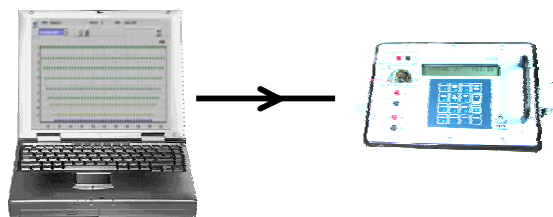


RESISTIVITY IMAGING:

step-by-step operation of SYSCAL Switch resistivitymeters

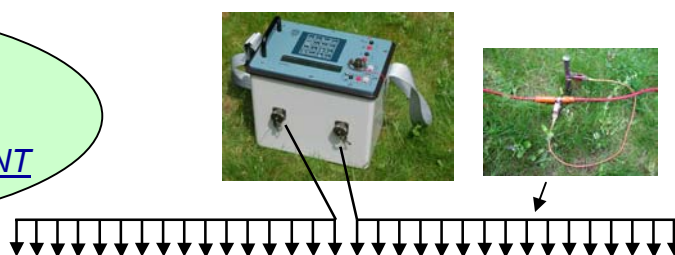
1st STEP:

CREATE A SEQUENCE OF READINGS
WITH ELECTRE II SOFTWARE



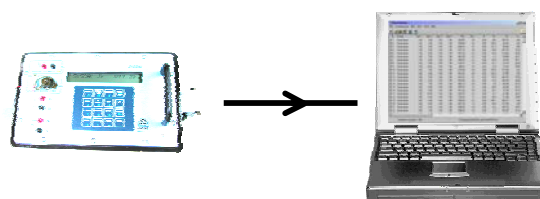
2nd STEP:

TAKE READINGS IN THE FIELD
WITH SYSCAL SWITCH EQUIPMENT



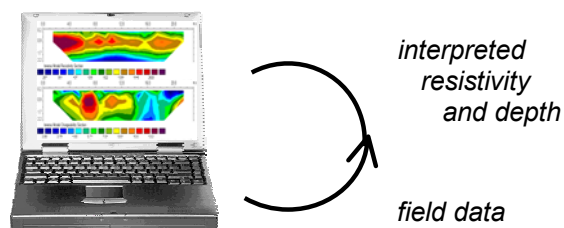
3rd STEP:

TRANSFER AND PROCESS THE DATA
WITH PROSYS SOFTWARE



4th STEP:

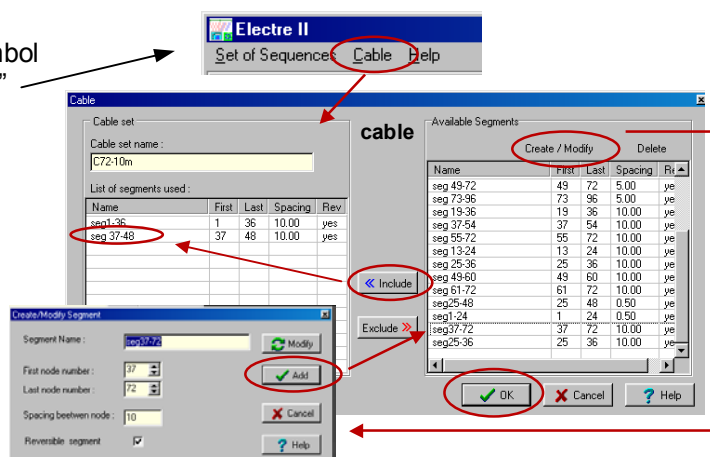
INTERPRETE THE DATA
WITH RES2Dinv SOFTWARE



1st STEP: CREATE A SEQUENCE OF READINGS WITH ELECTRE II SOFTWARE

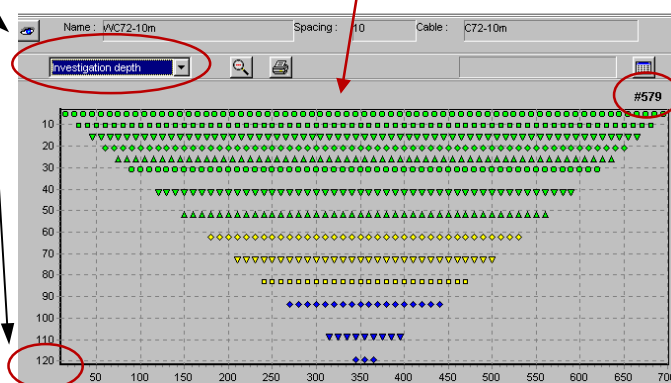
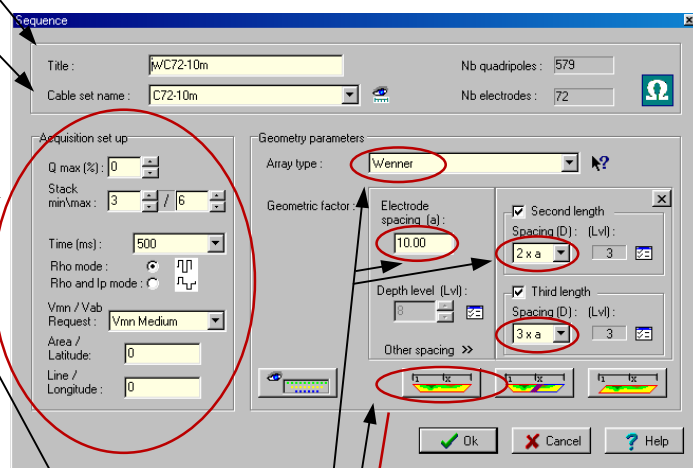
■ DEFINITION / SELECTION OF THE CABLE:

- in ELECTRE II software, "." must be the decimal symbol
- run the ELECTRE II software, click on "Cable", "New"
- use pre-set segments with the "include" function or "modify" and "add" and "include" them:
 - segment name: seg1-36
for electrodes 1 to 36, at 10m spacing
 - segment name: seg37-72
for electrodes 37 to 72 at 10m spacing
- give a name to the cable:
 - cable name: **C72-10m.cbl**, for the cable with the two previous segments, then "OK"



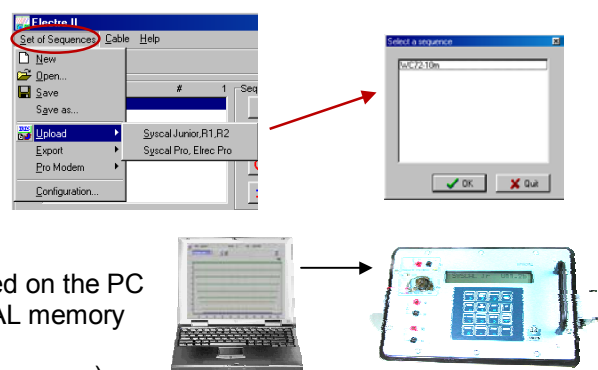
■ DEFINITION / SELECTION OF THE SEQUENCE:

- click on "Set of sequences", "New"
- give a name (title) to the sequence to create (ex: WC72-10 for Wenner with 72 electrodes at 10m)
- give the name of the file which contains the definition of the cable (ex: C72-10m.cbl)
- acquisition: Qmax: 3%, stackmin: 3, stackmax: 6, time: 500ms, Rho mode, Vmn medium
- array type: Wenner (other: dipole-dipole, ...)
 - electrode spacing: 10m, depth levels: 1, 2, 3, 4, 5, 6, 8, 10
 - other spacing, second length, spacing 2xa, depth levels: 6, 7, 8
 - other spacing, third length, spacing 3xa, depth levels: 6, 7, 23/3
- click on the left coloured icon:
 - introduce the abscissa of the first electrode of the array (ex: 0m) and the nb of electrodes
 - the section appears with the levels defined by the sequence previously defined
 - observe the number of quadriple combinations (# 579 readings)
 - check the max depth obtained: max about 20% of the line length (0.2x72x10m, or 140m)
- click on "Set of sequences", "Save as"
 - create a new directory which will include the sequence file just defined: \dir-1, then "OK"
 - the file **WC72-10m.sqx** is stored in directory dir-1



■ LOAD THE SEQUENCE IN THE SYSCAL MEMORY:

- in ELECTRE II software, "Open" the sequence to transfer to the SYSCAL
- click on "Set of sequences", "Upload", "Syscal R1", "select a sequence", WC72-10m
- switch the SYSCAL on, press "CONFIG" key, select "load new sequence", "ENTER"
- connect the SYSCAL to the PC with serial link, "ENTER"
- click on "OK" on the PC window to start the transfer
- the PC displays the name of the file which will be necessary to copy if the PC where the data will be transferred is not the same as that from which the sequence has been loaded: **sequ1-E72-Q579-#1.ele**; "OK"
- "upload in progress", then "sequ1 correctly loaded" is displayed on the PC
- several sequences may be successively loaded in the SYSCAL memory
- maximum sequence number in the SYSCAL is 9
- maximum quadriple combinations is 1500 (in 1 or up to 9 sequences)



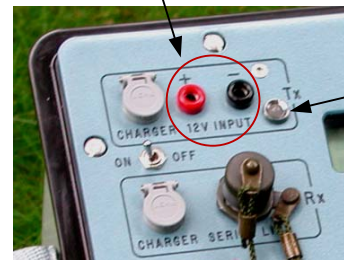
NOTE : a library of most common sequences (ex: dipole-dipole, Wenner-Schlumberger array, 48 or 72 electrodes, 5m spacing, with various investigation depths) is available in the "ELECTRE II / Library" directory of the CD supplied with the SYSCAL Switch

2nd STEP: TAKE READINGS IN THE FIELD WITH SYSCAL SWITCH EQUIPMENT

▪ SET UP THE SYSCAL SWITCH AND ITS ACCESSORIES:

- internal receiver battery of the SYSCAL: checked with the **"BATT"** key (ex: 12.24V, 72%). Min is 10V, 0%
- internal transmitter battery of the SYSCAL (1hour autonomy): checked by the green/red light
- external transmitter battery (recommended): to be plugged when the previous light remains steadily red
 - (some units have an int / ext switch for the transmitter battery)
- set up the multicore cables and connecting boxes, dig electrodes, connect alligator clips
- check with the **"MODE"** key, that the "multi-electrode" option is selected
- press the **"SPACING"** key
 - to introduce the area and line parameters
- check the connection of electrodes with the **"RS CHECK"** key:
 - if "open line" is displayed during the automatic test of the 48 or 72 electrodes, dig more into the ground the electrode under control, or press **"ENTER"** to check the resistance of the following electrodes
- by pressing **"MONITOR"**, it is possible to introduce a set of A, B, M, N electrodes (ex: 1, 2, 10, 11), and select "Rs Check" to measure the resistance of AB electrodes, or "Monitor" to make a resistivity measurement with this quadripole. This can help to check a given stake, or decide the stack number

external transmitter battery plug



transmitter battery control light



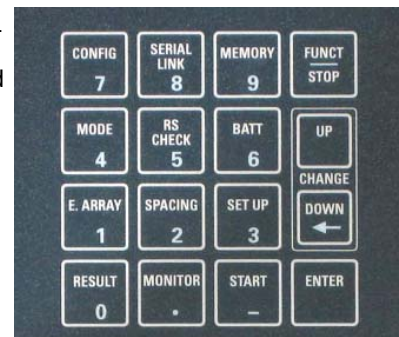
multicore cable



▪ LAUNCH THE AUTOMATIC SET OF READINGS CORRESPONDING TO THE SEQUENCE:

- select the sequence file with the **"E.ARRAY"** key:
 - # 1 corresponds to the first sequence file loaded,
 - # 2 corresponds to the second sequence file loaded, etc.
- press **"SET UP"** to check or modify the quality (ex: 3%), stack-min (ex: 3) and max (ex: 6), time (ex: 500 ms), level of voltage required (ex: < 50mV)
- press the **"START"** key: 1 reading with 4 stacks takes about 6s, 500 readings about 1/2 h
- during the readings, a first display gives the numbers of the electrodes A, B, M and N where the measurement is currently made, the number of the present quadripole (n°5) over the total number of readings to take (579), also the output voltage (HV) used selected by the SYSCAL
- a second display gives the values of the signal (v), of the current (i) of the standard deviation (q), and of the number of stacks in progress (#)
- during the readings, a pause can be made with the **"DOWN"** key:
 - to reconnect an electrode which would be disconnected
 - to change the transmitter battery if the red light remains on
 - to modify the stack number, required voltage with the **"SET UP"** key
- after a pause, press **"START"** to resume the sequence
- press **"FUNCT / STOP"** to stop the acquisition of a sequence of readings before its normal end
- when the sequence is finished, "Select function" is displayed

SYSCAL Switch keyboard



A1 B2 M6 N7 Sp= 3
5/579 HV = 100V - - -

v = 53.3 i = 14.6
q= 0 # 3

SYSCAL displays during acquisition

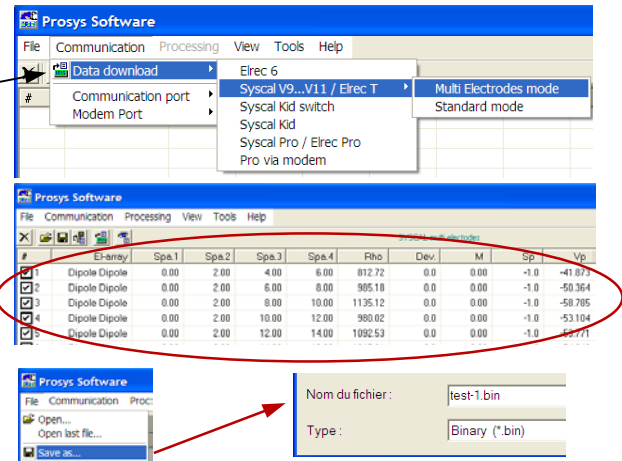
▪ CHECK THE RESULTS STORED IN THE SYSCAL MEMORY:

- the data are automatically stored in "DATA FILE # 1" for the 1st set of readings, #2 for the 2nd one,...
- to check the data after their acquisition, press the **"RESULT"** key, select the file number to read (#1, # 2,...) and check all the readings (voltage, current, resistivity) of this data file by pressing **"ENTER"**.
- capacity of the memory: 2 730 readings, in 1 to 83 data files max, with 1 500 readings max/data file
- to delete data files, press **"MEMORY"**, **"DOWN"**, then select "Del. all datafiles", and "0, 9, -, 7"
- to delete sequence files, press **"CONFIG"**, **"DOWN"**, then select "Del. all sequences", and "0, 9, -, 7"

3rd STEP: TRANSFER AND PROCESS THE DATA WITH PROSYS SOFTWARE

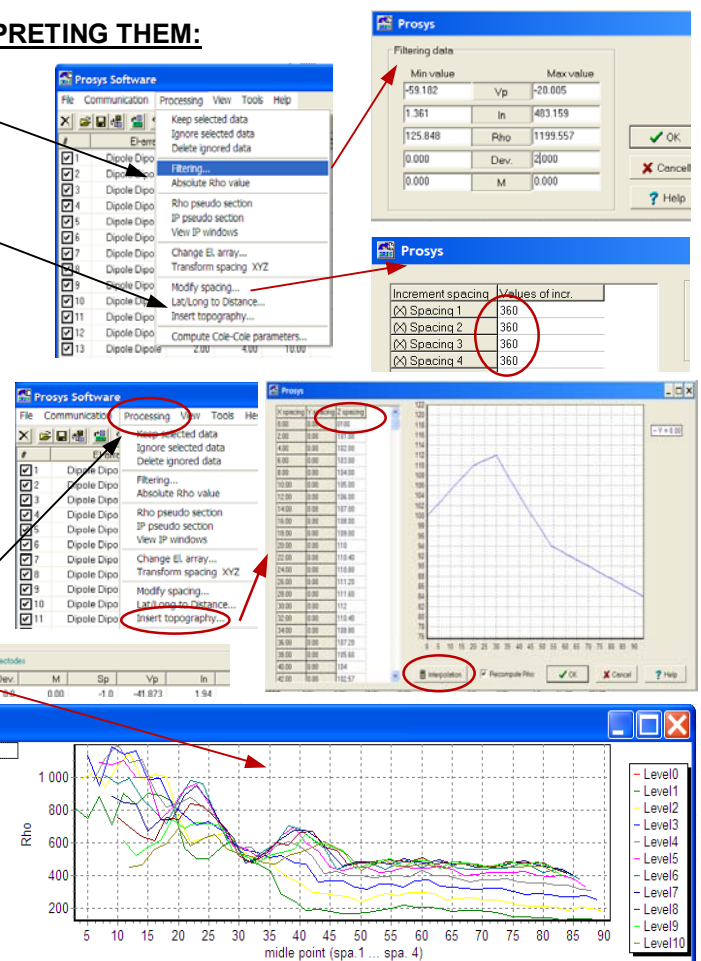
• TRANSFER THE DATA FROM THE SYSCAL TO THE PC:

- connect the serial cable to the SYSCAL and to the PC, run the PROSYS software
- click on “communication”, “data download”, “SYSCAL V9”, “multi-electrode mode”, “OK”
- switch the SYSCAL on, press the “SERIAL LINK” key, then the “ENTER” key on the SYSCAL
- all the data files are transferred (1 mn / 500 readings)
- at the end of the transfer, a name must be given to the 1st file transferred (**test-1.bin**), then to the second one, if any, etc. Data are displayed, one reading per line, with the co-ordinates (spa1, ...4) of the electrodes, and the values of resistivity (Rho), voltage (Vp), current (In), standard deviation- quality (Dev), the SYSCAL can then be switched off.



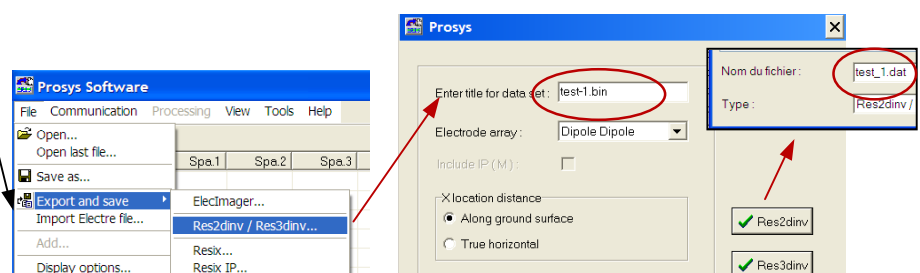
• CHECK AND PROCESS THE DATA BEFORE INTERPRETING THEM:

- click on “processing” and “filtering” to eliminate the data with high deviation (ex: only keep the readings which have a quality coeff. < 3%) or with a good Vp signal
- click in a box to ignore ☐ or to validate ☒ a reading
- click on “processing” and “modify spacing” to modify the abscissa (X value) of the electrodes of a file, if the data of this file have been obtained after a translation of a first sequence. Introduce the value of the translation (ex: 360m) for spa1, 2, 3, and 4 electrode co-ordinates.
- if two files have to be merged, because they are successive segments of the same profile:
 - click on “file, open”, give the name of the 1st file
 - then click on “file”, “add”, give the name of the 2nd file to merge with the 1st one
 - then click on “file”, “save as” to give a name for the new combination file.
- click on “processing” and “insert topography”, to give Z spacing values for the electrodes; an interpolation function for the points located between two Z referenced electrode positions is available
- click on the “Rho” of the table header to display the curves of the voltage measured at various depth levels. Check these values by validating the various levels selectively (clicking in the level boxes). Large spikes may represent bad data readings
- click on “processing” and on “rho pseudo section” to display a color image of the apparent resistivity



• MAKE A FILE READABLE BY THE INTERPRETATION SOFTWARE:

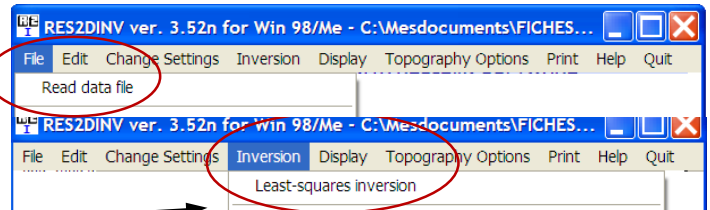
- click on “file”, “export and save”, “Res2Dinv / Res3Dinv”, then click on “Res2Dinv”
- confirm the name of the current file to export: test-1.bin
- give a name to the file which will be read by Res2Dinv: **test-1.dat**



4th STEP: INTERPRETE THE DATA WITH RES2Dinv SOFTWARE

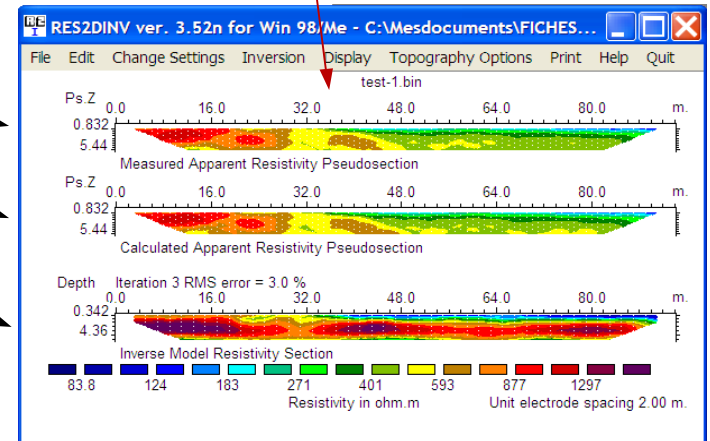
Introduce the data file:

- click on "file" and "read data file"
- give the name of the file: test-1.dat, then "OK", "OK", ... until no more message



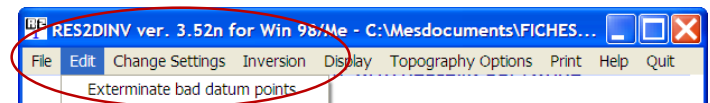
Run a standard inversion:

- click on "inversion" then on "least squares inversion"
- after a few iterations, three sections are plotted:
 - the apparent resistivity measured (data)
 - the apparent resistivity re-computed from the model
 - the interpreted resistivity with its depth (model, or solution)



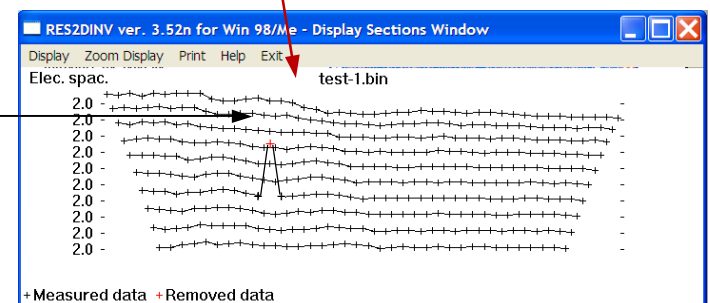
Eliminate bad data:

- click on "edit", then "exterminate bad datum points"
- the apparent resistivity profiles corresponding to given levels of investigation are displayed.
- when a point seems erroneous, click on it, the + becomes red (+), meaning that the datum point will be discarded during the next inversion which will be carried out. The point can be re-introduced in the inversion by clicking on it again (+)



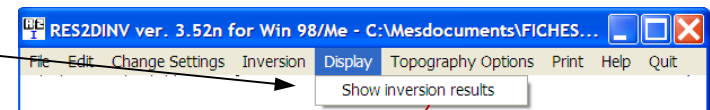
Change the colours of the sections:

- click on "display", then "show inversion results"
- click on "display sections", then "display data and model sections"
- it is then possible to control the scale of colours of the sections:
 - the resistivity limits for these colours
 - the colours themselves



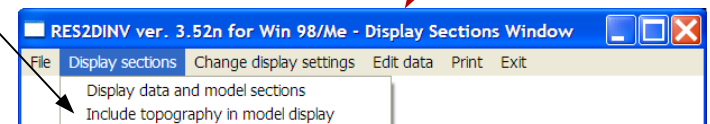
Introduce the topography:

- click on "display", then "show inversion results"
- click on "OK", "display sections", then "include topography in model display"
- the interpretation section is then displayed with the elevations for the electrodes.



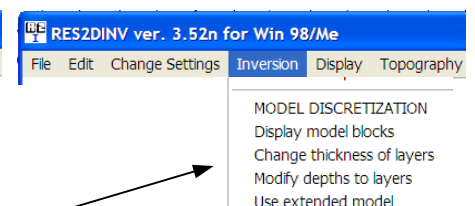
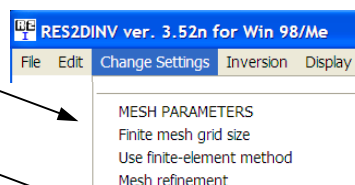
Change the size of the cells:

- click on "change settings", then "mesh parameters, mesh refinement"
- click on "finer mesh" or on "finest mesh" to improve the resolution of the model.



Constrain the model

- by depth or thickness of layers: click on "inversion, model discretization"



- Other options of the software:** see the RES2Dinv notice

SYSCAL SWITCH

a range of multi-electrode resistivitymeters



SYSCAL Kid Switch

24 electrodes
spacing between cable take-out (std): 3m, 5m
power: 25 W – voltage: 200V
pre-programmed sequences of measurements

SYSCAL Junior Switch

24 - 48 or 72 electrodes
spacing between electrodes (std): 5m, 10m
power: 100 W – voltage: 400 V
programmable sequences of measurements

SYSCAL R1 Plus Switch

24 - 48 or 72 electrodes
spacing between electrodes (std): 5m, 10m
power: 200 W – voltage: 600 V
programmable sequences of measurements



SWITCH Plus unit

48 or 72 electrodes
accessory of SYSCAL Junior, R1 Plus Switch
for increasing the number of switched electrodes

SYSCAL Pro Switch

10 simultaneous channels for high speed readings
48, 72 or 96 electrodes
spacing between electrodes (std): 5m, 10m
power: 250 W – voltage: 800 V
programmable sequences, 3D imaging

SWITCH Pro units

48, 72, 96 electrodes for SYSCAL Pro Switch upgrade

