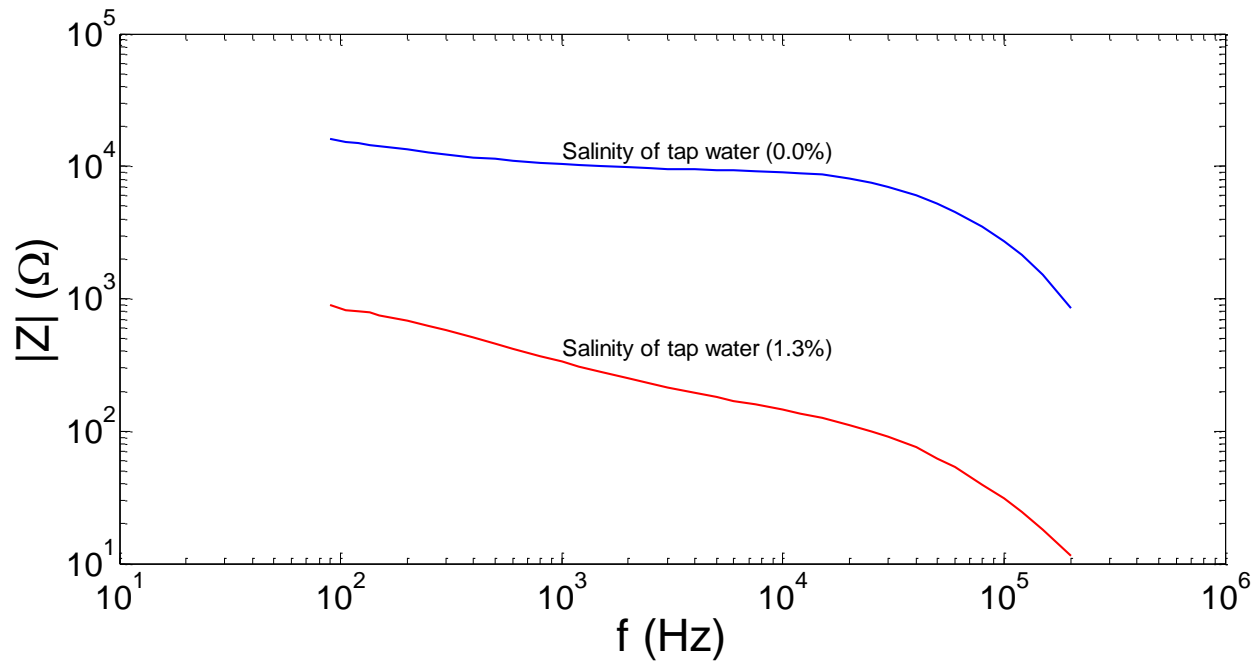




"Simatec - Revealing future of measuring"¹

EIS-101 v2

Impedance gauge



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DESCRIPTION: Electric Impedance Spectrometer

MECHANICAL

- dimension: 190,5x190,5x66,5mm (aluminium, Fig.1)
- input terminals (two BNC adapters)
- weight ca. 600 g
- protection class IP30



Fig. 1. EIS-101 v1 box.

INPUT

- operating power via a USB2 cable from computer
- input/output signals through coaxial cable joint with BNC adapter. Electrical properties of coaxial cable are considered in footnote².

OUTPUT

- signals through USB2 cable to computer

MEASURING RANGE

- impedance 1 Ω - 10 M Ω ³
- frequency 20Hz - 1MHz (c.f. α - and β -dispersion regime⁴)
- signal resolution 0.1Hz in the range of 1kHz - 100kHz
- maximum sampling numbers of a spectrum 512
- selectable regimes for measuring peak to peak (V_{pp}) signal levels:
200mV, 400mV, 1V and 2V
- averaging 2.5 measurements per second in Schwan's α -dispersion range; 20Hz to 10kHz and 10 measurements per second in Schwan's β -dispersion range; 10kHz to 1 MHz, which applies to both calibration and actual measurements.

² Specific dispersion of a shielded coaxial cable pair is considered theoretically in the user manual. The knowledge of these dispersion properties is useful to understand, because dispersion has impacts to the signals of electric impedance spectroscopy (EIS). Thus, this knowledge helps to plan and execute the EIS measurement. In theoretical simulations the R, C, G and L characteristics of a coaxial cable are used, and these characteristics are appearing in literature.

³ Extended impedance range of measuring requires embedding of additional microcontroller and clock circuit into system, which adds space to the enclosure.

⁴ Repo T., Cao Y., Silvennoinen R. and Ozier-Lafontaine H., Electrical impedance spectroscopy and roots, in: Mancuso, S. (ed.), Measuring Roots - An updated approach, ISBN 978-3-642-22066-1, Springer-Verlag Berlin Heidelberg, Part I Lab Methods, Chapter 2, pp. 25-49, 2012.

ENVIRONMENT

- operating temperature 0 - 40 °C
- storage temperature -20 - 80 °C
- use of ambient humidity non-condensing 20 - 80%
- storage environment humidity non-condensing 10 - 90%

CALIBRATION

- closed and open loop correction function
- closed and open loop calibration is carried out internally by the program under the guidance of the micro control. More details in the user manual, "How to calibrate and use the impedance spectrometer".

Control unit of the EIS-101 v2 spectrometer for an internal calibration

- EIS-101 v2 calibration functions are performed internally under the drive of the microcontroller.
- The microcontroller and the spectrometer are physically located in the aluminium box, and it is controlled by the main program. For the closed-circuit calibration, the measuring cables are connected together. For further details, see the user manual.

APPLICATIONS

- Practically same as mentioned in the case of EIS-100.
- However, in EIS-101 v2 measuring also small impedances (1Ω - $10\text{ M}\Omega$) at low frequencies (20Hz - 1MHz) is now possible, covering for example wet and salty bio-samples.
- Determining the amount of water (% w/w) in soil, gravel and sand.
- Corrosion studies.
- As an example, in Fig. 3 is shown a Wessel plot of a basic cell, which is typical for bio-samples. Before starting the actual measurements, the measuring person can still verify the success of the calibration by measuring (according to this choice either the Schwan's α or β dispersion range, or both in low and high impedance regimes) with the calibration circuits included. These circuits (Z_1 - Z_3) are placed in an aluminium box (50x50x35mm), counter-clockwise from bottom to top (Fig. 2, left view). Circuits correspond to the basic electrical model of the cell (Fig. 2, right view), which can be represented by the mathematical models in the formulas (1-3).

$$Z_1 = R_S + (R||C), \text{ where } R_S = 47\text{k}\Omega, R = 147\text{k}\Omega \text{ and } C_\alpha = 2.2\text{nF}. \quad (1)$$

$$Z_2 = R_S + (R||C), \text{ where } R_S = 47\text{k}\Omega, R = 147\text{k}\Omega \text{ and } C_\beta = 22\text{pF}. \quad (2)$$

$$Z_3 = R_S + (R||C), \text{ where } R_S = 470\text{k}\Omega, R = 1.47\text{M}\Omega \text{ and } C_\alpha = 220\text{pF}. \quad (3)$$

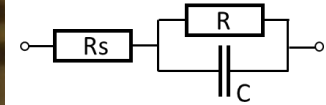


Fig. 2. Box and test circuits inside.

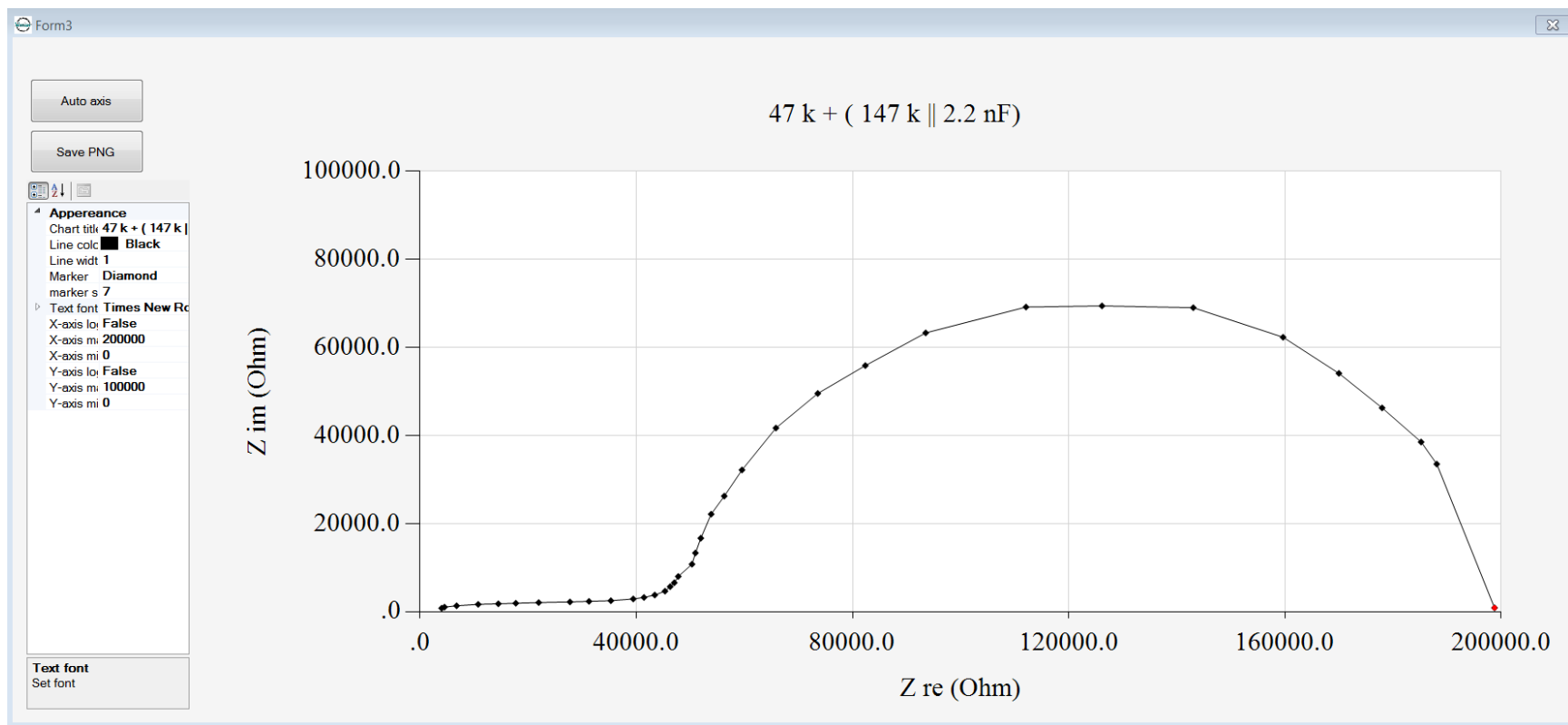


Fig. 3. Wessel plot of the circuit (1).

EIS-101 v2 SPECTROMETER MEASUREMENT SETTINGS AND PLOT

SETTINGS DOMAIN is shown in Fig. 4.

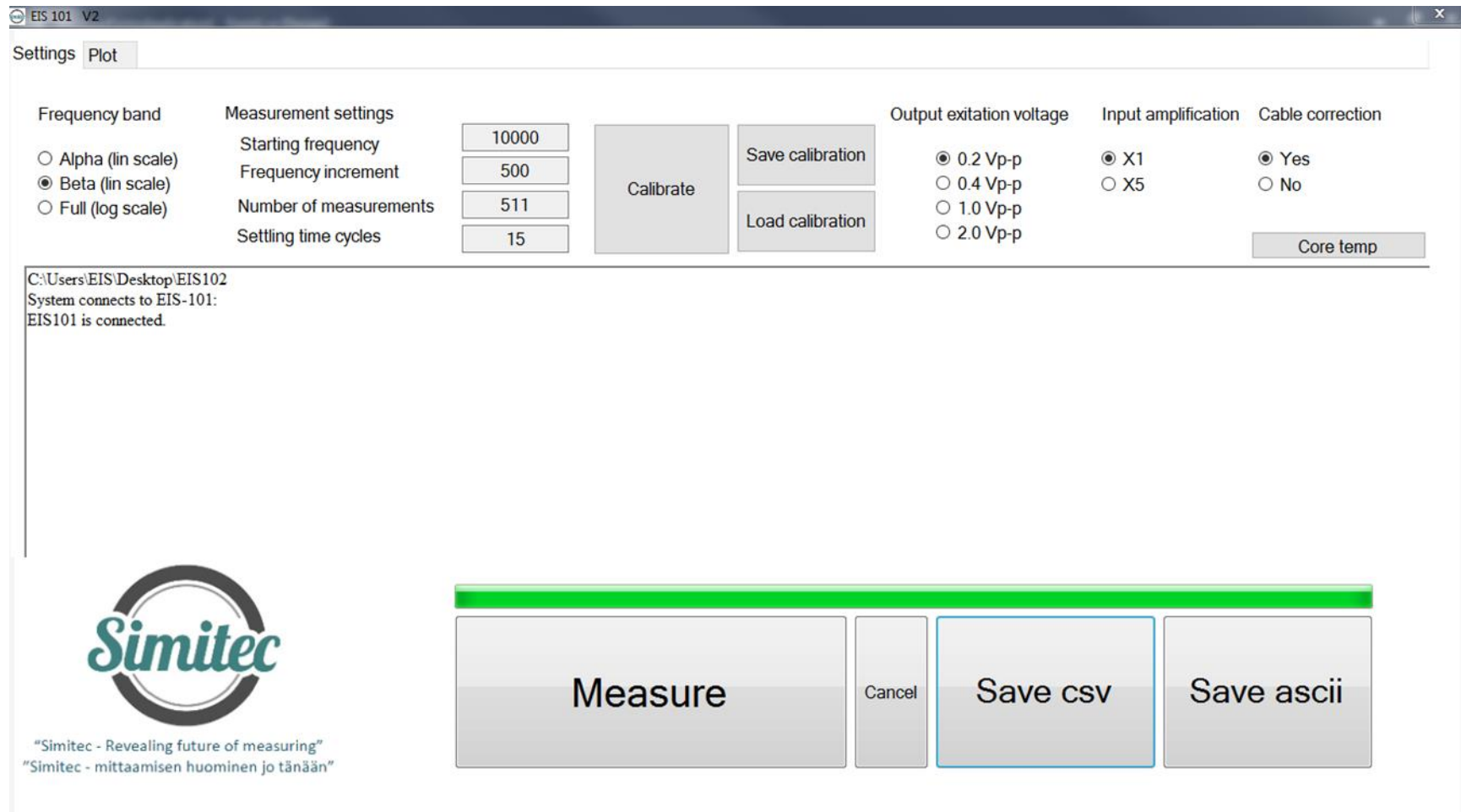


Fig. 4. EIS-101 v2 Spectrometer setting domain, after the setting of the measurement parameters ("Settings"): measurement with "Measure" button, possible interruption of measurement with "Cancel" button, recording of measurement data in either csv and / or ascii format (with buttons "Save csv" and / or "Save ascii").

- Frequency band
 - *Alpha* (lin scale) button can be used to select a frequency range (20 Hz to 10 kHz). The maximum number of frequencies to be selected is 512. The frequency range is known as Schwan's α -dispersion range. The sampling rates are selectable from the "Starting frequency" button, the frequency increment ("Frequency increment") and the total number of measurement points ("Number of measurements"). It is also possible to select other quantities that are smaller than the maximum number of samples.
 - *Beta* (lin scale) button can be used to select a frequency range (1 kHz -1 MHz). The maximum number of frequencies to be selected is 512. The frequency range is known as Schwan's β -dispersion range. The sampling rates are selectable from the "Starting frequency" button, the frequency increment ("Frequency increment") and the total number of measurement points ("Number of measurements"). It is also possible to select other sample quantities that are smaller than the maximum number of samples.
 - *Full* (log scale) button can be used to select the entire frequency range (80 Hz -1 MHz). The maximum number of frequencies to choose is 43 and is fixed. The frequencies are listed in the footnote⁵. When "Beta (log scale)" is selected, in the selection icons below, the "Measurement settings" buttons are deactivated: "Starting frequency", "Frequency increment", "Number of measurements" and "Settling time cycles".
- Select the V_{pp} voltage level ("Output excitation voltage") of the sinusoidal measurement signal: 0.2V_{pp}, 0.4V_{pp}, 1.0V_{pp} or 2.0V_{pp}.
- If the result obtained with the selected sinusoidal V_{pp} measurement signal proves to be noisy, the noise level can be reduced by internal signal amplification by selecting X5 instead of X1 ("Input amplification"). The buttons X1 and X5 have no effect on the selected V_{pp} level⁶.
- Setting the recovery time between the Impedance Measurement by using the "Settling Time Cycles" by entering a numeric value (e.g. 15 is sufficient) in the field.
- "Core Temp" button can be used to monitor the temperature of the spectrum of the spectrometer (processor) - and no changes can be made through the button.
- Recording a measurement result can be done either directly (without preview) or through the preview icon via the "Save csv" and "Save ascii" buttons, which prompts you for a file associated with the recording.

⁵ [90 105 120 135 150 200 250 300 400 500 600 800 1000 1200 1500 2000 2500 3000 4000 5000 6000 8000 10000 12000 15000 20000 25000 30000 40000 50000 60000 80000 100000 120000 150000 200000 250000 300000 400000 500000 600000 800000 1000000].

⁶ Recommended combinations of V_{pp} , X1 and X5 for different impedance ranges are shown in user manual.

PLOT DOMAIN is shown in Fig. 5.

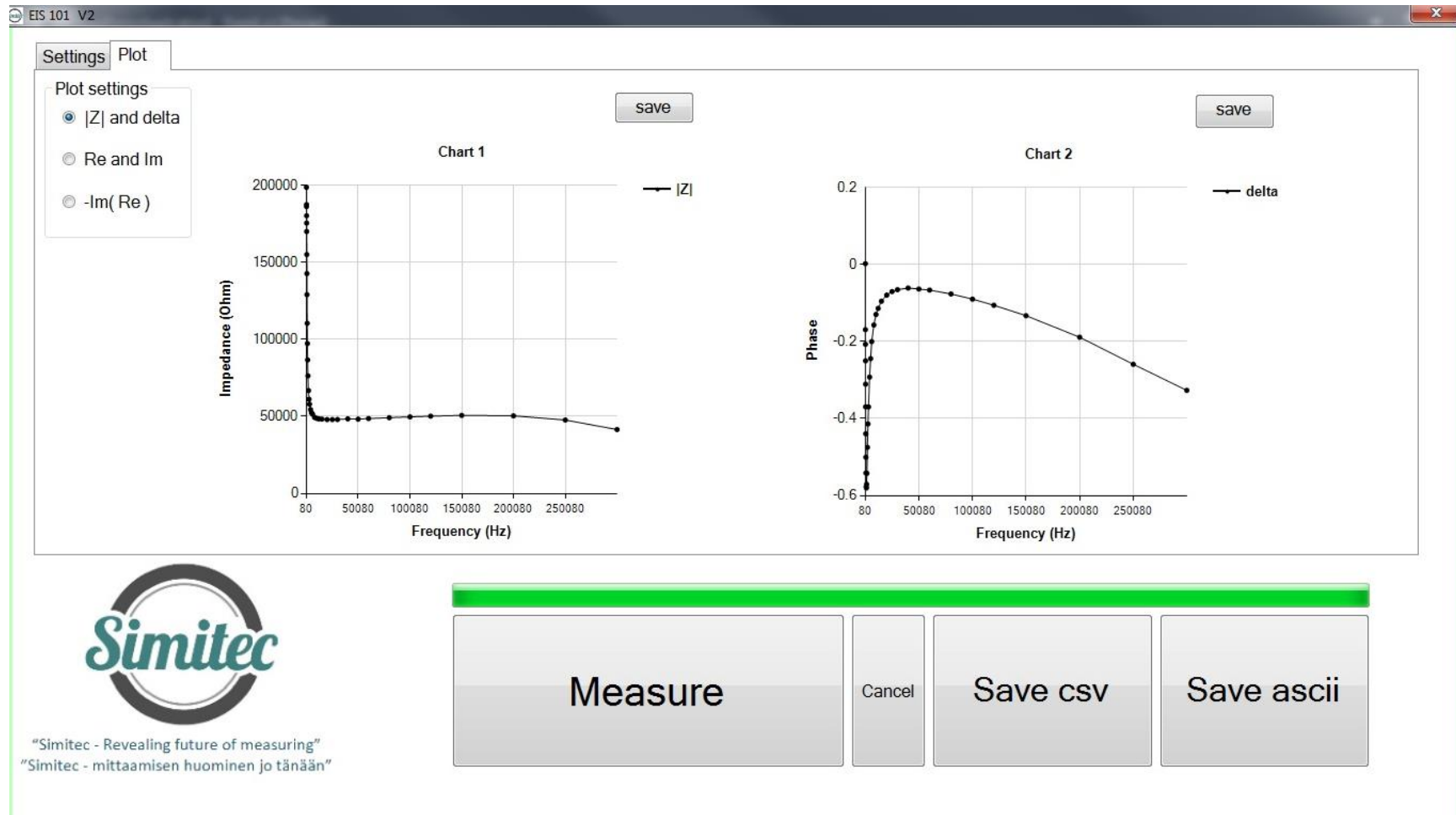


Fig. 5. EIS-101 v2 plotting domain, where the scan of the measurement results ("Plot") within the program is activated. It is also possible to record data from this icon using "Save csv" and / or "Save ascii". Additionally, saving images to jpg format can be done using the "save" keys.

- The "Plot" icon has three preview "Plot settings" options
 - 1) " $|Z|$ and delta" i.e. impedance module = $\sqrt{\text{Re}^2 + \text{Im}^2}$ and phase angle as a function of frequency,
 - 2) "Re and Im", i.e. the real and imaginary part of the impedance, as a function of frequency and

- 3) "-Im (Re)", that is, a negative impedance imaginary part as a function of the real part of the impedance (known as Wessel plot), whereby the parameter is a frequency.

RECOMMENDED CUSTOMER GROUP

- Industry and companies
- Universities and Research Institutes

PRICE

- EIS-101 v2; Electric Impedance Spectrometer 3 625,00 € (*Device embedded additional microcontroller and clock circuit, USB2 cable and three calibration impedances as shown in Fig. 2*)
- EIS-101 v2; Installation media and operating license 3490,00 € (*Software and license for software of measuring instrument*)⁷
- EIS-101 v2; Sample cell for the root measurement 150,00 € (*Measuring cell with 1 m coaxial cable pair*)
- EIS-101 v2 (Option); Program called the Appropriate Gain Indicator 450 €. (*The program will be embedded into the operating license. This will help the operator select the correct gain range so that the impedance to be measured will not be distorted*).
- EIS-101 v2 (Option); The Electric Impedance Spectrometer and Laptop placing in one measurement portfolio. In shipment, cables, calibration impedance, manuals, etc. are placed in another smaller portfolio⁸ 320€ (*Electric Impedance Spectrometer, Laptop and Installation media and operating license*)⁹
- Laptop (Option); Key features (minimum requirements):
 - anti-glare 15.6 "HD WLED Display (1366x768) or better
 - 5th Generation Intel Core i5 2 core processor (max 2.70GHz) or equivalent
 - integrated Intel HD Graphics 5500 graphics card or better
 - 4GB DDR3L memory or more
 - 320GB SATA hard disk or larger
 - WLAN and Bluetooth 4.0, min. 2pcs USB 3.0 and 1pc USB 2.0 connectors
 - Gigabit Ethernet (RJ-45) network interface
 - operating system Windows 7 Pro 64bit or higher (e.g. Win10)

IN TOTAL: 7585 € (VAT 0%)¹⁰; EXW Joensuu

⁷ To installation the software there exist several options: (i) The subscriber can do it firsthand, (ii) The supplier can do it through a reliable internet connection, (iii) The subscriber purchases a laptop that meets the above minimum requirements and sends it to the vendor for software installation, or (iv) The supplier purchases the laptop, installs necessary software and invoices the subscriber separately for laptop price and installation work according to the Simatec Ltd service price list.

⁸ The size of portfolios depends on the selected laptop.

⁹ Electric Impedance Spectrometer, Laptop and Installation media with operating license are the basic set and are therefore mandatory.

¹⁰ Changes in prices are reserved.

Terms & Conditions

Equipment EXW JOENSUU (Incoterms 2010). Other terms and conditions according to TK Services 2010. The ownership of the supplied equipment will be transferred to the subscriber when the entire trade amount has been paid to the supplier. Equipment and work not mentioned in this offer and its annexes and other components are treated as additional work.

Delivery terms in the following order: 1. EIS-101 v2 Price list, 2. TK Services 2010

Transfer of risk

The risk is transferred to the Subscriber when the goods are handed over to the subscriber or transported by an independent carrier in accordance with the contract, subject to the delivery clause.

If the item is not handed over at the right time and this is due to the fact that the Subscriber or the Subscriber is involved, the Liability shall be transferred to the Subscriber when the Supplier has done what he or she is required by the contract to enable the transfer.

Delivery time

Delivery time is agreed separately. The Agreement enters into force when the Subscriber's written order confirmation (including e-mail is accepted) has been received and confirmed from the Supplier's side to the Subscriber.

Payment terms

The terms of the offer are as follows. Late interest rate 10.5%.

60% when ordering the total price of item, 14 days net.

40% of the total price of item EXW, 14 days net

Additional work and any other supplies and equipment not included in the delivery will be billed after delivery, 14 days net.

Warranty and maintenance

The warranty for the devices to be delivered is 12 months from the time the equipment is ready for EXW. The warranty does not include travel and accommodation costs.

This offer includes EIS-101 v2 for email and phone support for the warranty period without any charge. If the Subscriber makes his own changes to the EIS-100 system, the warranty will expire. The repair of the program is done by Simitec Ltd and the costs are invoiced according to the company's service price list and they are charged 100% afterwards, 14 days net.

After the warranty period, the training, support and installation services and repair work will be billed according to the current Simitec Ltd service price list and will be charged afterwards at 100%, 14 days net.

For example, the cost of repairing a bug or installing an update will be charged on the basis of work hours and parts used for repair after work.

Fee for additional work

Additional and modifications must be agreed in advance and are based on a service price list. Other costs will be charged to actual amounts based on the Supplier's selling prices and terms and conditions set out in the Job Charging Pricing Schedule.