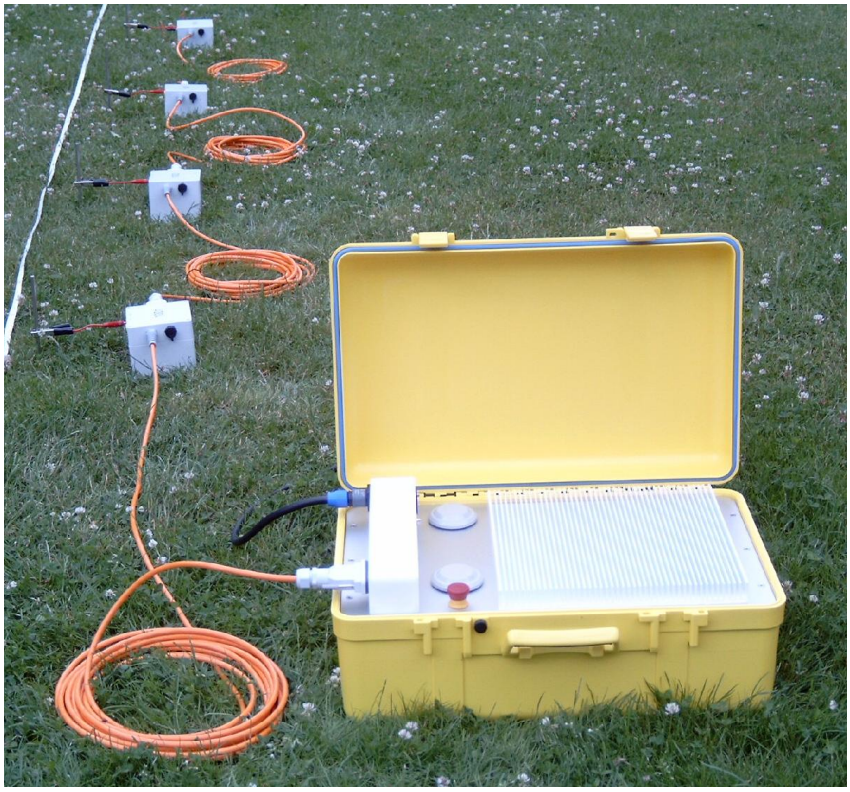
SIP256D

• Fast 2-D and 3-D measurements on frequency dependence of electrical resistivity of rocks and sediments

Spectral Induced Polarization

Geophysics



The **SIP256D** system is a true multi-channel instrument for fast SIP measurements. It is optimized for 2-D and 3-D measures of the complex resistivity (amplitude and phase) distribution in the soils over more than 7 decades of frequency. The instrument allows synchronic measurements with up to 256 Remote Units. Currents and voltages are measured directly at the electrodes. In doing so, systematic measurement errors can be largely avoided such as those which occur with many multi-core using instruments. External noise can be cancelled due to a novel Reference Noise Cancelation technique.

SIP256D System consists of:

- Base Unit with built-in 50 W Transmitter.
- External 600 W Transmitter.
- Up to 256 Remote Units (RU) for synchronic current and voltage recording.
- 2 Reference Remote Units (RRU) for noise recording or for 4-point Laboratory measurements.
- PC software to control the whole system: data visualisation, processing, storage, export.

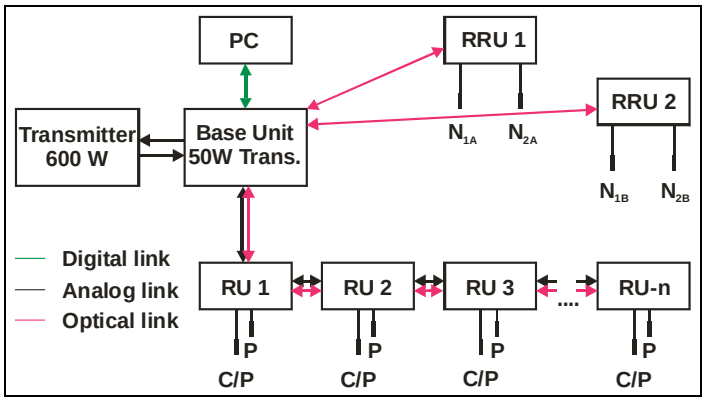


Fig. 1: Schematic diagram of the **SIP256D** System.

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RADIC RESEARCH - Dr. Tino Radić
Web: www.radic-research.de, Email: radic@radic-research.de
Zehntwerderweg 188A, 13469 Berlin, Germany, Phone: +49-30-40399210

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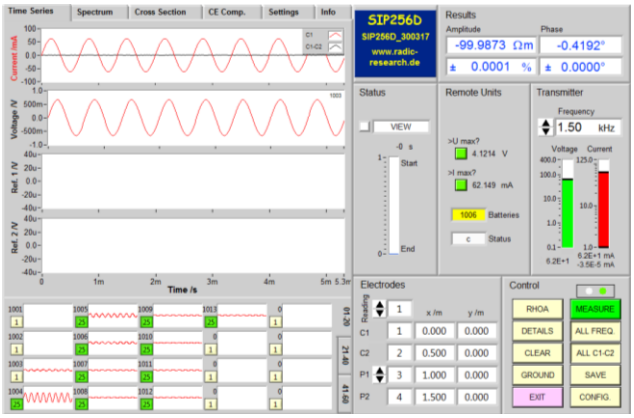
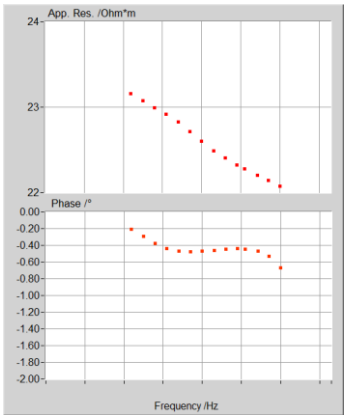
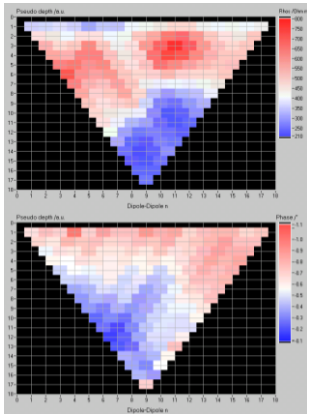


Main Panel of operating software



Impedance Spectrum



Impedance
Cross Section

▲ OPERATING SOFTWARE

The operating software runs on every Windows 7-10 PC. The PC and measuring system are connected via USB (WiFi on request). All the measurement configurations and measurement frequencies are saved in an initialization file and are loaded when starting the program. The user can cancel the completely automatic measurement process at any time and intervene manually. During the measurement, the main menu of the operating program displays (real time) the recorded time series (currents and voltages), the resistivity spectrum (amplitude, phase, confidence interval) and the cross section (amplitude, phase, confidence interval). This makes a data quality check very easy. The measurement starts at the highest frequency. Depending on the lowest measured frequency the acquisition of a complete spectrum takes from less than a minute (1 Hz) up to one hour (0.001 Hz).

NEARLY ALL FIELD LAYOUTS ARE POSSIBLE ▶

AC measurements make higher requests on the cables and the instrument than DC measurements. The cables of the SIP256D system are optimized for low cross coupling. Therefore, the user can design his IP measuring array almost as simply as for direct current measurements. Every Remote Unit can be used for current injection. Potential differences can be measured between neighbouring as well as between distant electrodes. For this, two or more adjacent potential wires can be linked together.

FASTER MEASUREMENTS

With each measurement, all the Remote Units are always active in order to measure voltages and currents. The progress of measurement increases with the amount of Remote Units used. Each RU can independently calculate the relevant Fourier coefficients using a real time DFT. Delays through data transfer and time series analysis are therefore negligible. Of course, it is also possible to measure a “classic” resistance cross section. This can be achieved by carrying out the measurement at a single frequency (e.g. 100Hz). The result is then available immediately.

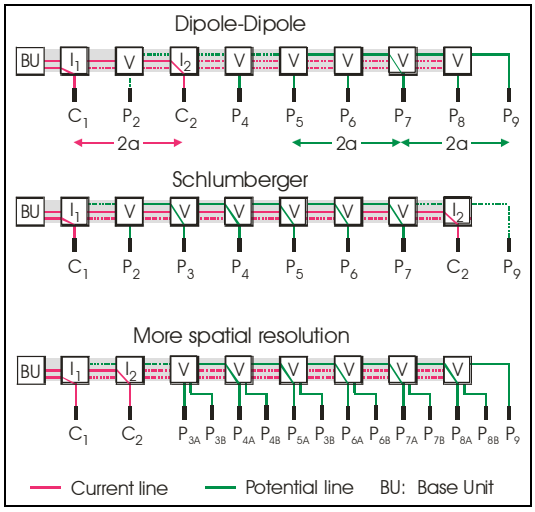


Fig. 2: Examples for field layouts

REFERENCE REMOTE UNITS FOR NOISE REDUCTION

The quality of data from geoelectric field measurements is more of less strongly reduced by technical or natural noise voltages. Reference Remote Units (RRU) are provided to determine these large-scale correlating interference voltages; these RRUs can be placed at a distance of up to 300 m from the profile. With the help of a multi-variate coherence analysis of all the measured time series, the noise can be separated from the wanted signal. By doing so, the signal to noise ratio increases up to one or more magnitudes. This innovative technique does not prolong the measuring time.

REFERENCE REMOTE UNITS FOR LAB MEASUREMENTS

Spectral impedance measurements on rock samples compliment each professional field measurement because they can help to make the lithologic classification of field data easier. The two Reference Remote Units are best suited for these measurements. One of the RRUs measures current, the other measures voltage. The operating software supports such a 4-point measurement.

RADIC RESEARCH - Dr. Tino Radić
Web: www.radic-research.de, Email: radic@radic-research.de
Zehntwerderweg 188A, 13469 Berlin, Germany, Phone: +49-30-40399210

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AVAILABLE VERSIONS ▶

The measuring system **SIP256D** is available in different versions. All versions measure the voltages and the currents directly at the respective electrodes. Furthermore, the digitalized data is transferred through an optical cable to a measuring computer. Two Reference Remote Units can be connected to the Base Unit. With AC measurements, coupling can take place, resulting in large systematic measurement errors. The significance of this problem increases proportionally to the frequency. Therefore, different versions can be chosen depending on the varying requirements of the client regarding acceptable systematic measurement errors. The basic versions 1 and 2 already allow undistorted spectral resistance measurements of at least 1 kHz. The high-end versions 3-4 allow measurements up to 20 kHz.

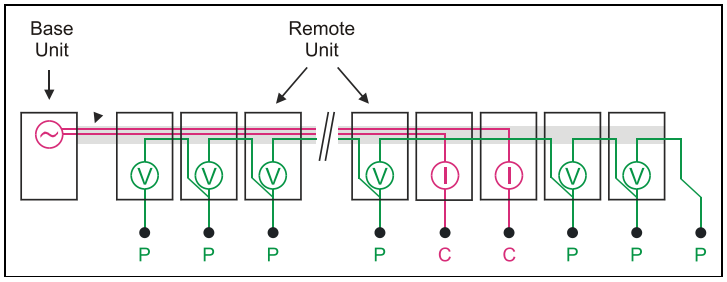
Version 1: The transmitter is located at the beginning of the profile built-in the Base Unit. A power cable connects the transmitter with the respective current electrodes (C). An active shielding avoids capacitive current leakage between the power cable and the ground, as well as between the power cable and the parallel running potential cables.

Version 2: Current wires and potential wires are separated. This reduces coupling with/in configurations in which current and potential wires run parallel.

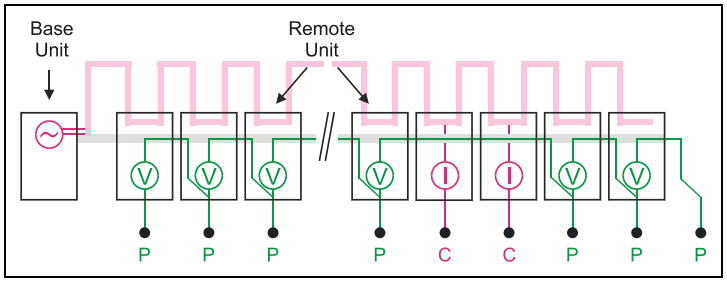
Version 3: Unlike with versions 1 and 2, a transmitter is located at each electrode. The length of the power cable is reduced to a bare minimum. Capacitive couplings can be avoided almost completely.

Version 4: The use of a mobile transmitter provides the same quality of measurements as Version 3, but is cheaper. However, the user needs to relocate the transmitter manually.

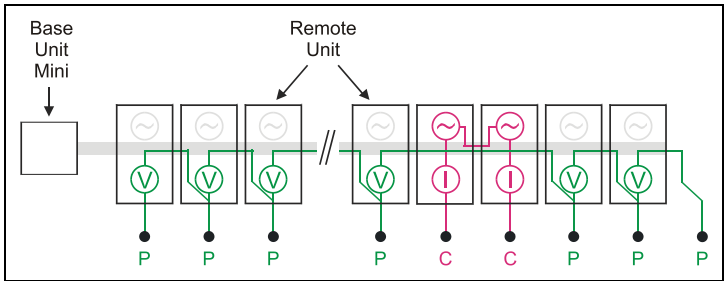
Version 5: Each Remote Unit has 8 additional receiver channels. This way, more information about the ground can be collected at the same speed.



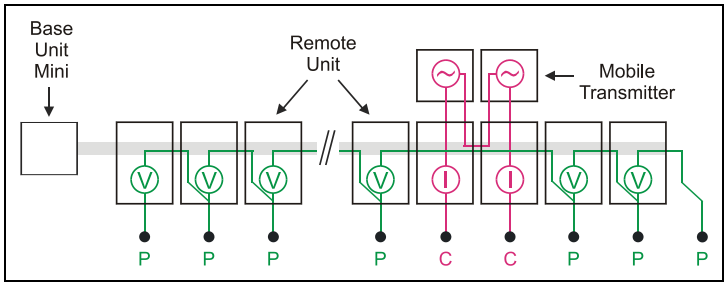
Version 1: The potential wire (green), the two current wires (red) and the optical fibres are combined in one interconnection cable. Current wires are actively shielded.



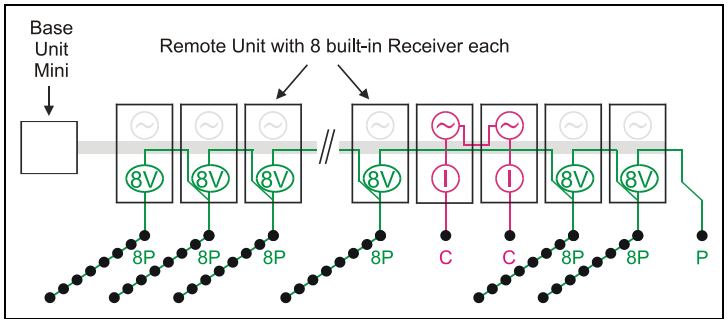
Version 2: Potential wires and current wires are guided in two separated cables. Current cable is actively shielded.



Version 3: Built-In Transmitters shorten current wire length.



Version 4: With mobile Transmitters.



Version 5: Multi-Receiver Remote Units.

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Web: www.radic-research.de, Email: radic@radic-research.de
Zehntwerderweg 188A, 13469 Berlin, Germany, Phone: +49-30-40399210

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NON-POLARIZED ELECTRODES

Each Remote Unit has two sockets to connect electrodes. The red (see following diagram) is suitable for the power input and for the voltage measurement. Normally, one uses metal electrodes for this. The natural potential drift of metallic electrodes can, however, reduce the data quality of low-frequency SIP measurements. Therefore, an non-polarized electrode can be additionally connected to the yellow socket. In this case, the metal electrode serves only as the power input and the non-polarized electrode only the voltage measurement.

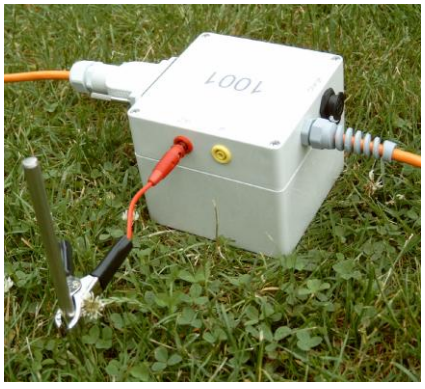
CE COMPENSATION

The current is measured at both current electrodes. This allows to quantify and to compensate the unavoidable capacitive current leakage at high frequencies between each current wire and the soil.

SYSTEM COMPONENTS

Base Unit with 50 W Transmitter

600 W Transmitter



Remote Unit

Reference Remote Unit

SIP256D

Technical specifications

Base Unit (BU)

- Frequency range: 0.001 - 20.000 Hz
- Signal shape: 1-4x sinusoidal
- Interfaces to RUs: 2
- Interfaces to RRUs: 2
- PC interface: USB
- Built-in transmitter: ±250 V, ±0.2 A or ±400 V, ±0.125 A (50 W)
- Interface to ext. 600 W transmitter
- Supply: Car battery (12 V, 65 Ah)
- Weight: 10 kg
- Size: 50 x 18 x 50 cm^3

Remote Units (RU)

- Input voltage range: ±5 / ±0.2 V
- Input current range: ±2 A / ±80 mA
- A/D converter: 24 bit
- Initial sample rate: 96 kHz
- Data rate: 96 kHz / 2^n, n=0,1,2…18
- Buffer length: up to 250 k samples
- Data format: 32 bit
- Stacking: 1,2,4,8,...,256
- Digital 50 / 60 Hz filter
- Digital drift filter
- Built-in DFT
- Socket 1: P & C Electrode
- Socket 2: Non-Polarizable Electrode
- Interconnection cable: 0.5 - 20 m
- NiMH Battery: 16 h (2 Ah, Eneloop)
- Water resistance: splash-proof
- Weight: 800 g
- Size: 12 x 12 x 12 cm^3

Reference Remote Unit (RRU)

- Similar specs as remote unit
- For noise recording & eliminating: lab & field
- For resistivity measurements on lab samples
- Optical cable: 1 - 300 m
- Weight: 5 kg
- Case: Cable drum ∅ 23 cm

PC Operating Software

- Windows 7 - 10
- Control of the whole system
- Time series recording, storing, displaying, transfer function, confidence limits, exporting to commercial inversion programs

600 W Transmitter

- Frequency range: DC - 20.000 Hz
- Maximum output: ±400 V, ±1.5 A
- Powered by: 230 VAC, 47-63 Hz
- Plastic case size: 57 x 63 x 62 cm^3
- Weight: 41 kg

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