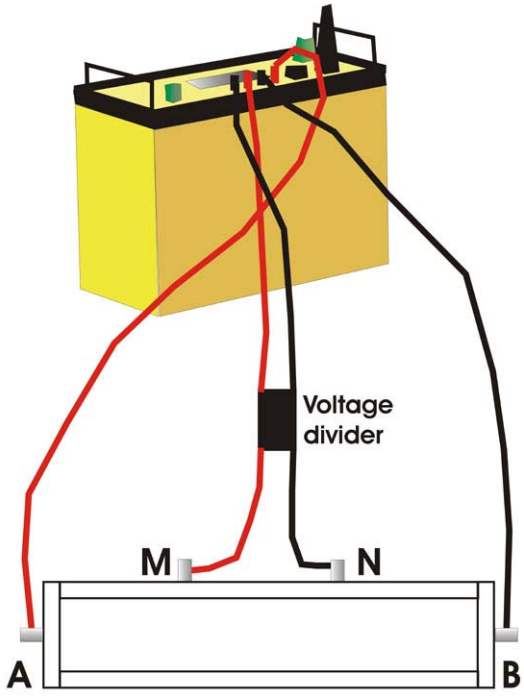


Figure 35 Connect SuperSting to the soil box using the voltage divider for the M and N terminal.

8.8.2 Sample preparation

Soil samples should be representative of the area of interest. Where the stratum of interest contains a variety of soil types, it is recommended to sample each type separately. It will also be necessary to prepare a mixed sample. The sample should be reasonably large and thoroughly mixed so that it will be representative.

The resistivity of soils is to a large degree a function of moisture content. Therefore it is important to protect the samples from drying during storage/transportation by wrapping them in plastic sheet or putting them in plastic bags. Measurement should be taken as soon as possible after sampling and as soon as possible after removing them from their container/wrapping.

Unscrew and remove temporarily the two potential terminals (brass pins) to facilitate filling the soil box. The soil should be well compacted in layers, with air spaces eliminated as much as possible. Fill the box and level off the top with a straightedge. Replace the two potential brass pins.

The measured resistivity is depending on the degree of compaction, moisture content, constituent solubility and temperature. The effect of variation in compaction and moisture content can be reduced by fully saturating the sample before placing it in the box. When possible, use ground water from the sample excavation for saturation. Otherwise use distilled water. If the soil resistivity is expected to be below 10,000 Ωcm, local tap water can be used without introducing serious error. Some soils absorb moisture slowly and contain constituents that dissolve slowly, and the resistivity may not stabilize for as much as 24 hours after saturation.

The saturated measurement will provide a "worst-case" resistivity and can be usefully compared with "as-received" resistivity measurements. Surplus water should not be poured off as this will remove soluble constituents.

8.8.3 Measurement procedure

- Connect the SuperSting to the terminals of the soil box, with the voltage divider, delivered with the SuperSting soil box, connected to the M and N terminals. Note that because of the voltage divider the result has to be multiplied with the factor 101 in order to give the result in Ωcm.
- Go to menu 6/1 and set the measurement settings to the following recommended settings:

Cycles:	2
Max error:	2.0
Max repeat:	1
Max current:	1 or 2 mA
Measure time:	1.2 s
Separate potential	OFF
Measure mode:	RES
Address Table:	Use Address Table

- Press **MEN** twice to get back to the main menu.
- Go to menu 2 and select array type: 1 Resistance.
- Select 2. to create a data file where to store the result.
- X and Y is used for coordinates when performing resistance measurements in the field, but can be used to identify different soil samples in the lab situation.
- Press the measurement key (MEA) and note the result on the display. This result has to be multiplied by a factor 101 to give the result in Ωcm (even though the display will not show cm). Also note the unit prefix, for example k Ω for 1000 Ωcm (kilo Ωcm).

8.8.4 Cleaning

The soil box should be thoroughly cleaned between measurements in order to avoid contamination by previous sample. It is easy to disassemble the box and clean, first with tap water then rinse with distilled water.

8.8.5 Temperature correction

The resistivity of soils is a function of temperature. In order to obtain results which best agree with field conditions, the sample should be at the same temperature as would be experienced at the test site.

Correction to 15.5°C (60°F) is recommended if the sample temperature exceeds 21°C (70°F).

$$R_{15.5} = R_T\left(\frac{24.5+T}{40}\right)$$

where T = soil temperature, °C
R_T= resistivity at T °C

8.9 Soil resistivity measurements for corrosion control

Soil resistivity measurements are performed to be used in the control of corrosion of buried metal structures. Normally the measurements are carried out using the Wenner electrode configuration with a number of specified Wenner-spacings. The Wenner spacing used is in most cases fairly short, most commonly not more than 5 meters (15 feet). For spacing of 1 - 5 meter (3 - 15 feet) use at least 20 mA or more in order to get noise free data.

The resulting resistivity measurement represents a weighted average resistivity of a hemisphere of soil of a radius equal to the electrode spacing (Wenner spacing).

The result is reported as Ωcm. If the SuperSting has been set for meters (Ωm) in the field, then just multiply the apparent resistivity with 100 to get the value in Ωcm.

In the United States, soil tests are standardized to be measured with Wenner-spacing in feet and the result reported in Ωcm. This is easiest achieved by setting the SuperSting in feet-mode, when collecting the field data. The SuperSting will download the data in meter-mode. In meter-mode all apparent resistivities are automatically recalculated to Ωm, therefore this value only has to be multiplied by 100 to give Ωcm.

9 Measurements

The SuperSting is a DC resistivity and induced polarization (IP) time domain instrument. The instrument automatically commutates the signal, but for the resistivity measurement it basically operates in the DC region of the signal.

The instrument has two modes of measurement, the resistivity (RES) mode and the resistivity/IP (RES/IP) mode.

9.1 Resistivity mode.

In the resistivity mode, for each measurement, the instrument injects a current, reverses polarity and injects the current and then reverse polarity back to original and injects the current again. The time for this cycle can be selected from four different settings: 0.4, 0.8, 1.2 sec, 3.6 sec, 7.2 sec or 14.4 sec. The default setting is 3.6 seconds.

Above method has been used in the Sting R1 instrument and has there proved to be very effective for resistivity measurements. This measurement scheme has therefore been kept in the SuperSting instrument as an option for resistivity measurement. If only resistivity data is required, an advantage of this method is that it is faster than if the resistivity/IP option is selected.

9.2 Resistivity/IP mode.

When measuring resistivity/IP the current injection pattern is different. The measurement cycle is: one period current +ON, one period of current OFF during which IP is measured, one period of current –ON and finally one period of current OFF during which IP is measured again. For each time slot the last measurement is subtracted from the first and the average is presented as the result. The result for each time slot as well as the total is saved in the SuperSting data file.

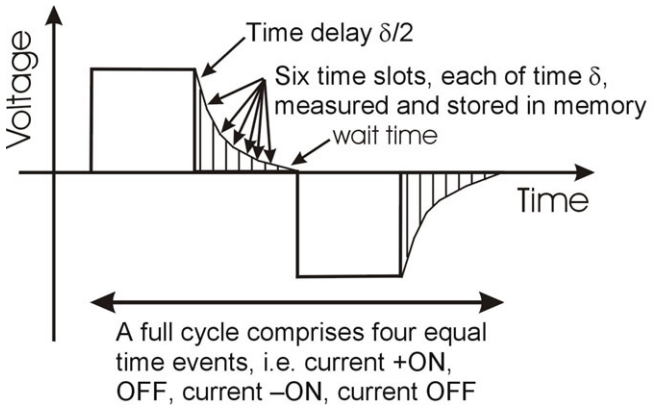


Figure 36 IP measurement parameters

This method has become a standard for measuring time domain IP in the mineral industry. There are five user selectable time constants in the SuperSting: 0.5, 1, 2, 4 and 8

seconds. The default setting is 0.5 seconds. The time constants and the different time events associated with each time constant is listed in the table below:

Time constant seconds	Total time cycle seconds	Time delay (δ/2) mseconds	Time slot (δ) mseconds	Wait time mseconds
0.5	2.33	65	100	0
1	4	65	130	155
2	8	130	260	310
4	16	260	520	620
8	32	520	1040	1240

10 Field procedures

10.1 Weather conditions

10.1.1 Rain

The instrument and the smart electrodes are weather proof, meaning that they can be out in the rain. However they can not be submerged into water. Further, any moisture on the front panel of the instrument or in the connectors increase the chance of electrical leakage between the current and potential lines resulting in degrading data quality.

Water in the connectors may cause electrolysis and severe corrosion of the contact pins and contact receptacles. Therefore make sure to keep the instrument and connectors clean and dry at all times. Use dust caps at all times on connectors, which are not in use.

Heavy rain will affect your survey negatively. After a rainstorm, surface water will percolate down into the ground. When water moves through soil, streaming potentials are created and these will be recorded by the instrument resulting in a “noisy” image of characteristic look. Therefore try to wait with the survey for a day after a heavy rainstorm.

10.1.2 Cold weather

The instrument will work well below 0°C. However around 0°C the LCD screen becomes “sticky” and changes of display happens slower and slower the colder it is. Around -10°C the LCD will stop working. Therefore if you are planning to work in colder weather you will need to somehow keep the SuperSting warm. The smart electrodes work well down to at least -20°C.

Snow and ice is highly resistive but does not affect the measurement in any other way. Actually the resistivity method works well for mapping permafrost.

10.1.3 Hot weather

When temperatures approaches +40°C the insulation performance of some plastic materials starts to break down and may cause electrical leakage problems between the current and potential lines. It is therefore important during hot weather to keep the instrument as cool as possible by keeping it in the shade.

When the instrument works at full power, i.e. with two external batteries, it generates excess heat, and it may then give an overheating warning “TEMP WARM” on the LCD screen. When this warning is issued it is important to make sure the instrument temperature is lowered. By keeping the instrument in shade from direct sun light the internal temperature of the instrument is lowered 10 – 15 ˚C. It is also a good practice to lower the current setting in case you get a “TEMP WARM”.

If no action is taken and the instrument continues to heat up, a “TEMP OVERHEAT” is displayed and the instrument shuts down and can be restarted when it has cooled down.

By placing the instrument in a large camping cooler with cold camping gel packs the instrument can be kept cool even during high ambient temperatures.

10.1.4 Blazing sun

The LCD may darken when heated up by the sun, should this happen it can easily be compensated by repeatedly pressing the LCD contrast key in the top right corner of the key board until the display is clear.

As described above, it is a good practice to shade the instrument during sunny days, booth to eliminate overheating problems and darkening of the LCD display.

10.1.5 Thunderstorms

Thunderstorms are dangerous both for you and the equipment. The instrumentation contains sensitive CMOS circuitry and can be destroyed by nearby lightning strikes. For you it is not a good idea to stand at the end of a long conductive cable during a thunderstorm.

Thunderstorms typically move very quickly and it takes some time to pick up the equipment, therefore it is time to interrupt the survey and pick up the equipment when you first hear the thunder in the distance.

Figure 37 Typical deer chew

10.1.6 Night time

Do not leave cables out over night. Many animals, like deer, rabbits, mouse etc. are moving around during the night time and their

way of testing if something is edible is to chew on it. Therefore it is important to keep animals off the survey line during the day and bring the equipment in during the night.

10.2 Batteries

The SuperSting is powered by one or two external 12 V DC batteries. When used In the main mode, the instrument is powered by one 12 V battery, in the boost mode powered by two 12 V batteries.

The batteries are attached to the instrument using the power cable that was shipped with the instrument. When in main mode the power cable is connected to the connector marked “Power” on the SuperSting front panel, the red and black Mueller clips are attached to the positive and the negative poles respectively of a 12 V battery.

When in boost mode, the SuperSting requires an additional 12 V battery. This battery is attached to the pig-tail connector of the main battery power cable using the red and black Mueller clips for the positive respectively negative pole of the boost battery.

When selecting the external batteries, we recommend the deep cycle marine battery type. This type of battery is used by fishermen to power their electrical trawling motors. The deep cycle marine batteries are designed to be discharged and charged repeatedly without loosing their capacity. An automobile battery could also be used, but this type of battery is designed to always be fully charged and will loose its capacity to be charged sooner.

10.3 Multi-electrode cables

There are two major systems for performing automatic data acquisition for resistivity and IP imaging, the distributed switching system and the central switching system.

When using a distributed switching system, the actual switching happens at each electrode. The instrument assigns which electrode shall be the current and which shall be the potential. The advantage is that the cable, connecting all the electrodes, only needs to have six wires (single channel system). There are two for signaling to the electrodes, two for the current electrodes, and two for the potential electrodes. In the distributed system the electronic detection and switching circuit is molded into special take-outs along the cable. This type of cable is also referred to as an active cable and the electrodes as smart electrodes.

When using a central switching system, the electrode switching typically happens at the instrument. For this method, there is one wire, in a multi-wire cable, for each electrode connected to the central switching unit. Central switching systems use “seismic type cable.” These types of cables are referred to as passive cables. Passive cables and central switching is used in applications not suitable for distributed switches, such applications are underwater measurements, borehole measurements etc.

There are a few terms which need to be clarified at this point.

Multi-electrode system, both distributed and central switching systems are multi-electrode systems, entailing a large number of electrodes, typically 20 – 100 or more, to be laid out and connected to the instrument.

Single-channel system, the instrument has one receiver. Thus, for each current injection, the potential can only be measured between two electrodes. Therefore, when using a single channel instrument only four electrodes, two for current and two for potential, are used for each measurement.

Multi-channel system
A multi-channel instrument has more than one receiver. For example, the SuperSting R8/IP has eight receivers. Therefore, for each current injection the potential between nine electrodes can be measured simultaneously, thus speeding up the measurement process.

10.3.1 Swift cable with dual mode electrode switches (active cables)

The Swift cable used for automatic resistivity or resistivity/IP survey. The cable has a number of electrode switches (smart electrodes) mounted, most commonly at equal intervals along the cable.

The electrode switches are numbered consecutively along the cable. The number of each electrode switch is marked on the cable beside the switch. Each electrode switch also has this number , or address, stored in its memory.

The cable has a 17-pin connector (SuperSting R8) or a 7 pin connector (SuperSting R1) in each end. In the lower address number end of the Swift cable, the connector is a female connector, in the higher address end of the cable there is a male connector.

Figure 38 Dual mode operation

Figure 39 Single mode operation

The electrode switches are of the patented (patent 6,404,203) dual mode type meaning that they can be used in two different modes. Each switch has two take-outs, a large cylindrical stainless steel take out and a micro banana jack (small cylinder take-out on old style switch see figure 25) take-out. When the switch is used in single mode the large take-out is used booth for current transmission and for potential measurement.

When the switch is used in dual mode, the large take-out is only used for current transmission and the smaller take-out is only used for potential measurement. Dual

mode switches makes it possible, if so required, to use non-polarisable electrodes also during automatic IP surveys.

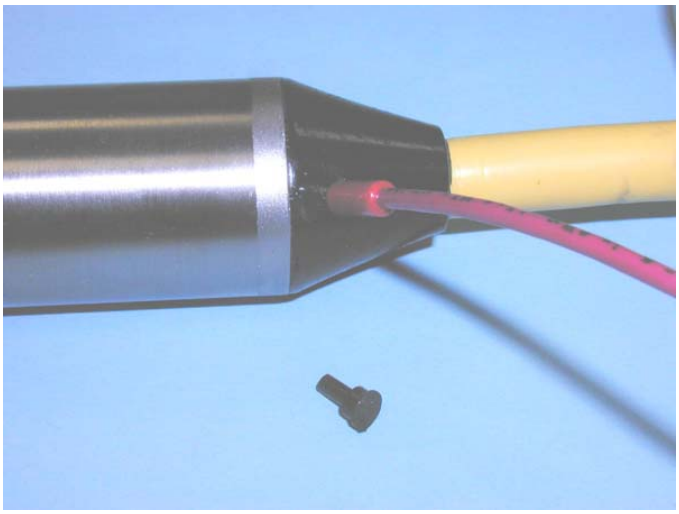


Figure 40 Remove the plastic plug using your finger nails

The micro banana jack is covered by a plastic plug, before using the electrodes in dual mode, remove all plastic plugs and keep in a safe place. After the survey is over replace all plugs.

There is a Swift cable system available both for the SuperSting R1/IP and the SuperSting R8/IP.

10.3.1.1 Swift electrode cable design

Figure 41 Old style dual mode electrode switch

With time there has been several changes in electrode cable design. However all electrode cables are compatible respectively within the SuperSting R1 and the SuperSting R8 series cables.

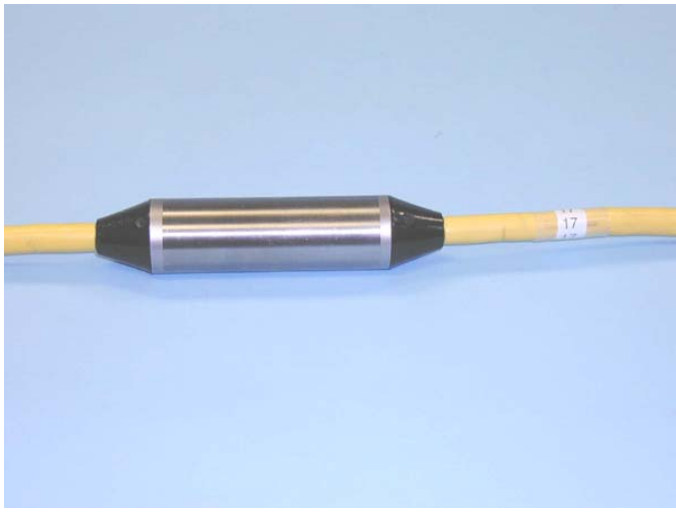


Figure 42 New style dual mode electrode switch

The dual mode electrodes used to have two cylindrical take-outs. In dual mode operation the large cylinder was used for current and the smaller cylinder was used for potential measurement.

The new design dual mode electrodes have one large cylinder and a micro banana jack. In dual mode operation the large cylinder is used for current and the micro banana jack is used for potential.

In single mode operation the large cylinder is used as take-out for both types of electrodes.

The SuperSting R8 uses a 17-pin connector. The SuperSting R1 uses a 9-pin connector. Previous Sting/Swift R1 cables used a 7-pin connector, current R1 cables have a 9-pin connector. It is therefore important to indicate what kind of cables and instrument you have when ordering new parts. To use R1 cables with the SuperSting R8 you will need an adapter with either the new (9-pin) or old (7-pin) R1 connector. To use R1 cables with the SuperSting R1 you will need an adapter if you have the old style R1 cables. All adapters can be ordered from AGI.

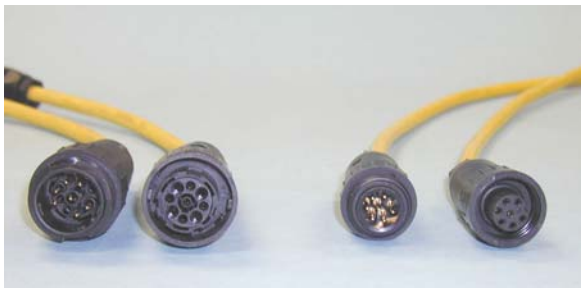


Figure 43 New style male and female R1 connector to the left, old style R1 connector to the right

10.4 Manual cables

Even though the SuperSting was designed primarily to be used with the Swift automatic electrode system to collect large amount of data in a fast way, it can also be used for sounding and profiling using four cable reels and stakes.

The most common field problem relates to problem with the cables. Therefore it is a good practice to treat the cables carefully. Below follow some hints on how to avoid "cable problems."

1. In order to avoid "crosstalk" between the cables, try to run the current cables and the potential cables at a distance from each other wherever possible.

2. Do not un-reel and reel in cable by pulling the cable. Instead "walk" the cable in and out.

3. Inspect the cable frequently to detect any cut in the insulation. Remove worn sections of the cable.

4. Use plastic reels in order to avoid "creep currents" to the ground. Do not use metal reels.

Of the cable problems, the most common has to do with the banana connectors. The best way is to use banana connectors which are soldered on the cables and carry a set of spare banana connectors of the "screw on type" in case one of the soldered connectors comes off in the field.

10.5 Electrodes

For regular resistivity work both automatic survey with the Swift system and manual survey use our stainless steel electrodes. For resistivity/IP surveys stainless steel electrodes are often used. However for the highest quality IP data we recommend that you use non-polarisable electrodes for potential electrodes when performing a manual survey. When performing an automatic IP survey using the Swift and the highest data

quality is required, use our dual mode electrodes in dual mode with a stainless steel stake in combination with a non-polarisable

10.5.1 Stainless steel electrode stakes

electrode.

Figure 44 Non-polarisable electrodes

For manual resistivity work using four cable reels and four stakes, the stainless steel electrode stakes are sufficient. Connect the cables to the electrodes with a solid copper Muller-clip soldered to the cable. When the electrode distance is short at shallow surveys, remember not to push the electrodes too deep into the ground in order to avoid changing the geometry (the electrode is supposed to be a point source). In these cases, do not put electrodes deeper into the ground than about 5% of the distance between the electrodes.

10.5.2 Non-polarisable electrodes

When using smart electrodes for automatic survey simply attach the electrode switch to the stake using the stainless steel spring. Make sure that there is a good contact between the smart electrode and the stake. Make sure to get the stake deep into the ground so that the crossbar is about 5 cm (2") above the ground.

Non-polarisable electrodes**.** are used when high quality IP data is required. The non-polarisable electrodes are shipped dry. To prepare for use, just unscrew the end with the porous tip, and fill with distilled water to 1 cm (1/2") below the threads. Replace the tip and shake the electrode to dissolve the copper sulfate crystals.

Note that there shall always be some undissolved copper sulfate crystals in the electrode, i.e. the copper sulfate solution shall be saturated.

For operation, connect the top copper terminal of the electrode to the potential cables (M and N) or when performing automatic survey with the Swift connect the top terminal to the micro banana take-out with a jumper cable. Remove the vinyl protective cap from the ceramic porous tip. Place ceramic tip in contact with the moist soil and take your reading.

Always replace the vinyl cover on the electrode after each usage to prevent moisture loss in the ceramic plug.

If the solution level is getting low, remove the porous tip end of the electrode and fill with distilled water. Replace the end piece, making sure both ends are on firmly to affect proper sealing. Shake electrode to obtain proper solution saturation.

11 Maintenance

11.1 Calibration

We recommend that the SuperSting instrument should be calibrated once a year. For calibration contact your nearest AGI distributor or contact AGI direct by e-mail to agi@agiusa.com or phone +1 512-335-3338 or fax +1 512-258-9958.

11.2 Fuses

There are a total of three fuses in the SuperSting instrument. The main fuse is located in a fuse holder next to the On/Off switch on the front panel. This fuse is a 20 Amp/32 V, 1 ¼"x ¼" fuse.

The two other fuses are internal fuses. To check these fuses proceed as follows:

- Make sure that you are at a non-static workplace (static electricity could damage the sensitive CMOS circuit inside the instrument when it is opened.)
- Place the instrument upright in front of you.
- Make sure you are well grounded.
- Use the Allen Wrench, 9/64" originally delivered with the instrument to unscrew the six hex screws located along the edge of the front panel.
- Carefully slide the instrument out of the enclosure by pulling the handles upward.

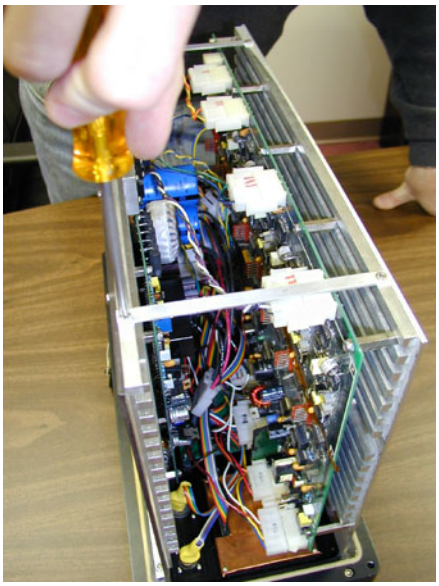


Figure 45 Unscrew two screws holding the bars to the transmitter board on the left side.

Figure 46 Unscrew the five hex screws, holding the transmitter board mounting plate to the front panel.

- Place the front panel/circuit board assembly upside down in front of you on a table. Unscrew the two Phillips screws, one for each bar between the two aluminum plates (see figure 31).

- Unscrew the five hex screws holding the mounting plate for the transmitter board to the front panel (see figure 32).
- Carefully lean the transmitter boar assembly outwards so that you can reach in between the boards. Make sure no connectors fall out when you do this. Especially the two small connectors with one blue and one yellow wire are easily disconnected by mistake.

The cable fuse is situated in an in-line fuse holder, placed on a red wire between the electrode cable connector and receiver board (the largest circuit board in the instrument). The fuse is a 1 Amp/250 V, 20 mm fuse.

The receiver fuse is situated in an in-line fuse holder, placed on a red wire between the transmitter board and the receiver board. The fuse is a 2.5 Amp/250 V, 20 mm fuse.

11.3 Battery life

The clock battery should last up to 10 years from the time the clock was manufactured. Note that the clock may have spent some time on the shelf before it was delivered to us and installed in the SuperSting. Estimate at least 5 year of operation.

The backup battery for the RAM memory depends on how often the SuperSting is used. If the SS were to sit on the shelf without being used at all, the backup battery will last for about 1 year. However, this will vary depending on how often the SuperSting has been used.

For battery replacement contact your nearest AGI distributor or contact AGI direct by e-mail to agi@agiusa.com or phone +1 512-335-3338 or fax +1 512-258-9958.

11.4 Electrode cable

Small cuts and holes in the yellow polyurethane jacket of the Swift cable can be repaired by using a soldering iron set for not more than 200ºC to melt together the insulation. Use extreme caution not to melt the insulation of the inner leads.

It is extremely important to keep the connectors clean and dry in order to avoid current leakage between the cable members, resulting in bad readings. Always keep the dust cap on the connector, whenever it is disconnected. Never leave an open connector on the ground.

If the connectors have been contaminated or wet, try to blow them clean using dry compressed air, rinse in distilled water (careful not to get water into the connector housing), blow dry and finally dry the connector in a warm place over night. If compressed air is not available there is “Air on a can” which can be obtained from most computer stores. This product is used to blow dust of keyboards and computer components.

11.5 Error codes and messages

HVOVL Issued when the SuperSting cannot send out current. Usually caused by a discontinuity in the AB circuit. Check for disconnected cables and disconnected electrode switches or try to decrease current electrode contact resistance by wetting the soil around the electrode with water.

TXOVL Issued when there is a problem with the transmission of the current after the measurement cycle has started. Could be caused by poor electrode contact to ground (varying resistance) or loose connections somewhere in the AB circuit. When using the automatic electrodes, the measurement is automatically restarted if Repeat (M6/1/3) is not set to Off. If this error persists during the last Repeat, then this measurement station is skipped.

INOVL Issued when one of the input amplifiers has been overloaded. Measurement will continue on all other receivers as normal. When the measurement is finished, the measurement is automatically restarted if Repeat (M6/1/3) is not set to Off. If this error persists during the last Repeat, then this measurement station is skipped.

Electrode stakes not being planted firmly in the ground typically causes both INOVL and TXOVL error messages.

TRANSMITTER OFFLINE !!! This error message is issued; when the office power supply is powering the instrument, the firmware cable is attached to the instrument or if there is a malfunction in the transmitter/instrument communication. Contact AGI or the nearest distributor in case of the latter.

TEMP WARM When this warning is issued it is important to make sure the instrument temperature is lowered. By keeping the instrument in shade from direct sun light the internal temperature of the instrument is lowered 10 – 15 °C. It is also a good practice to lower the current setting in case you get a “TEMP WARM” warning.

TEMP OVERHEAT If no action is taken and the instrument continues to heat up, a “TEMP OVERHEAT” is displayed and the instrument shuts down and can only be restarted when it has cooled down.

BLANK SCREEN OR DARK SCREEN The LCD is sensitive for temperature and may turn pale or too dark with change of ambient temperature. To adjust the contrast to a suitable level, press the contrast key repeatedly (see page 30).

12 SuperSting R8/IP technical specification

Measurement modes	Apparent resistivity, resistance, induced polarization (IP), battery voltage
Measurement range	+/- 10V
Measuring resolution	Max 30 nV, depends on voltage level
Screen resolution	4 digits in engineering notation
Output current	1mA – 2 A continuous
Output voltage	800 Vp-p, actual electrode voltage depends on transmitted current and ground resistivity.
Output power	200 W
Input channels	Eight channels
Input gain ranging	Automatic, always uses full dynamic range of receiver.
Input impedance	>20 MΩ
SP compensation	Automatic cancellation of SP voltages during resistivity measurement. Constant and linearly varying SP cancels completely.
Type of IP measurement	Time domain chargeabilitiy (M), six time slots measured and stored in memory
IP current transmission	ON+, OFF, ON-, OFF
IP time cycles	0.5 s, 1 s, 2 s, 4 s and 8 s
Measure cycles	Running average of measurement displayed after each cycle. Automatic cycle stop when reading errors fall below user set limit or user set max cycles are done.
Resistivity time cycles	Basic measure time is 0.4, 0.8, 1.2, 3.6, 7.2 or 14.4 s as selected by user via keyboard. autoranging and commutation adds about 1.4 s.
Signal processing	Continuous averaging after each complete cycle. Noise errors calculated and displayed as percentage of reading. Reading displayed as resistance (ΔV/I) and apparent resistivity (Ωm). Resistivity is calculated using user entered electrode array coordinates.
Noise suppression	Better than 100 dB at f>20 Hz Better than 120 dB at power line frequencies (16 2/3, 20, 50 and 60 Hz).
Total accuracy	Better than 1% of reading in most cases (lab measurements). Field measurement accuracy depends on ground noise and resistivity. The instrument will calculate and display running estimate of measuring accuracy.
System calibration	Calibration is done digitally by the microprocessor based on correction values stored in memory.
Supported configurations	Resistance, Schlumberger, Wenner, dipole-dipole, pole-dipole, pole-pole.
Operating system	Stored in re-programmable flash memory. New version can be downloaded from our web site and stored in the flash memory.
Data storage	Full resolution reading average and error are stored along with user entered coordinates and time of day for each measurement. Storage is effected automatically.
Memory capacity	More than 30000 measuring points can be stored in the internal memory.
Data transmission	RS-232C channel available to dump data from the instrument to a Windows type computer on user command.
Automatic multi-electrodes	The SuperSting is designed to run dipole-dipole, pole-dipole, pole-pole, Wenner and Schlumberger surveys including roll-along surveys completely automatic with the patented (patent 6,404,203) Swift Dual Mode Automatic Multi-electrode system. The SuperSting can run any other array by using user programmed command files. These files are ASCII files and can be created using a regular text editor. The command files are downloaded to the SuperSting RAM memory and can at any time be recalled and run. Therefore there is no need for a fragile computer in the field.
User controls	20 key tactile, weather proof keyboard with alpha numeric entry keys and function keys. On/off switch Measure button, integrated within main keyboard. LCD night light switch (push to light).
Display	Graphics LCD display (16 lines x 30 characters) with night light.
Power supply, field	12V or 2x12V DC external power, connector on front panel.
Power supply, office	DC power supply
Operating time	Depends on conditions, internal circuitry in auto mode adjusts current to save energy. At 20 mA output current and 10 kΩ electrode resistance more than 2000 cycles are available from a fully charged battery pack.
Weight	10.7 kg (23.5 lb.)
Dimensions	Width 184 mm (7.25"), length 406 mm (16") and height 273 mm (10.75").

13 SuperSting R1/IP technical specification

Measurement modes	Apparent resistivity, resistance, self potential (SP), induced polarization (IP), battery voltage
Measurement range	+/- 10V
Measuring resolution	Max 30 nV, depends on voltage level
Screen resolution	4 digits in engineering notation
Output current	1mA – 2 A continuous, measured to high accuracy
Output voltage	800 V_{p-p}, actual electrode voltage depends on transmitted current and ground resistivity
Output power	200 W
Input gain ranging	Automatic, always uses full dynamic range of receiver
Input impedance	>20 MΩ
SP compensation	Automatic cancellation of SP voltages during resistivity measurement. Constant and linearly varying SP cancels completely.
Type of IP measurement	Time domain chargability (M), six time slots measured and stored in memory
IP current transmission	ON+, OFF, ON-, OFF
IP time cycles	0.5, 1 , 2 , 4 and 8 seconds (combined resistivity/IP mode)
Measure cycles	Running average of measurement displayed after each cycle. Automatic cycle stop when reading errors fall below user set limit or user set max cycles are done.
Resistivity time cycles	Basic measure time is 0.4, 0.8, 1.2, 3.6, 7.2 or 14.4 seconds as selected by user via keyboard, auto-ranging and commutation adds about 1.4 s.
Signal processing	Continuous averaging after each complete cycle. Noise errors calculated and displayed as percentage of reading. Reading displayed as resistance (ΔV/I) and apparent resistivity (Ωm). Resistivity is calculated using user entered electrode array coordinates.
Noise suppression	Better than 100 dB at f>20 Hz Better than 120 dB at power line frequencies (16 2/3, 20, 50 and 60 Hz) for measure cycles of 1.2 s and above
Total accuracy	Better than 1% of reading in most cases (lab measurements). Field measurement accuracy depends on ground noise and resistivity. Instrument will calculate and display running estimate of measuring accuracy.
System calibration	Calibration is done digitally by the microprocessor based on correction values stored in memory.
Supported manual configurations	Resistance, Schlumberger, Wenner, dipole-dipole, pole-dipole, pole-pole, SP-absolute, SP-gradient
Operating system	Stored in re-programmable flash memory. New version can be downloaded from our web site and stored in the flash memory.
Data storage	Full resolution reading average and error are stored along with user entered coordinates and time of day for each measurement. Storage is effected automatically in a job oriented file system
Data display	Apparent resistivity (Ohmmeter), injected current (mAmp) and measured voltage (mVolt) are displayed and stored in memory for each measurement
Memory capacity	The memory can store 24,468 measurements in Resistivity Mode and 14,966 measurements in combined Resistivity/IP Mode
Data transmission	RS-232C channel available to dump data from the instrument to a Windows type computer on user command.
Automatic multi-electrodes	The SuperSting is designed to run dipole-dipole, pole-dipole, pole-pole, Wenner and Schlumberger surveys including roll-along surveys completely automatic with the Swift Dual Mode Automatic Multi-electrode system (patent 6,404,203) or with switch box and passive cables. The SuperSting can run any other array by using user programmed command files. These files are ASCII files and can be created using a regular text editor. The command files are downloaded to the SuperSting RAM memory and can at any time be recalled and run. Therefore there is no need for a fragile computer in the field.
Manual measurements	The instrument has four banana pole screws for connecting current and potential electrodes during manual measurments
User controls	20 key tactile, weather proof keyboard with alpha numeric entry keys and function keys. On/off switch Measure button, integrated within main keyboard. LCD night light switch (push to light).
Display	Graphics LCD display (16 lines x 30 characters) with night light.
Power supply, field	12V or 2x12 V DC external power (one or two 12 V batteries), connector on front panel.
Power supply, office	DC power supply
Operating time	Depends on survey conditions and size of battery used. Internal circuitry in auto mode adjusts current to save energy
Operating temperature	-5 to +50ºC
Weight	10.9 kg (24 lb.)
Dimensions	Width 184 mm (7.25"), length 406 mm (16") and height 273 mm (10.75").

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