The Syscal family of resistivity meters.

Designed for the surveys you do.

Resistivity meters may conveniently be broken down into several categories according to their capabilities and applications. The first we call Traditional Resistivity meters, or four electrode systems. These systems offer a meter that performs surveys in the traditional manner of placing four electrodes, taking a reading, and then moving the electrodes for the next reading. These meters will typically be used by those with minimal survey needs, such as utilities, cell phone tower grounding surveys, or universities wanting an instrument that will be used primarily for teaching.

The next category we refer to as Resistivity Imaging Systems. These meters come equipped with a number of switches to allow automated sampling through some number of electrodes. Syscal meters that fit in this category will have a Switch designation to indicate that they support this type of approach. Users of imaging systems will in general have greater requirements for survey speed and will need to survey larger areas.

A third category we refer to as Multi Channel systems. These systems permit simultaneous measurement of a number of dipoles. In the case of the Syscal Pro up to ten adjacent dipoles may be measured simultaneously. Multi channel systems are typically used by those with the most intense survey needs, as system productivity is improved by a factor of roughly eight. They are useful for special applications, such as ERT(Electrical Resistance Tomography) which has a need to collect large sample volumes quickly, for Marine applications where the additional dipoles permit continuous data collection, and for Monitoring Systems where remote system access is needed.

Traditional Four Electrode Systems

Within this group we have a range of meters whose principle difference is the amount of transmitting power they offer. Transmitting power is the biggest factor in determining the depth an instrument can reasonably be expected to reach. Three models are offered, the Syscal Kid, The Syscal Junior, and the Syscal R1 Plus. These same models, but with the Switch designation, will be discussed under imaging systems.

The general design principles of all Syscal meters are the same. Each instrument is a two channel design, allowing simultaneous measurement of the voltage and current. This principle seems to remain unique to Syscal instruments, yet its benefit is obvious. A more accurate calculation of apparent resistivity can be made when starting with accurate values for the measured voltage and current. A close examination of competing instruments will show that they assume a constant current during the measurement process, though we know this value may drop when batteries are placed under load.

Much attention is often given to the lowest possible voltage measurement that can be made by an instrument. This is somehow felt to indicate the sensitivity of one design over another. Yet, this number is often quite misleading. Syscal meters all use a 20 bit converter. With any analog to digital converter(A/D) there will be some noise in the hardware itself. Some manufacturers will attempt to amplify a very small signal buried in the A/D noise and report this as the theoretical sensitivity of the instrument. Rather than try to create a specification that is meaningless you will see the Syscal meters claim a very attainable 1 microvolt sensitivity.

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The real issue is to be able to measure a signal that is above the noise of the A/D. This signal must be well above the noise of other artifacts of the measurement process, such as spikes in the SP value. These spikes are always present and may not be removed completely even by linear drift correction. This is why Syscal instruments offer a range of transmitting power, so that you can use an instrument with sufficient power for your typical survey and measure a signal significantly above the noise level.

Syscal instruments are known for their excellent results in noisy conditions. Sufficient power and excellent electronic design deserve much of the credit for this result. All Syscal instruments allow the operator to set a minimum number of stacks, a maximum number of stacks, and a standard deviation such that when this quality level is reached the stacking process is stopped. This permits surveys to be done in a timely and efficient manner, while retaining the quality of results desired.

Syscal Kid

The most striking feature of the Syscal Kid is probably its size and weight. Just 3.5kg, with internal battery, and measuring 22 x 18 x 12cm, it is an instrument you can carry almost anywhere. Yet it offers more power, 25 Watt, than many instruments that you are probably already familiar with. The numbers tell the story: maximum transmitting voltage of 200V(400V peak to peak) and maximum output current of 500mA.

The Syscal Kid has the same microprocessor features found throughout the entire line of Syscal meters. Preprogrammed arrays for Schlumberger, Wenner, Gradient, Dipole Dipole, Pole Dipole, Pole Pole, and more, including the possibility for a user defined array. Features include calculation of apparent resistivity, memory storage for 1,800 readings, including standard deviation value for each measurement, and a warning message for high resistance(open electrode), which can be manually overridden.

Induced Polarization(IP) measurement is standard. Pulse duration can be selected at 0.5, 1.0, or 2.0 sec. Wave form for IP is positive on, off, negative on, off. In IP mode pulse duration is 2.0 sec. Like all Syscal meters the Kid is autoranging, meaning that the best setting for transmitting voltage is made automatically. Noise may be monitored before injection. Standard deviation for each reading is computed and stored.

Syscal Junior

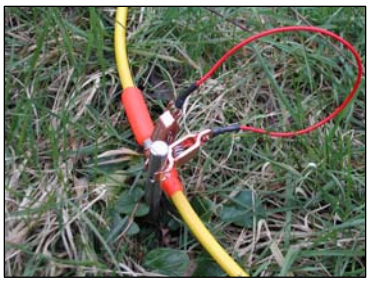
The Junior builds on the Syscal Kid design, adding more power, and more options. The Syscal Junior has maximum transmitting voltage of 400V(800V peak to peak), maximum current of 1.2A, and transmitting power up to 100Watt. IP measurement has been expanded to include up to four partial chargeability windows, plus total chargeability. Suggested depth range for the Junior is 100m.

Syscal R1 Plus

With the Syscal R1 Plus we come to a design with 600V maximum output voltage, 2.5A maximum current, and a full 200 Watt power rating. Suggested depth range is 200m for the standard instrument

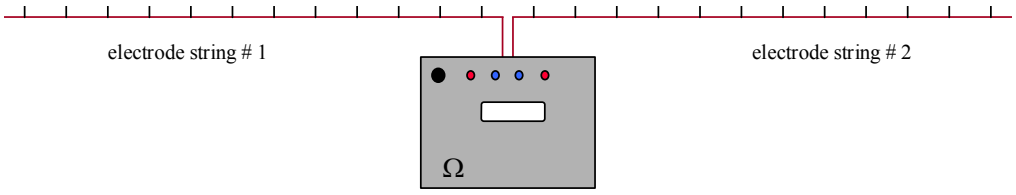
Imaging Systems

If you are considering a multi electrode sampling system for your meter then the design of the Syscal Switch system will be of interest. The Switch designation is used for meters that have been fitted with electronic switches, or nodes, to allow automatic sampling through a set of electrodes. In the early versions of multi electrode systems manufacturers placed the electronics for switching out on the cable at each electrode position. Over time it became apparent that this was a less than ideal solution, as the nodes received a lot of wear and tear on the cable, and the cost to manufacture individual nodes was high. A better solution was found by putting the switches in the meter. Manufacturing cost was reduced and a much more robust cable was the result. Today the Syscal Switch type meters use a multiconductor cable, designed by a company that has been making such cables for more than twenty years. The cables are reliable, lighter in weight than the previous generation, and more easily field repaired if ever required.



Syscal Kid Switch 24

The Switch designation on a Syscal meter indicates that it is equipped with internal electrode switches for automated array sampling. The model name is abbreviated to the Syscal Kid S24 for ease of discussion. The Syscal Kid S24 comes with two cables of 12 nodes each. The cables are double ended, and are plugged into the back of the meter into one of two connectors labeled for nodes 1-12, and for nodes 13-24.



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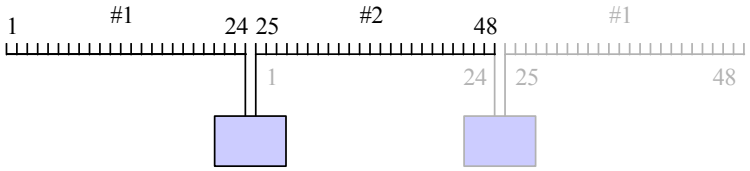
The standard spacing between electrode positions for the Syscal Kid S24 is 3m. Other optional spacings may be ordered, such as 1m, 2m, etc., out to 5m maximum.

A profile is collected by setting up the instrument with all 24 electrodes and collecting the array desired. The profile line is extended by then moving the instrument to the end of the first line(nodes 13-24), and the first cable section(nodes 1-12) is rolled forward in front of this. This is much the same method as used for seismic data collection. Since the cables are double ended there is no need to move the second cable section. The instrument is preprogrammed to automatically change the array for a roll along so that only the new electrode positions are sampled in the next measurement sequence.



Depth capability for any resistivity meter is a very difficult number to suggest, as it is highly dependant on geology, and how much stacking time an operator is willing to invest. For the Syscal Kid we feel a depth of 50m is a conservative value that should be possible in all but the most difficult locations. For the Syscal Kid S24 system the survey depth is limited by the profile length. With an electrode spacing of 5m, yielding a profile length of 120m, a survey depth of 25m would be typical. Whether your choice is the basic Syscal Kid, or the automated Syscal Kid S24, either package offers an instrument easy to use, easy to transport, and easy to own.

Syscal Junior

The Junior builds on the Syscal Kid design, adding more power, and more options. The Syscal Junior has maximum transmitting voltage of 400V(800V peak to peak), maximum current of 1.2A, and transmitting power up to 100Watt. IP measurement has been expanded to include up to four partial chargeability windows, plus total chargeability. Suggested depth range for the Junior is 100m.

The Switch versions of the Syscal Junior are offered in configurations of 24, 48, or 72 nodes. These would be designated as models Syscal Junior S24, Syscal Junior S48, and the Syscal Junior S72. Standard spacing on any Syscal Junior Switch type system is 5m, and may be optionally specified at any spacing up to 10m. Typical survey depth capability for a 72 node system at 5m intervals is 70m(360m profile length).

Creation of the array to be sampled with multi electrode systems used to be time consuming and difficult. This problem was addressed with the release of the Electre II software. The user friendly interface allows the user to see the array as it is designed, with electrode position, depth, and total number of readings required. Electre II will automatically generate a full sequence of “a” spacings, such as “2a”, “3a”, etc. As these are selected the operator can see the expected depth, and the lateral and vertical density of data points. Once an array is designed Electre II permits the generation of a roll along sequence corresponding to this array with only the added readings required.

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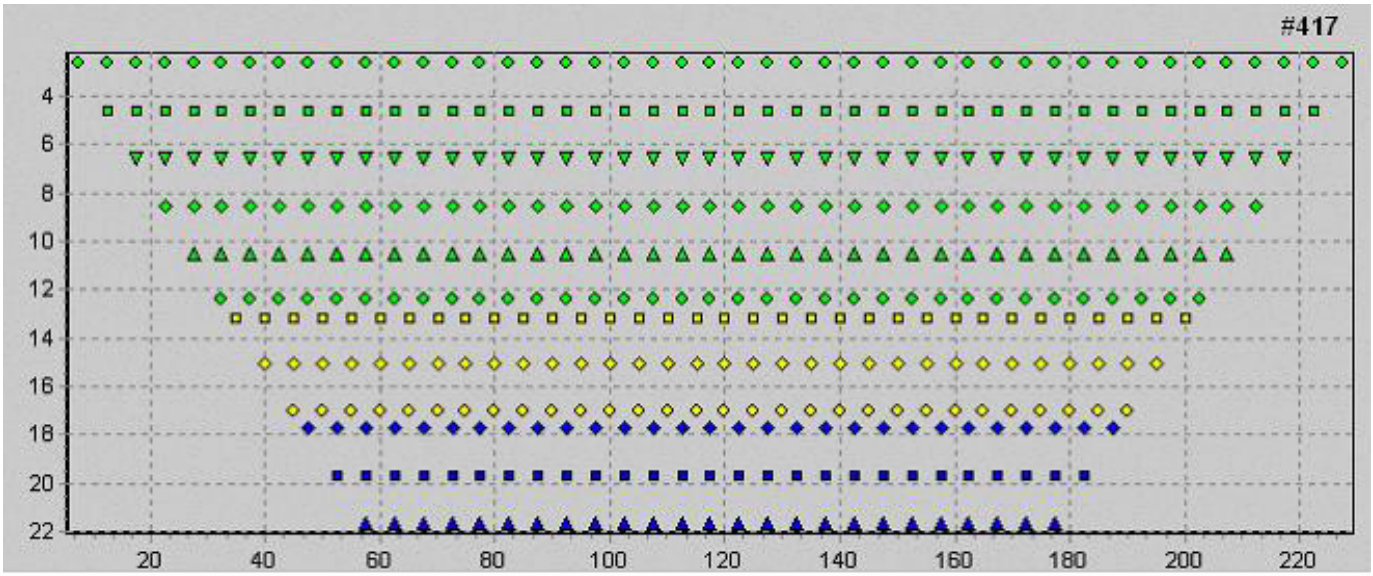
Example of Plotting Section from Electre II Software



This section represents the position of each plotting point for a sequence of measurements. The section has been interactively defined by the operator to include the following parameters:

-Cable Definition: cable shall consist of two sections, each with 24 electrodes at 5m spacing
-Electrode Array: Wenner-Schlumberger
-First Electrode Spacing: a=5m; Depth Levels n(a)=1, 2, 3, 4, 5, 6 **Green Dots**
-Second Electrode Spacing: 2a=10m; Depth Levels n(2a)=3, 7/2, 4 **Yellow Dots**
-Third Electrode Spacing: 3a=15m; Depth Levels n(3a)=8/3, 3, 10/3 **Blue Dots**

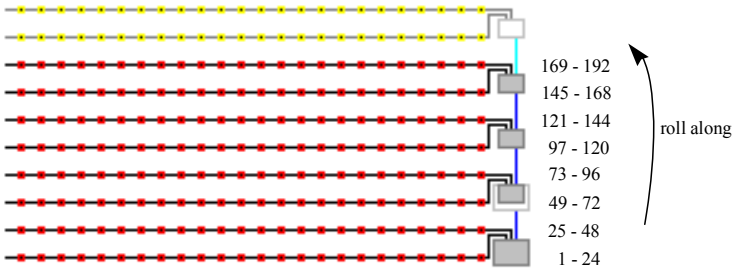
At each step of introducing these parameters the operator can make changes and see in real time the effect this will have on the section. The horizontal axis indicates the profile length for a cable of two sections of 24 electrodes at 5m spacing. The vertical scale is the plotting depth in meters, as defined by Edwards and Loke. In this case the maximum depth for this sequence is 22m. The total number of readings is indicated in the upper right corner as 417 readings. This entire sequence will be completed with an acquisition time of about forty minutes, based on a typical number of stacks per reading of 5, and a pulse duration of 0.5 seconds.

After data collection and transfer back to a PC the ProSys software package allows further data processing capabilities. The user may edit the data set and remove erroneous data manually, or automatically by entering a specified criteria, such as data points exceeding a certain standard deviation. The final data file is formatted for the popular 2D and 3D interpretation software packages such as Res2D/3DInv.

An option unique to the Junior and the R1 Plus(described next) is the **Remote Control Option**. With this option a second serial port is added which allows remote communication with the meter by an external computer. Software is provided so that arrays may be called up and run at preselected intervals. In this mode data is stored on the computer hard disk. If the computer is connected to the Internet then data may be collected and uploaded unattended. The Remote option allows a Syscal Junior or R1 Plus to become a true monitoring system, able to collect surface or borehole arrays in an unattended mode at user scheduled times.

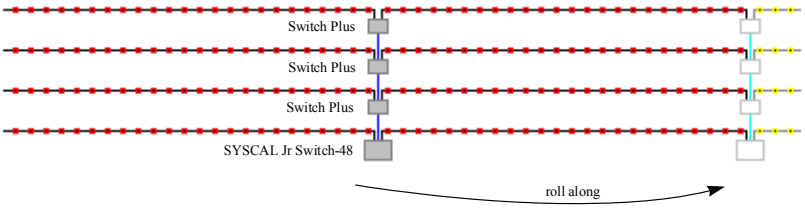
Speaking of borehole arrays and multi electrode sampling systems, the standard cable supplied with these systems is double ended. We do not recommend this standard cable for use in a borehole, due to potential water infiltration hazards. In this case we deliver a single ended cable which has proven to be quite reliable in a number of installations.

A second option offered beginning with the Junior series is the **Switch Plus Box**. We can put a maximum of 72 nodes into the case of either a Syscal Junior or R1 Plus. For users who want to go to greater than 72 nodes, particularly for 3D surveys, we connect one or more Switch Plus Boxes which typically will contain 48 nodes. These boxes may be spaced a maximum distance of 20m from the meter and each other. As illustrated below this concept allows rolling along the line, or down the line, with several hundred nodes.



Two types of line layouts are possible, as shown to the left and below. At the left are shown eight lines of 24 electrodes each, with the system set to roll to additional lines.

Here we show the ability of the system to roll along the line, running 4 sets of 48 nodes per line. For practical ease the recommended array is a combination of in-line colinear dipole-dipole, and broadside equatorial dipole-dipole, the latter having a greater depth of investigation.



Syscal R1 Plus

With the Syscal R1 Plus we come to a design with 600V maximum output voltage, 2.5A maximum current, and a full 200 Watt power rating. Suggested depth range is 200m for the standard instrument and 150m for a Syscal R1 Plus S72 at 10m spacing(720m profile length). All of the options available with the Syscal Junior may be added to the Syscal R1 Plus. These include internal nodes of up to 72, and external Switch Plus Boxes to a maximum limit of 2,054 electrodes. The largest system delivered so far is 1,152 nodes, for a multiple borehole array in the state of Washington.

Syscal Pro

The Syscal Pro is the newest member of the Syscal line. The Syscal Pro offers ten independent measuring channels(ten simultaneous dipoles), yielding a system up to ten times faster than a single channel design. We have offered a ten channel IP receiver for a number of years. With the Syscal Pro we have combined a proven design with the knowledge gained from many years of building resistivity meters to offer a system with extraordinary data collection speed, and the power to make it happen. The Pro features a maximum rating of 1,000V transmitting, 2.5A, and 250W with internal battery. Add an external DC/DC converter and the Syscal Pro goes to a 1,500V maximum, with a 500W power capability, or up to 1.2KW with an AC/DC converter.

The Syscal Pro features a graphics screen. IP measurements are expanded to include 20 partial chargeability windows, which can be adjusted to the time window desired. It is compatible with all the options described for the Junior and R1 Plus models, including internal Switches to 120 nodes, use of external Switch Plus Boxes, and the Remote Option. When used in a multi electrode configuration output voltage is limited to 800V due to limitations of the cable. The Syscal Pro is recommended to depths of 250m..

Marine Surveys

Marine resistivity surveys are becoming more popular. They allow characterization of not only the bottom sediments, but also the water column itself. Many times marine resistivity surveys can provide data not available in any other way, and often at very high data collection speeds. A multi-channel unit, such as the Syscal Pro makes the most sense for this type of work, though a single channel system could be used, but at much lower acquisition speeds.

In fresh water the typical approach is to float the cable at the surface using a dipole dipole array with an “a” spacing greater than the water depth. In salt water the cable is submerged and dragged on the bottom. In either case single ended cables, as used for borehole work, are provided, and strain relief is needed to prevent excessive wear on the cable.

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Monitoring(ERT) Systems

The Syscal Pro is ready to go for monitoring, with 2 internal alarm settings available in the standard instrument. Optional adapter boxes are available to connect the meter directly to bare wires, so that any site with surface and/or borehole electrodes may have all the cables brought back and easily connected at a single point. Alternatively, having these adapter boxes remain on site permits a monitoring crew to return at prescribed intervals and quickly reconnect the cables to the resistivity meter. The remote ComSys optional software package permits a local PC to be used as the system control center, storing arrays and their sampling schedule, along with the raw data, so that the system may be checked from time to time by the operator, or even remotely accessed if the PC is part of a network.

Design a resistivity meter built for your needs.

Heritage is pleased to offer these four basic designs. To build the meter that meets your needs, and matches your budget, start with the model suited to the depth range you expect to work in. If you want a multi electrode sampling system add the Switch option with number of nodes and spacing desired. For remote monitoring add an R to the model designation. With this approach you have a system designed for you and you will only pay for the power and options you need. This makes it easy for you to enjoy an instrument with a cost and size appropriate for the surveys you typically do.

Specifications	Syscal Kid	Syscal Junior	Syscal R1 Plus	Syscal Pro
Max. Output Voltage	200V	400V	600V	1,000V
Max. Output Current	0.5A	1.2A	2.5A	2.5A
Max. Output Power	25W	100W	200W	250W
Voltage Resolution	1 µV	1 µV	1 µV	1 µV
Accuracy	1%	0.5%	0.3%	0.3%
Input Impedance	22MΩ	10MΩ	10MΩ	10MΩ
Temperature Range	-10° to 50°C	-20° to 70°C	-20° to 70°C	-20° to 70°C
Dimensions, cm	22 x 18 x 12	31 x 21 x 25	31 x 21 x 21	30 x 25 x 25
Weight, kg	3.5	7	9.5	10
Depth Range, meters	50	100	200	250
IP, Total Chargeability	Yes	Yes	Yes	Yes
IP, Partial Chargeability	No	4 Windows	4 Windows	20 Windows
Channels	One	One	One	Ten
Remote Option	No	Yes	Yes	Yes
Max. Internal Switches	24	72	72	96
Max. External Switches	None	192	2,054	2,054

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