CHAMELEON II

Resistivity & Permittivity Measurement

- **Instrument for Electrical Impedance measurements.**

- Wide frequency range: 100 μHz - 230 kHz
- Capacitive and galvanic electrodes
- WLAN, LAN (USB)

Geophysics

The geophysical field instrument *CHAMELEON II* is optimized for high-precision impedance measurements in a wide frequency range (9.5 decades). It is ideally suited for SIP (Spectral Induced Polarization) measurements with galvanic electrode coupling (100 μHz - 230 kHz) as well as for permittivity measurements with capacitive electrodes (~100 Hz - 230 kHz). In order to minimize systematic measurement errors at high frequencies, a separate 100 watt transmitter is placed at each current electrode. For voltage measurements, active "probes" are connected directly to the potential electrodes. The maximum dipole width is 50 meters. The basis equipment includes two Transmitters and one Receiver. Hardware and software supports up to nine Receivers.

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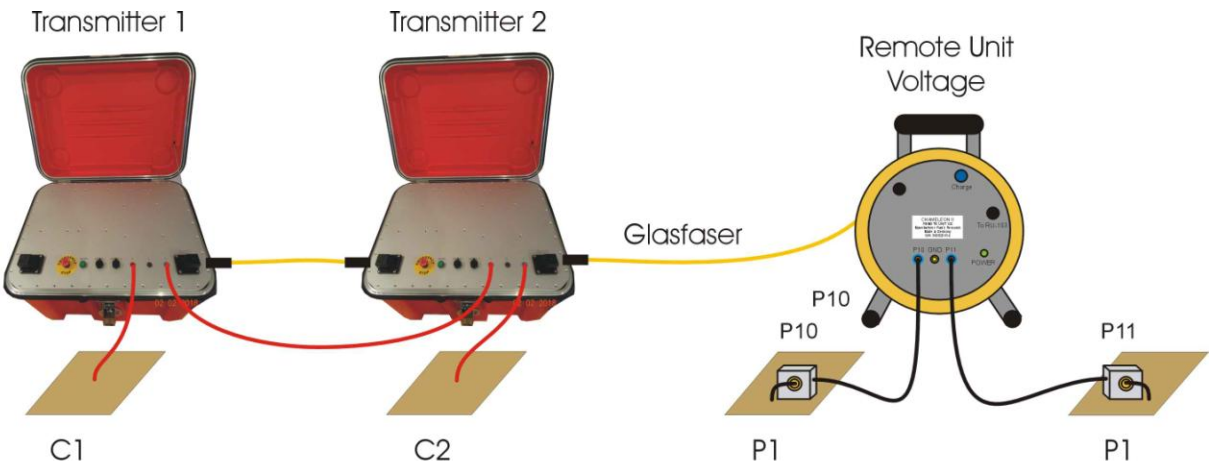
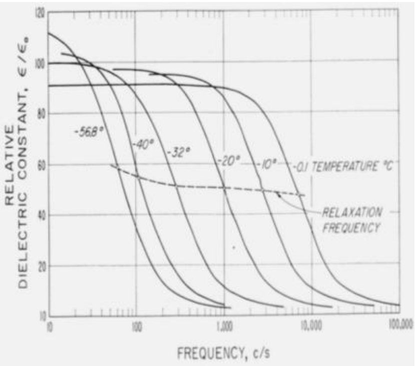


Fig. 1: Arrangement of the components of the *CHAMELEON II* measuring system for capacitive impedance measurements. There is a transmitter at each current electrode.

GEOELECTRICS WITH CAPACITIVE ELECTRODES

Figure 1 shows the measurement setup for performing impedance measurements with capacitive electrodes. Capacitive measurements are indicated when the ground is too hard to hit spikes. The permittivity of high impedance soils (permafrost, ice, ...) can be calculated from high frequency impedance measurements. Laboratory measurements (Fig. 2) show that the frequency dependence of permittivity is closely linked to the temperature of ice. Measurements on a glacier show that the frequency dependencies observed in the laboratory can also be measured in the field. Figure 3 shows an example of the frequency-dependent relative permittivity ε_r derived from an impedance spectrum. Using a Cole-Cole model (Equ. 1), this can be parameterized. The ice temperature can be determined from the parameter τ. The parameter ε_r^{LF}, on the other hand, quantifies the water content.



$$\varepsilon_r^*(\omega) = \varepsilon_r^{HF} + \frac{\varepsilon_r^{LF} - \varepsilon_r^{HF}}{1 + (i\omega\tau)^c}$$

Equation. 1

Fig. 2: Frequency-dependent relative permittivity measured in the laboratory on ice as a function of temperature. (Quelle: xxx).

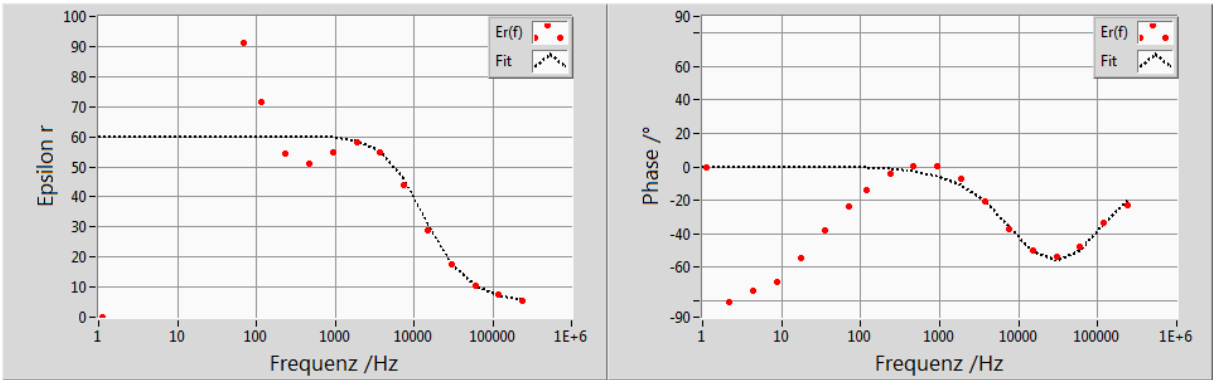


Fig. 3: Frequency-dependent relative permittivity (red dots) measured at an ice field on the Schilthorn (Switzerland). Between 1 kHz and 230 kHz the measured values can be fitted very well with a Cole-Cole model. Model: ε_r^{LF} = 60, ε_r^{HF} = 5.5, τ = 18 μs, c = 1. Data from Jan Mudler (TU-Braunschweig).

LOWER CROSS COUPLING

Measurements at high frequencies require special measures to avoid interfering coupling. The capacitive coupling between the power cable and the soil, in combination with a high potential difference, leads to considerable leakage currents. This results in systematically falsified measurement data. To counteract this, a separate transmitter is placed at each current electrode. The amplitude of each transmitter can then set so that the effective potential difference is minimized. Leakage currents and systematic measurement errors are thus avoided.

To avoid a coupling between the two transmitters and the receiver, they are connected with a fiber optic cable. This cable is used to set and synchronize the units and transmit the measurement data.

The CHAMELEON II measuring system is controlled by a measuring program installed on a laptop PC. Measuring device and PC are wirelessly connected via WLAN.

Transmitter 1 & 2

Remote Unit - Voltage

CHAMELEON II

Technical Specifications

Transmitters (one of two)

- Power: 100 W
- Output Voltage: ±400 V
- Frequency range: 100 μHz-230 kHz
- Signal shape: 1-4x sinusoidal
- Built-in current measurement:
  - Shunt: 20 Ω
  - Data format: 32 Bit
  - A/D converter: 24 Bit
  - Max. data rate: 512 kHz
  - Input range: ±250 mA / ±25 mA
  - Discrete Fourier Transform
  - Digital power line & drift filter
- Built-in 2x LiFePO4, 12 V, 18 Ah
- Interfaces: 1-9x RU - Voltage
- WLAN (USB)
- Weight: 20 kg
- Plastic case size: 60 x 44 x 42 cm^3

Remote Unit - Voltage

- A/D converter: 24 Bit
- Max. data rate: 512 kHz
- Input range: ±5 V / ±0.5 V
- Probes: 2x
- Data format: 32 Bit
- Digital power line & drift filter
- Discrete Fourier Transform
- Optical cable length: 50 m
- Battery capacity: ~10 h
- Weight: 4 kg
- Casing: Cable Drum
- Size: 31 x 30 x 21 cm^3

Separate Laptop PC

- Windows 7-10, WLAN
- Control of the whole system
- Time series recording, storing, displaying, transfer function, confidence limits

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