Development of Experimental Electrochemistry-based Methods for the Study of Redox-Processes of Uranium in Brine Solutions

EDUKEM

GRS - 563

Gesellschaft für Anlagen-
und Reaktorsicherheit
(GRS) gGmbH

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Final Report of the
Joint Research Project
EDUKEM

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1 Preface

The joint research project EDUKEM is born from the necessity to generate precise data for the evaluation of event processes in a repository system, in which contact of aqueous solutions with the stored radioactive waste might result. While in a repository in a salt rock formation such events are less probable, a contact between pore waters and waste is expected in a repository in a clay formation, even in probable developments. In both repository systems, a contact of the waste with an aqueous saline solution might occur.

The derivation of source terms requires data describing the retention of radionuclides by precipitation of solid phases or adsorption at minerals in the near field of the repository. This information is mainly provided by precise thermodynamic data. Data concerning the highly complex uranium system are required, because uranium accounts for more than 98% of the total amount of all actinides in the spent nuclear fuel. A consistent thermodynamic database is already provided for a low-saline range in the OECD-NEA compilation work /GUI 2013/. But the knowledge of uranium chemistry in highly saline solutions is still insufficient. This applies to both U(VI) and U(IV) species. The consequence of this is that in some cases the solution concentrations of U(VI) and U(IV) in highly saline solutions can be roughly estimated.

The thermodynamic description of the high complex uranium solid-liquid systems in high saline environments requires the implementation of complementary experimental approaches and the improvements of current methods. As shown schematically in Fig. 1.1, a consistent thermodynamic description is the result of a puzzle of experimental information based fundamentally on solubility and potentiometric experiments. While solubility experiments are grounded on the knowledge of properties, such as the structure and composition of solid phases and the solution chemistry, the potentiometry requires precise data of ionic mobilities and an accurate knowledge of the reaction mechanism at the measuring electrode. This challenge was undertaken by three institutions which have gathered their expertise and measuring potential: the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, the Institute for Nuclear Waste Disposal (KIT-INE), Karlsruhe Institute of Technology, and the Institute of Resource Ecology (HZDR-IRE), Helmholtz Center Dresden-Rossendorf eV.

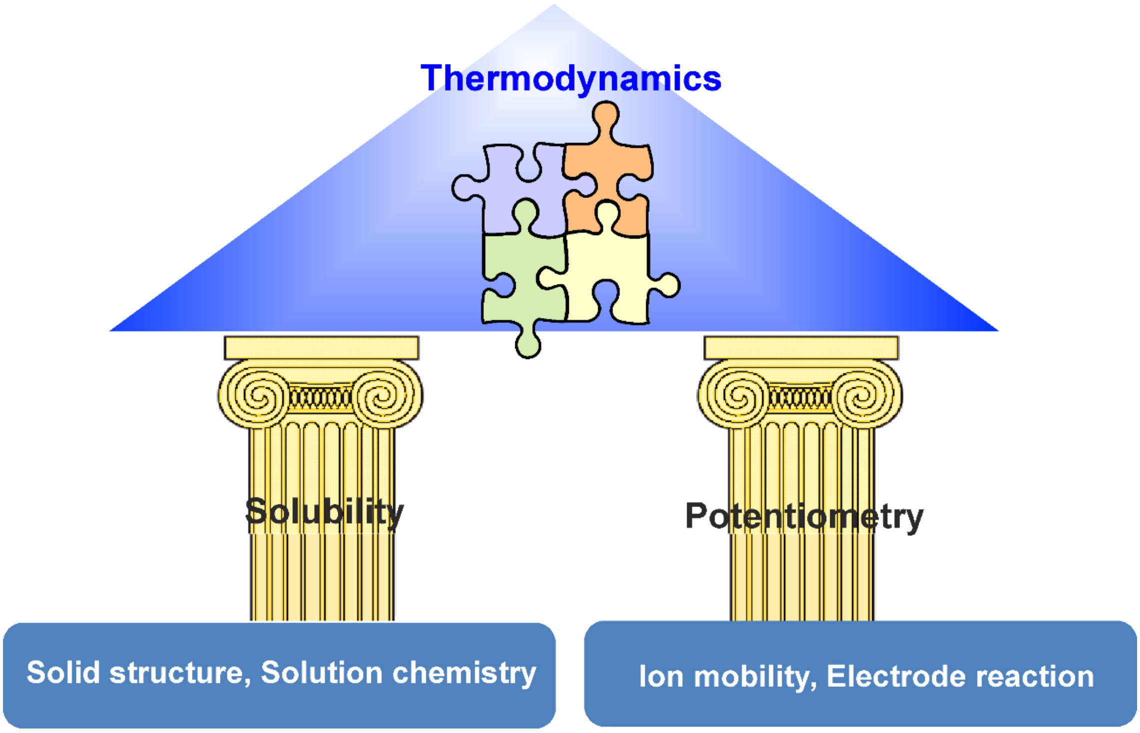

Fig. 1.1 Structure followed by the generation of a thermodynamic data basis of uranium in high saline media

In this report, the activities concerning the contribution of the GRS to this project are described. They aim the development of novel methods for solving two critical issues in the potentiometric technique:

- the membrane potential introduced by the reference electrode,
- the reaction mechanism at redox electrodes.

The solution of these issues would allow to provide a precise way for measuring thermodynamic data of uranium solutions of high saline contents by applying this technique. The calculation of the membrane potential needs values of concentration dependent transport data. But these data are only scarcely available in the literature. Classical measuring methods introduced in the 19th century are, on the other hand, cumbersome and not precise. Therefore, a modern method for measuring the electrodynamic properties of salt solutions based on the application of time-varying electric fields was conceived for measuring the transport number or its equivalent ion mobility in a wide concentration range.

Based on a previous literature survey, it has been found that a large frequency range should be covered to get information from solutions ranging from 0.001 kg l^{-1} to saturation.

This can only be achieved by the application of two complementary electrodynamic techniques:

- the Electrochemical Impedance Spectroscopy (EIS), which covers the region 1 mHz to 1 MHz and
- the Time Domain Reflectometry (TDR), which extends the frequency region up to 2 GHz.

The application of these techniques for measuring electrodynamic properties in high saline solutions is a novel issue, which not only requires the construction of adequate sensor devices but also demands the formulation of an adequate theoretical background to extract the pursued information. Therefore, the aims followed in this project constitute a great challenge. Any progress on this matter would lead to a significant resonance in the scientific community concerning electrochemistry and physical chemistry of electrolytes.

The second point, the identification of the reaction mechanism on redox electrodes for uranium solutions, arises from the application of redox-potentiometry to a non-ideal, multi-electron transfer reaction system, such as the interconversion U(VI)/U(IV). This method promises to be a precise way for obtaining valuable thermodynamic quantities required for the modelling of reactive transport of actinides. This system, however, does not follow the ideal Nernst-behavior and thus kinetic and speciation information is required as well. In this project, classical electrochemical techniques were combined with spectroscopic measurements to formulate an electrode redox-mechanism that prepare the basis for the application of the redox-potentiometry to uranium-system.

In the following report, a description of the experimental and theoretical progress achieved by GRS in the above-mentioned techniques is presented.

2 Ion mobility in potentiometric methods

2.1 Diffusion potential

Potentiometry is a powerful technique for the measurement of thermodynamic quantities of electrolyte solutions. This method allows the determination of the activity of ions taking part in a redox reaction at the electrolyte-electrode interface by measuring the voltage generated between the investigated and a reference electrode. For a generic redox-reaction $A^{+za} + z\,e^{-} \rightarrow B^{+zb}$, the activity of the participating species and electrode potential built at the electrode/electrolyte interface are related by the known Nernst equation

$$\boldsymbol{\phi = \phi^0 + \frac{kT}{ze} ln\left(\frac{a_B}{a_A}\right)} \quad (2.1)$$

According to this relation, the relative error in the determination of activity is given by $\Delta a_i/a_i = \Delta\phi\ z\,e/k\,T$. Thus, regarding a maximal resolution $\Delta\phi = \pm$ 1 mV, a relative error $\Delta a_i/a_i = z\ 2.6\times10^{-5}$ is predicted. Except for some few cases, the reference electrode used to measure the potential of the redox reaction is separated from the ground electrolyte hosting the investigated redox species by a membrane, which restrains the diffusion of solutions to each other. Fig. 2.1 exemplifies the case of a membrane separating two solutions of MX with different concentrations: $m_1 > m_2$.

The different diffusion rates of cations and ions inside the membrane generate a charge separation which builds an internal potential drop. The flux of ions is driven by the gradient of electrochemical potential established in the separating membrane. It can be expressed as:

$$\boldsymbol{\vec{J}_i \left[\frac{1}{cm^2 s}\right] = -c_i \left[\frac{mol}{cm^3}\right] N_A \left[\frac{1}{mol}\right] v_i^* \left[\frac{cm^2}{s\,J}\right] \vec{\nabla}\tilde{\mu}_i \left[\frac{J}{cm}\right]} \quad (2.2)$$

where υ_i^* and $\boldsymbol{\tilde{\mu}_i}$ are the absolute mobility and the electrochemical potential of the species *i*, respectively. N_A is the Avogadro´s number: $6.022 \times 10^{23}\ mol^{-1}$. The system evolves towards a dynamic equilibrium state, where the ion fluxes mutually offset. Hence,

$$\boldsymbol{\sum_i \vec{J}_i = -\sum_i c_i\, v_i^*\, N_A\, kT\, \vec{\nabla}\, ln\, a_i - \sum_i c_i\, N_A\, v_i^*\, z_i\, \mathrm{e}\, \vec{\nabla}\phi = 0} \quad (2.3)$$

Solving $\nabla\phi$ from Eq. 2.3 and integrating, we obtain for unidimensional case:

$$\Delta\phi_{diff} = -\frac{kT}{e}\int_0^z \frac{\sum_i c_i\, \upsilon_i\, d\ln a_i}{\sum_i c_i\, \upsilon_i\, z_i} \qquad (2.4)$$

where υ_i [$cm^2s^{-1}V^{-1}$] = υ_i^* e, is the ionic mobility of the species i. Eq. 2.4 is the generalized expression used to calculate the diffusion potential drop at separating membranes when using a reference electrode with a separated compartment in a redox-potential experiment. In a conventional potentiometric experiment, the measured electrode potential is given by:

$$V_{redox} = \Delta V - V_{ref} - \Delta\phi_{diff} \qquad (2.5)$$

where ΔV is the voltage of the measuring cell and V_{ref} is the potential of the reference electrode. The precision of the potentiometric method is conditioned by the accuracy of the determination of diffusion potential $\Delta\phi_{diff}$. It can be measured experimentally only for some few electrode combinations. Generally, it is calculated by using Eq. 2.4. For dilute solution, this can easily be made, since the mobility and activity of ions can be calculated by the Onsager /ROB 2002/ and Debye-Hückel equations, respectively.

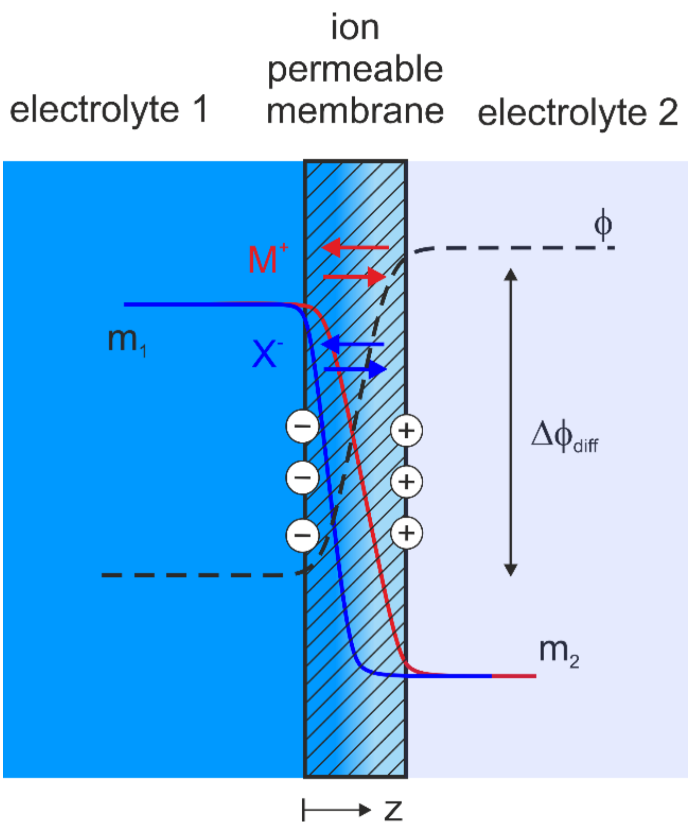

Fig. 2.2 Building of a voltage by differential diffusion in a membrane separating two electrolytes

But redox reactions of interest in final repository research take place in high concentrated brines, e. g. the transition from U(VI) to U(IV). Therefore, expressions for the concentration dependence of the mobility and the activity of ions are required to calculate the diffusion potential, e. g in the potentiometric system Pt/U(IV), U(VI), NaCl(m)//KCl(m_0)/AgCl/Ag. For the calculation of the ionic activity, a confident set of Pitzer parameters for salts of the oceanic system can be found in the THEREDA database /MOO 2015/. Confident values of ion mobility in a wide range of concentration, however, are only available for some few salts.

2.2 Ion mobility: Classical measuring methods

A comprehensive compilation of values of transport number of ions, defined as $t_i = \upsilon_i / \Sigma_i \upsilon_i$, was reported by Lobo /LOB 1989/ for inorganic salt solutions in a wide range of concentrations. Fig. 2.2 shows reported data for some salts. From the picture, it is quite evident that except from KCl, which practically does not exhibit any concentration change, no consistency can be seen under different data sources.

It is important to note that these reported values were obtained by using classical methods of measurement. These are essentially: a) the Hittorf method, b) the moving boundary method and c) concentration cells with liquid junction. The first two methods are based on a prolongated electrolysis of solutions. The Hittorf method requires selecting electrodes with a reversible behavior, at which no side reactions occurs after passing a substantial quantity of electricity. This condition restrains the use of this method to some few electrolytes. The method of the moving boundary bases on the displacement of the boundary between two electrolytes with a common anion after passing a convenient amount of electricity /HAR 1933/. The boundary is defined by the contact of the investigated electrolyte with other one of low concentration, whose cation has a low mobility. The accuracy of the method depends on the precision of the instrument used for determining the position of the boundary. As in the case of Hittorf method, the reactions of the electrodes used for electrolysis imply an additional analytic work to correct results. The concentration cell method consists in the combination of half-cells with the same electrode system but with different solution concentrations: one of them is fixed while the other is made variable.

They are connected together with (cell I) and without a separating membrane (cell II), as follow:

$$Ag,AgCl / MCl (m_0) / M / MCl (m) / AgCl / Ag \quad \text{cell I} \qquad (2.6)$$

$$Ag,AgCl / MCl (m_0) / M / MCl (m) / AgCl / Ag \quad \text{cell II} \qquad (2.7)$$

Thus, the transport number of the cation M^{z+} is given by $t_M = \Delta V(\text{cell I})/\Delta V(\text{cell II})$. In the case of salts of alkali and alkali earth metals, the connecting metal M in cell II should be replaced by an amalgam Hg(M). This approach represents the inverse direction of the procedure followed for the determination of activity coefficients using transport numbers calculated by other methods.

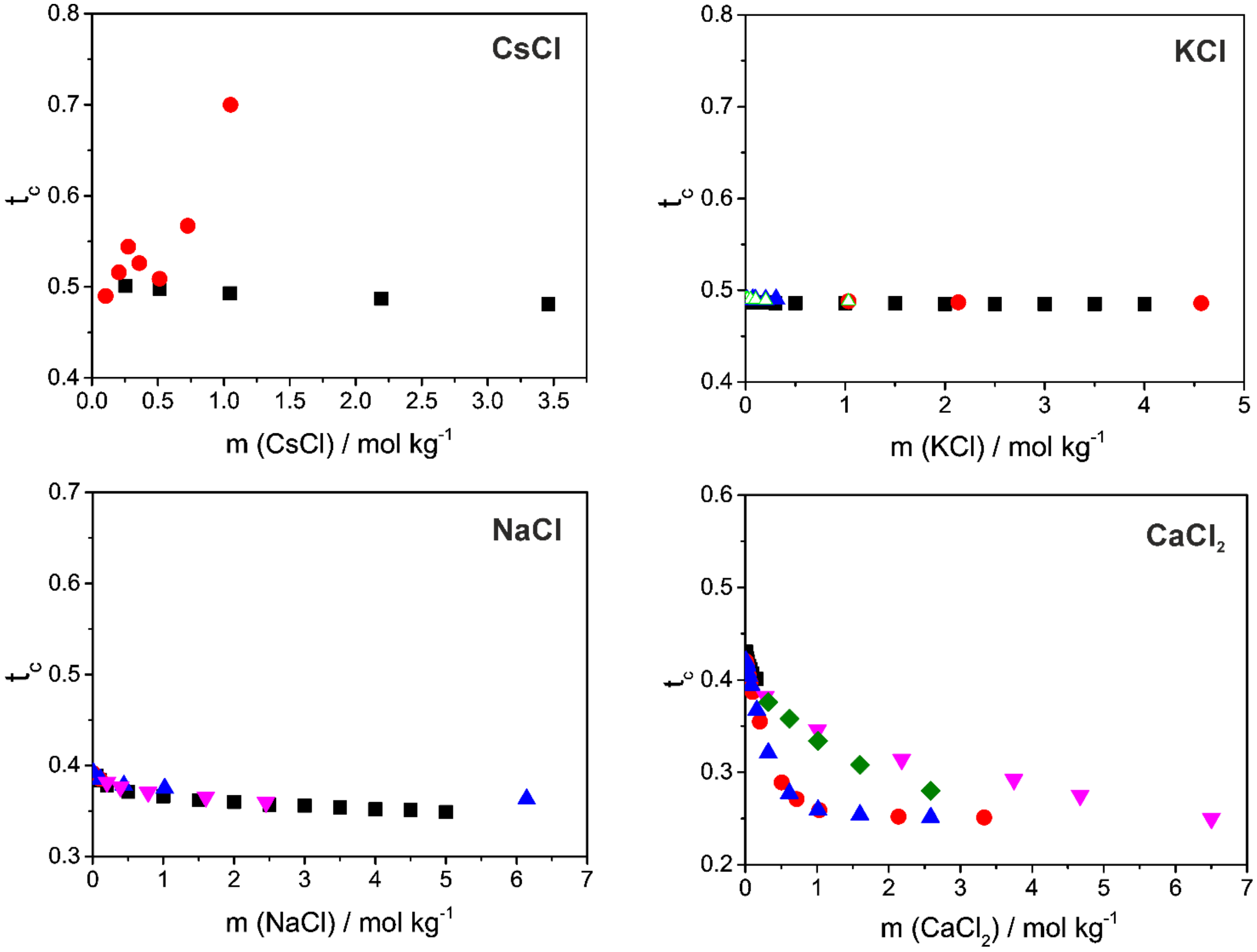

Fig. 2.3 Concentration dependence of the transport number of cations (t_c) in some chloride solutions taken from different sources as compilated in /LOB 1989/

3 Electrochemical impedance spectroscopy (EIS): Design of an electrodynamic method

3.1 Fundamentals

Negative and positive charged ions of electrolytes are driven in opposite directions when exposed to an external electric field e **E**. The imparted velocity is counterbalance by (i) average interionic forces, also known as relaxation effects, $\mathbf{F}_{rel}$, and (ii) a force transmitted by the solvent, $\mathbf{F}_{\eta}$, which arises from the dragging effect caused by the moving ion, better known as electrophoretic effect. This effect is schematized in Fig. 3.1. In the absence of an electric field, a statistically radial accumulation of ions of opposite charge around the ion occurs arises. This is commonly referred to as the ionic cloud.

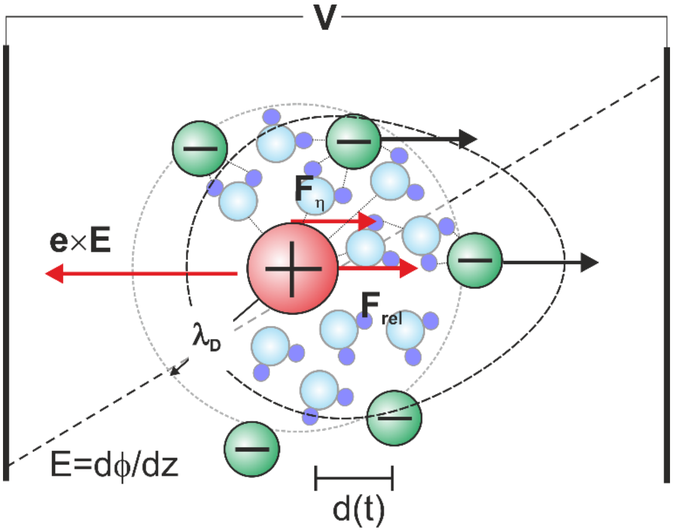

Fig. 3.1 Schematic showing the deformation of the ionic cloud by the ion drift induced by the driving force and retarding relaxation and electrophoretic forces

The size of this cloud is set to be by the Debye-length, as defined from the Debye-Hückel theory of electrolytes /BOC 1998/:

$$\lambda_D = \sqrt{\frac{\varepsilon_w \varepsilon_0 kT}{4\pi \sum_i c_i N_A {z_i}^2 e^2}} \tag{3.1}$$

where ε_w and ε_0 are the dielectric constant of water and the permittivity of vacuum, respectively. N_A is the Avogadro´s number and e is the elementary charge. The counter motion of ions of opposite charge under an electric field causes an elongation of this hypothetic cloud and to a shift of the center of charges by a distance d. Thus, an electrical dipole is formed. The counter migration is accompanied by a friction of the solvent shells attached to the ions which implies a breakdown and formation of new hydrogen bonds.

The movement of ions and the separation of charges induces the flow of current in the external circuit connecting the two electrodes. In the absence of electrochemical reactions at the electrolyte-electrode interface taking up the generated current, the application of a constant voltage yields an accumulation of ions at the electrodes with an exponential drop of the external current. The whole process involves a series of electrodynamic phenomena, to which of them a time constant can be assigned. Usually, they differ in several orders of magnitude. Therefore, the measurement of dynamic process in electrolytes in the time domain requires a complex equipment able to register current and time in a logarithmic scale.

The application of an alternating and sufficient low electric field, given by $\mathbf{E}^*= \mathbf{V}^*/L$, where L is the distance between the electrodes, generates a small perturbation of the system, so that the current (I*) to voltage (V*) relation can be regarded as linear, i. e. $\mathbf{I}^*.Z(\omega)=\mathbf{V}^*.Z(\omega)$ is the impedance of the system, a complex variable written as $Z(\omega)=Z_r(\omega)+I\ Z_{im}(\omega)$ or in its vectoral form as: $Z(\omega)=Mod[Z(\omega)]\ .\ exp(-I\ \theta)$ /MAC 1987/. Impedance spectra can be presented as Z_{im} vs Z_r, the so-called Nyquist-plots or as log Mod(Z) and θ vs log f, known as Bode-plots, depending on the features, one wishes to highlight.

It is a usual practice, to adjust the measured spectra to the theoretical impedance of an adequate combination of electric components, such as resistances, capacitors and inductances, referred to as equivalent circuit. The extraction of physicochemical parameters, however, requires from previous formulated theoretical model to provide the electrical elements with a physical meaning /MUN 2006/.

For the measurement of the electrodynamic properties of electrolytes, a system as schematized in Fig. 3.2a is commonly used. It consists of a tube of length L closed at its ends with inert electrodes of area A and filled with the investigated electrolyte. Fig. 3.2b shows typical Nyquist spectra obtained with CsCl at different concentrations. They show a semicircle at high to middle frequencies, typically 10^6 to 500 Hz followed by a tail at the lowest frequencies: 200 Hz to 0.1 Hz. This result can in principle be interpreted as the response of the electrical circuit depicted in Fig. 3.2c.

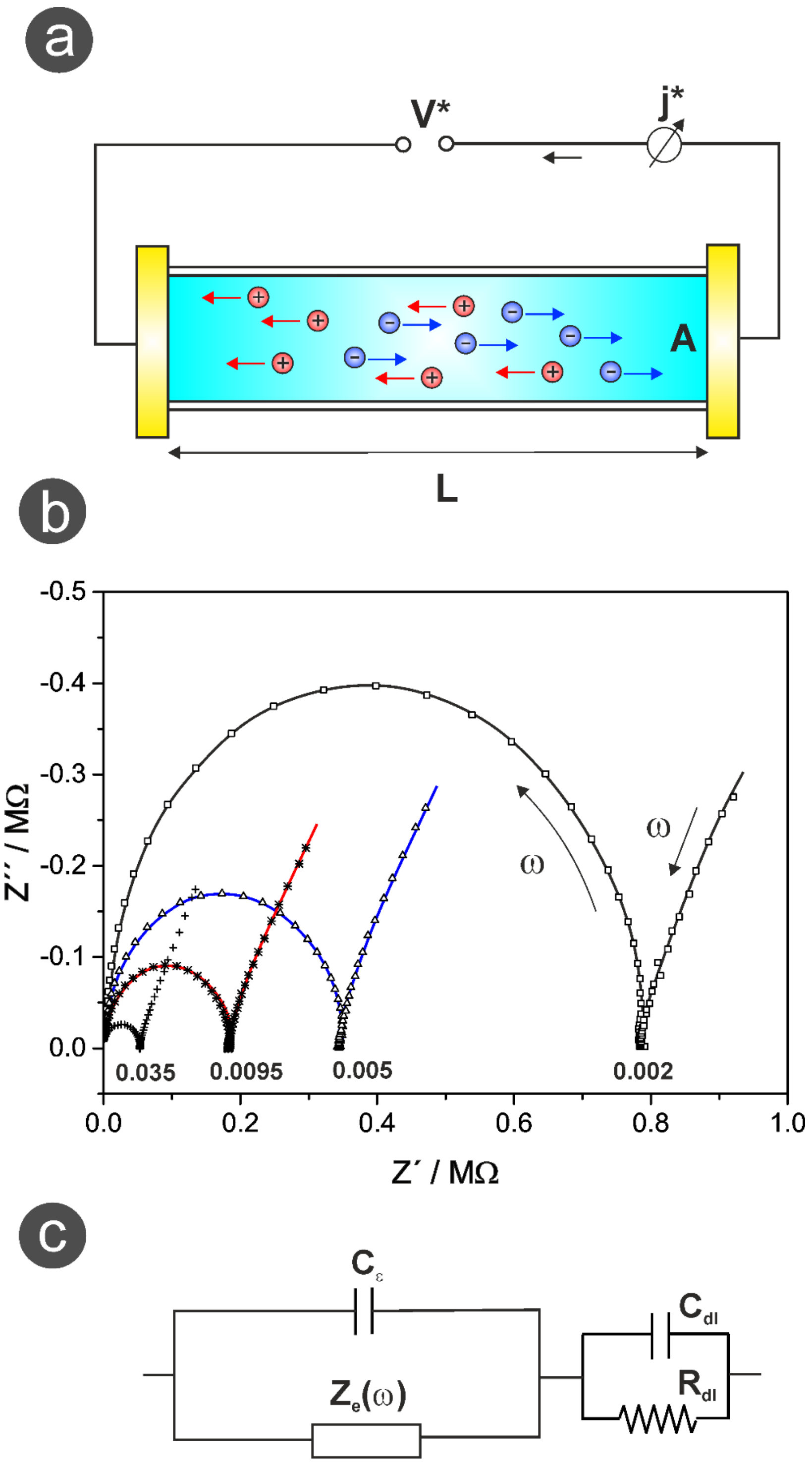

Fig. 3.2 a) Schematic of the measuring system for determining the conducting properties of electrolytes. L is the length and A the area of the tube; b) typically Nyquist impedance diagrams obtained with the device shown in a) for CsCl at different concentrations at 25 °C: L: 27.3 cm (numbers below the diagrams are concentrations in mol kg^{-1}; c) usual equivalent circuit used for fitting the experimental data

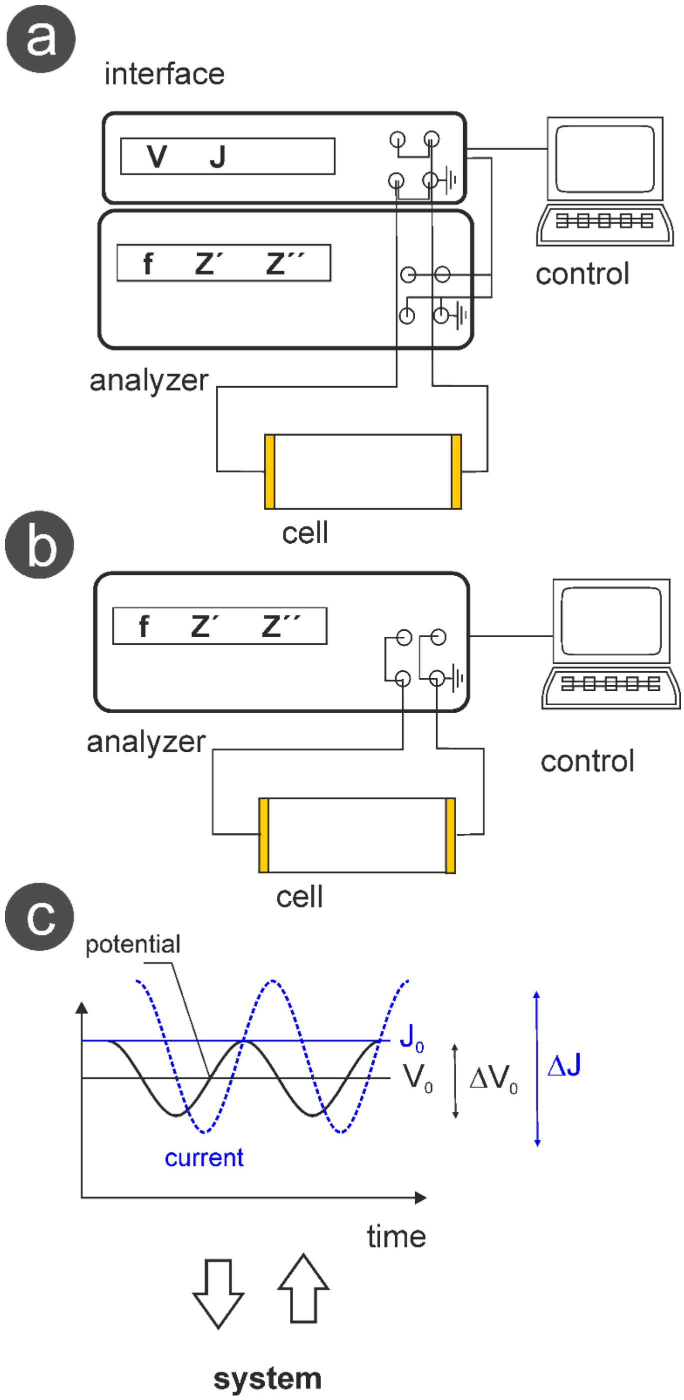

Fig. 3.3 Schematic depicting the technical principle of measuring the impedance of a system: a) by applying a ground potential with an electrochemical interface, b) using the frequency analyzer with V_0=0 V; c) time evolution of applied potential and the current obtained as a response of the investigated system

The combination of the dielectric response of the electrolyte, represented by the capacitance C_ε in parallel with the movement of ions represented by the impedance $Z(\omega)$ can describe the system. It is completed by the response of the electrode surfaces, classically associated to the capacitance of the double layer, C_{dl}, and in parallel with a resistance, R_{dl}, representing the surface reactions /MAC 1987/. In the case of blocking electrodes, where surface Faradaic reactions are hardly to imagine, a pure capacitive behavior is expected. Experiments show that the low frequency region, associated with response of the double layer, can be better described with a constant phase element (CPE) /MAC 1987/. Sanabria and Miller /SAN 2006/ have associated this behavior with an overdamped oscillation of cations and anions in harmonic restoring potentials.

The formulation of a transport model which allow obtaining an expression for the impedance $Z(\omega)$ is the main target of this part of project. As explained below, complex expressions of $Z(\omega)$ are disassembled in individual electrical units, whose parameters are the dynamical properties of the electrolyte, i.e. the ion mobility and diffusion coefficient.

Fig. 3.3 describes how the measurement of the system impedance is experimentally realized. The frequency analyzer generates a sinusoidal voltage $V=V_0 + \Delta V \sin(2\pi f\, t)$ applied between the two electrodes containing the electrolyte. The ground voltage V_0 is supplied by the electrochemical interface connected to the frequency analyzer. The two components register the current response of the system in the form $J=J_0 + \Delta J \sin(2\pi f\, t + \theta)$, where J_0 is the faradaic current and θ is the dephasing angle. This presumes a linear behavior of the systems under the applied perturbation ΔV.

The configuration shown in Fig. 3.3a is usually applied in systems, for which a potential control of the system is required, especially in connection with a three-electrodes measuring cell, where the potential of individual electrodes can be controlled. For our impedance measurements, only the voltage perturbation $V=\Delta V \sin(2\pi f\, t)$ is applied. Thus, measurements can be carried out by using the frequency analyzer only.

3.2 Experimental details

3.2.1 Electrolyte solutions

The investigated solutions constitute the so-called oceanic system which embraces the cations Na, K, Ca and Mg and the anions Cl and SO_4. NaCl 99.99 %, $CaCl_2 \cdot 4\,H_2O$ 99.995 %, K_2SO_4 99.999 % and KCl, $MgCl_2 \cdot 6\,H_2O$, Na_2SO_4 of Ph. Eur. quality were used for solution preparation. Additionally, solutions of CsCl prepared from a salt of 99.99 % of purity were investigated. Although this salt does not belong to the oceanic system, it was selected as a model system, since hydrated Cs^+ and Cl^- ions presents similar values of equivalent conductivity at infinite dilution, i.e. a transport number near 0.5. A set of solutions with different concentrations were prepared by dilution of a concentrated mother solutions for each one of these salts. The concentration was determined by weighting parts of water and mother solutions. The concentration of the $CaCl_2$ and $MgCl_2$ solutions was additionally verified by ICP-OES measurements.

3.2.2 Measuring device

Fig. 3.4a shows a picture of the experimental set-up assembled for impedance measurements after the concept shown in Fig. 3.2a. It consists of a measuring cell connected to a frequency analyzer Solartron 1260. The additional connection of an electrochemical interface for potential and current control is also observed at the picture for the sake of completeness. Since the ion mobility measurements do not require the application of a base potential, the interface was not further used. Instead a short two-electrode connection to the impedance-analyzer was preferred to avoid artifacts arising from cabling at high frequencies.

The measuring cell consists of two parallel tubes cut in an acrylic glass block with openings on the upper side to pour the measuring electrolyte into the tube (see drawing in Fig. 3.4b). The back side of the tubes are closed with gold disks. They are fixed by pressuring them against an O-ring by means of screws with gold plated spring contacts pushing a copper plate behind the gold electrodes. Both tubes are connected by the front side with a flexible PVC tube. After filling the tube with the electrolyte, it can be shifted through the seal until touch the smaller opening at the electrode, thus maintaining a constant diameter of the liquid connection.

Disk electrodes were cut from a 0.5 mm thick gold sheet and polished with diamond suspensions of 6 µm and 1 µm. They were cleaned by sonicating in ethanol and pure water successively.

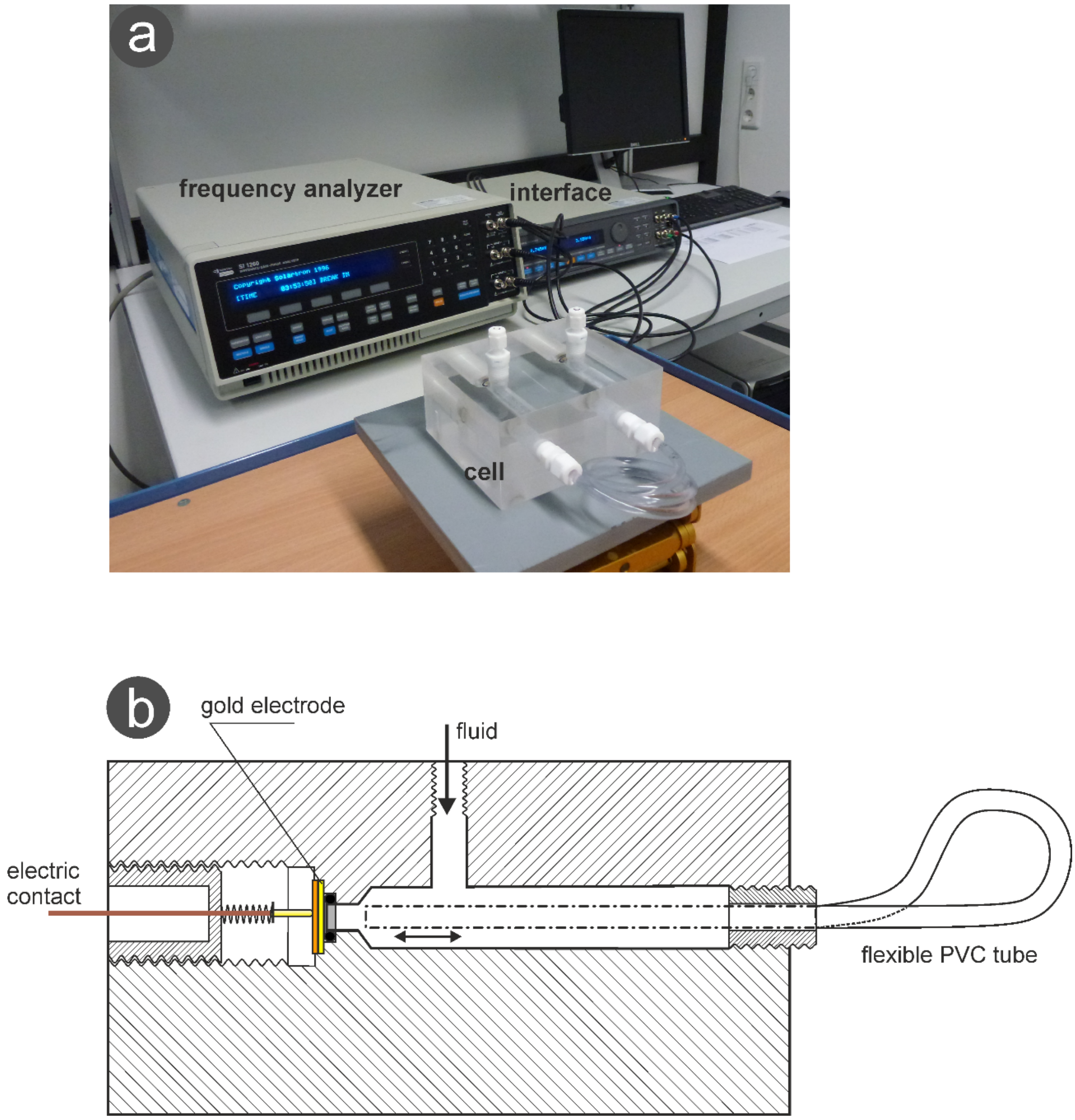

Fig. 3.4 a) Experimental set-up used for impedance measurements; b) Cross-section of the cell

The design of this cell was made based on published theoretical discussions about the interpretation of impedance measurements of electrolytes enclosed between to ideally polarizable electrodes, i. e. without the presence of faradaic currents. Results will be presented in chapter 3.6.

3.2.3 Electrical characterization of the measuring cell

As explained in more details in chapter 3.3, the experimental determination of dynamic properties of ions is conditioned to the formulation of an appropriate theoretical description of them. These models are based on the fundamental transport equation, whose solution is reduced to the unidimensional case for the sake of simplicity. The ionic movement induced by applying an electric field at high frequencies can be treated as a simple conduction case where the current is given by /IBL 1983/:

$$\vec{j}[\mathbf{A\ cm^{-2}}] = -\boldsymbol{\kappa}\,\vec{\boldsymbol{\nabla}}\boldsymbol{\phi}[\mathbf{V\ cm^{-1}}] \tag{3.1}$$

where κ [Ω^{-1} cm^{-1}] is the specific conductivity of the solution. For the ideal case of an electrically isolating tube of length L containing the electrolyte sealed at both ends with ideal polarizable electrodes of area A, Eq. 3.1 reduces to:

$$\boldsymbol{J}\ [\mathbf{A}] = \boldsymbol{\kappa}\ \frac{\boldsymbol{\Delta V}}{\boldsymbol{L}}\ \boldsymbol{A} = \frac{\mathbf{1}}{\boldsymbol{Re}\ [\boldsymbol{\Omega}]}\ \boldsymbol{\Delta V}[\mathbf{V}] \tag{3.2}$$

Any deviation from the relation Re=L / κ A represents a dispersion of the current lines and thus from the unidimensional model.

The KCl-system was analyzed, for which reliable specific conductivity data are available. Taking experimental data reported in /LOB 1989/, the following relation can be found by their regression with a polynomial of 3rd degree:

$$\boldsymbol{\kappa}\ [\boldsymbol{\Omega}^{-1}\mathbf{cm}^{-1}] = \mathbf{0.11884}\ \boldsymbol{m} - \mathbf{0.0105}\ \boldsymbol{m}^{2} + \mathbf{5.29271}\ \times \mathbf{10}^{-4}\ \boldsymbol{m}^{3} \tag{3.3}$$

The solution resistance can be directly measured from the real part of the Nyquist plots at sufficiently low frequencies, avoiding the induction region (see theoretical part in chapter 3.3). This can be compared with that calculated by Eq. 3.3 taking a tube area A = 0.128 cm^2 and assuming a unidimensional current distribution (Eq. 3.2). Thus, deviations are quantified by the coefficient β = (measured resistance)/(calculated resistance: eq.3.3). Fig. 3.5 shows that for a fixed concentration, the deviation coefficient β increases with the cell length by 4.09×10^{-4} cm^{-1}. This contrasts with the more marked variation with the electrolyte concentration observed for a fixed cell length. It is important to note, that the observed experimental behavior tends to the ideal one at dilute solutions. Therefore, the deviation of the experimental measured resistance does not seem to arise from perturbations of the primary current distribution /IBL 1983/. In this case, it can be postulated that this unusual increase of the electrolyte resistance is related with attracting

Lorentz forces between ions of different charges caused during its movement. This, in turn, would reduce the velocity of the moving charges, being macroscopically observed as a reduction of the solution conductivity. This type of effects is expected to manifest in very long electrolyte conduction paths, as in this case. Although an interesting effect, its investigation in detail is beyond the scope of the present project.

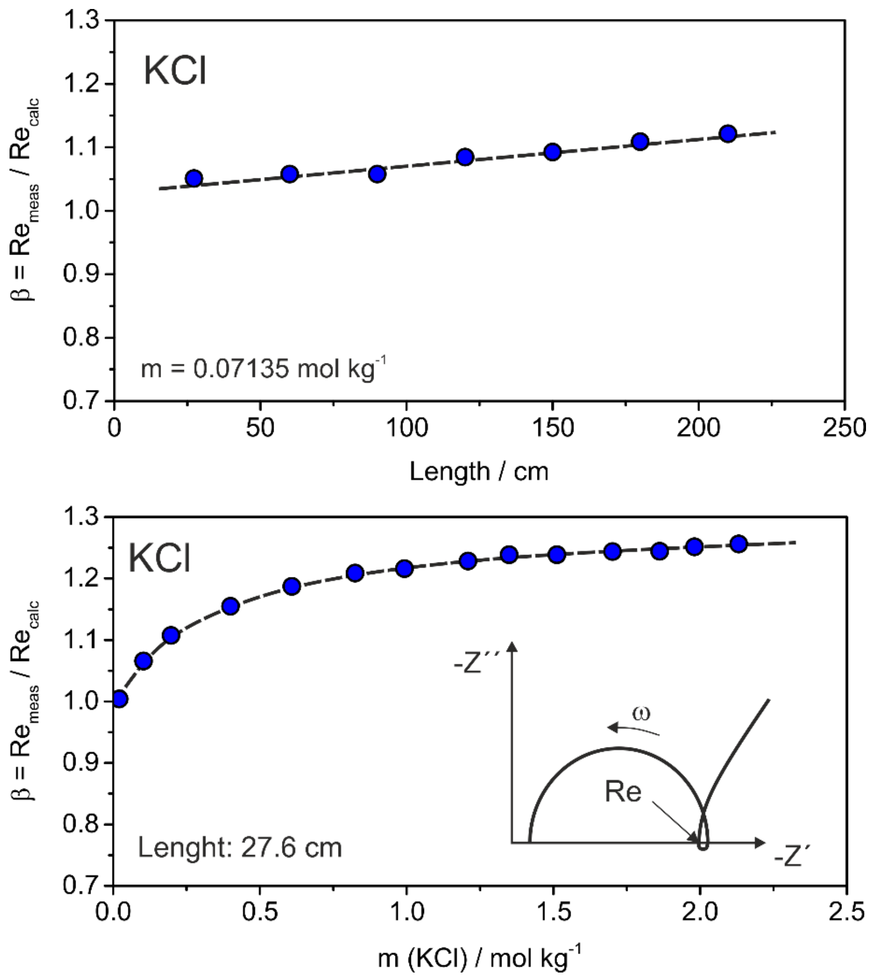

Fig. 3.5 Deviation from the unidimensional behavior for the experimental cell quantified as the ratio of measured and calculated electrolyte resistance β for different conditions

3.3 Electrodynamic models: a literature survey

One of the first treatment of the electrodynamic behavior of electrolytes was presented by Coehlo /COE 1979/, /COE 1983/. His work was focused in the effects of the accumulation of mobile charges on the dielectric behavior of a conducting material on polarizing it under two electrodes. Since his theoretical description constitutes the basis of the method developed in this project, it will be briefly reviewed.

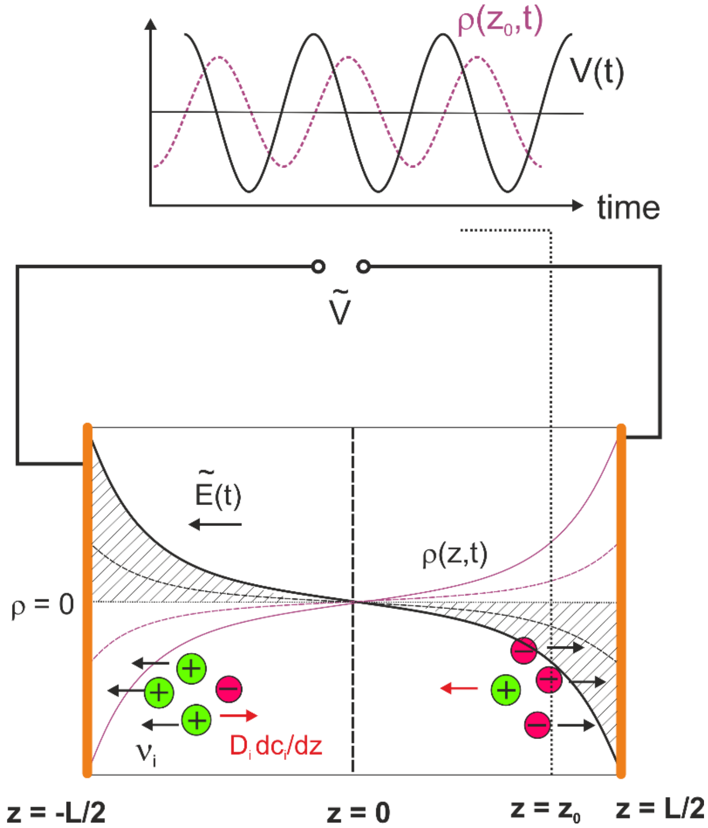

Fig. 3.6 Schematic of the temporal distribution of charges on applying an alternating electric field in a conducting material (see text)

On generating an electric field by application of a voltage V(t) between the two inert electrodes, a charge accumulation is induced at the ends of the cell. The accumulation process is counteracted by thermal diffusion, quantified by the diffusion coefficient D_i. The application of an alternating polarization induces a temporal variation of the profile of the excess density of charge, $\rho(z,t)$, which is zero in the absence of an external electric field. Fig. 3.6 schematizes this process. Provided the system behaves linearly, the response to a sinusoidal voltage V(t) is a phase shifted sinusoidal variation of the excess density of charge at a fixed point (see detail at the upper part of the figure). The distribution of excess of charge along the cell is inverted in a half wave period. The accumulation of charge of different sign at the ends of the cell creates a time depending electrical dipole μ_{dip}, given by:

$$\boldsymbol{\mu_{dip}(t) = \int_{-L/2}^{L/2} z\,\rho(z,t)\,dz} \tag{3.4}$$

The magnitude of the dipole is represented by the shaded area in Fig. 3.6. For the derivation of an expression of ρ(z,t), Coehlo /COE 1983/ has solved the transport equation considering that only one type of charge carrier can move:

$$\boldsymbol{F(z,t) = -\nu\, n \left(\frac{\partial \phi}{\partial z}\right) - D \left(\frac{\partial n}{\partial z}\right)} \tag{3.5}$$

where F(z,t) [$cm^{-2}\,s^{-1}$] is the spatiotemporal flux of mobile charges, n_0 [cm^{-3}] is the uniform concentration of them in the electrolyte and *D* is the diffusion coefficient. Thus, $\rho(z,t) = n(z,t) - n_0$. From the conservation of charge, we have:

$$\boldsymbol{n\,\frac{\partial F(z,t)}{\partial z} = -\frac{\partial n(z,t)}{\partial t}} \tag{3.6}$$

Substituting Eq.3.5 in 3.6:

$$\boldsymbol{\frac{\partial n(z,t)}{\partial t} = \nu\,\frac{\partial}{\partial z}\left(n\frac{\partial \phi}{\partial z}\right) + D\,\frac{\partial^2 n}{\partial z^2}} \tag{3.7}$$

The spatiotemporal differential equation can be solved by Laplace transform changing it from the real time-domain in the domain of the complex variable s. Thus, Eq. 3.7 converts in:

$$\boldsymbol{s\,n(z,s) = \nu\, n\,(z,s)\frac{\partial^2 \phi}{\partial z^2} + D\frac{\partial^2 n}{\partial z^2} + \nu\left(\frac{\partial n(z,s)}{\partial z}\right)\left(\frac{\partial \phi}{\partial z}\right)} \tag{3.8}$$

The modulation of charge excess by the applied potential is given by the Poisson´s equation:

$$\boldsymbol{\frac{\partial^2 \phi}{\partial z^2} = -\frac{e\,\rho\,(z,s)}{\varepsilon_s\,\varepsilon_0}} \tag{3.9}$$

where e is the elemental charge 1.6×10^{-19} C, ε_s is the dielectric constant of the electrolyte and ε_0 is the vacuum permittivity 8.8541×10^{-14} F cm^{-1}.

With Eq.3.9 and n(z,s) = ρ(z,s) + n_0, Eq. 3.8 becomes after some rearrangements:

$$\left(s + \frac{\nu\, e\, n_0}{\varepsilon_s\, \varepsilon_0}\right) \rho\,(z,s) = D\,\frac{\partial^2 \rho}{\partial z^2} \tag{3.10}$$

With the boundary condition:

$$\int_{-L/2}^{L/2} \rho\,(z,s)\, dz = 0 \tag{3.11}$$

and adopting the reduced variables:

$$\tau = \frac{\varepsilon_s\, \varepsilon_0}{\nu\, e\, n_0}\ ;\ \zeta = \sqrt{\frac{1+s\,\tau}{D\,\tau}} \tag{3.12}$$

the solution of the differential equation 3.10 gives:

$$\rho\,(z,s) = A \sinh(\zeta\, z) \tag{3.13}$$

To calculate the integration constant **A**, it is necessary to draw upon the integration of the Poisson´s equation:

$$E_z(z) = \frac{e}{\varepsilon_s\, \varepsilon_0} \int_{-\frac{L}{2}}^{\frac{L}{2}} \rho\,(z,s) dz = A\, \frac{e}{\varepsilon_s\, \varepsilon_0} \frac{1}{\zeta} \cosh(\zeta\, z) + B \tag{3.14}$$

where E_z (z) is the local electric field in the electrolyte. According to the boundary condition:

$$\int_{-L/2}^{L/2} E_z(z) dz = \Delta V \tag{3.15}$$

the following relation is obtained:

$$A\, \frac{e}{\varepsilon_s\, \varepsilon_0} \left(\frac{1}{\zeta}\right)^2 \sinh\left(\zeta\, \frac{L}{2}\right) + \mathrm{B} = \frac{\Delta V}{2} \tag{3.16}$$

Eliminating B by combining Eq. 3.16 and 3.14, we have:

$$E_z(z) = -\left(\frac{d\phi}{dz}\right) = \frac{\Delta V}{L} + A\, \frac{e}{\varepsilon_s\, \varepsilon_0} \left(\frac{1}{\zeta}\right) \left[\cosh(\zeta\, z) - \frac{2 \sinh\left(\zeta\, \frac{L}{2}\right)}{L}\right] \tag{3.17}$$

The constant **A** can be now calculated from the boundary condition set by the assumption of blocking electrodes, i. e.:

$$\boldsymbol{F(z,s) = \nu\, n(z,s)\, E_z(z) - D\left(\frac{\partial\rho(z,s)}{\partial z}\right) = 0} \tag{3.18}$$

at $z=\pm L/2$. Thus, introducing Eq. 3.17 in 3.18, we have:

$$\boldsymbol{E_z\left(\frac{L}{2}\right) = \frac{\Delta V}{L} + A\,\frac{e}{\varepsilon_s\,\varepsilon_0}\left(\frac{1}{\zeta}\right)\left[\cosh\left(\zeta\,\frac{L}{2}\right) - \frac{2\sinh\left(\zeta\,\frac{L}{2}\right)}{L}\right] = D\,\frac{\sqrt{D\,\tau}}{\zeta}\,\mathbf{A}\,\frac{1}{n\,\nu}\cosh\left(\zeta\,\frac{L}{2}\right)} \tag{3.19}$$

Assuming valid the Einstein-Smoluchowski´s relation:

$$\boldsymbol{D = \nu\,\frac{kT}{e}} \tag{3.20}$$

and that $n \cong n_0$, an expression for **A** can be deduced from Eq.3.19:

$$\boldsymbol{A = \frac{\varepsilon_s\,\varepsilon_0}{e}\zeta\left(\frac{\Delta V}{L}\right)\left[s\,\tau\,\cosh\left(\zeta\,\frac{L}{2}\right) + \frac{\sinh\left(\zeta\frac{L}{2}\right)}{\left(\zeta\frac{L}{2}\right)}\right]^{-1}} \tag{3.21}$$

Thus, the spatiotemporal excess of charges is given by:

$$\boldsymbol{\rho\,(z,s) = \frac{\varepsilon_s\,\varepsilon_0}{e}\zeta\left(\frac{\Delta V}{L}\right)\sinh(\zeta\,z)\,\left[s\,\tau\,\cosh\left(\zeta\,\frac{L}{2}\right) + \frac{\sinh\left(\zeta\frac{L}{2}\right)}{\left(\zeta\frac{L}{2}\right)}\right]^{-1}} \tag{3.22}$$

This expression is used by Coehlo /COE 1983/ to calculate the polarization per unit volume, P(s):

$$\boldsymbol{P(s) = \frac{e}{L}\int_{-L/2}^{L/2} z\,\rho\,(z,s)\,dz} \tag{3.23}$$

This relation, in turn, is used to calculate the complex dielectric constant of a capacitor with a conducting material, which per definition is given by:

$$\boldsymbol{\varepsilon^*(s) = \varepsilon + L\,\frac{P(s)}{\Delta V}} \tag{3.24}$$

In this way, we arrive to the expression:

$$\boldsymbol{\varepsilon^*(s) = \varepsilon\,\frac{1 + s\,\tau}{s\,\tau + \frac{\tanh\left(\zeta\frac{L}{2}\right)}{\left(\zeta\frac{L}{2}\right)}}} \tag{3.25}$$

To connect this expression with the impedance, we measured experimentally the impedance of an electrolyte contained between two polarizable electrodes.

Assuming the electrolyte behaves as a non-ideal capacitor, we have:

$$Z(s) = \frac{1}{s\,C^*} = \frac{L}{s\ \varepsilon^*(s)\ \varepsilon_0} \tag{3.26}$$

The corresponding frequency function of the real and imaginary parts of the impedance can be derived from Eq. 3.26 by replacing s = iω. Fig. 3.7a shows the Nyquist plot calculated by Eq.3.26 for a selected set of parameters. This diagram resembles the response of an equivalent circuit constituted by a parallel RC-element in series with a second capacity (see Fig. 3.7b). R_e represents the electrolyte resistance given by

$$R_e = \frac{L}{v\ e\ n_0} \tag{3.27}$$

The capacitance C_{diel} represents the net dielectric contribution to the impedance response:

$$C_{diel} = \frac{\varepsilon_s\ \varepsilon_0}{L} \tag{3.28}$$

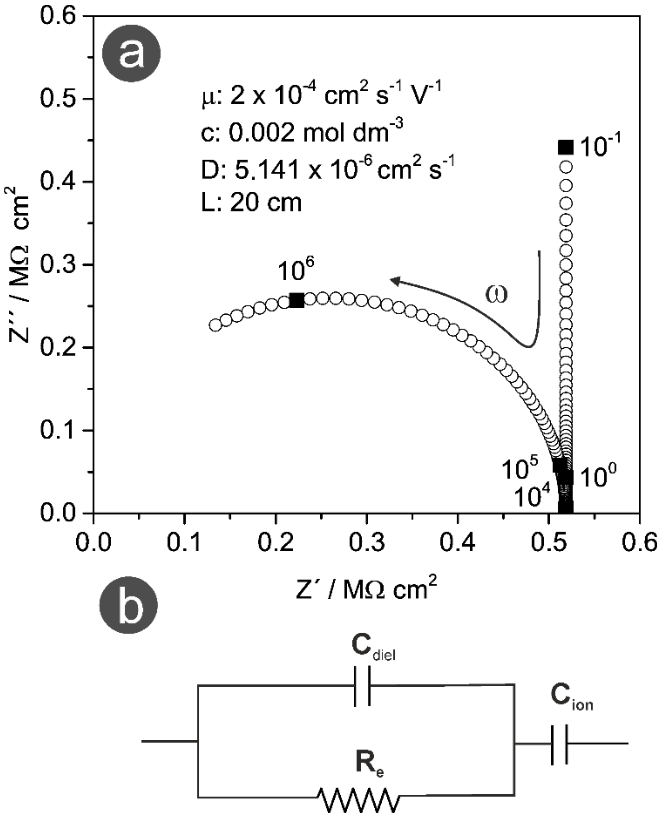

Fig. 3.7 a) Nyquist diagram of the impedance of an electrolyte between two polarizable electrodes as predicted by Coehlo´s theory; b) Equivalent circuit resembling the theoretical impedance response

The capacitance C_{ion} can be associated with the accumulation of ions at the electrodes and it is complex function of the time constant τ .

Coehlo´s formulation was found to suit for the analysis of impedance of ion conducting polymers. For instance, Klein et al /KLE 2006/ and Fragiadakis et al /FRA 2008/ have analyzed the conduction of polyethylene-oxide based ionomers with mobiles cations. Bandara et al /BAN 2011/ have also applied this theory to analyze the mobility of iodide in polyethylene oxide with tetrapropylammonium iodide. They also derived a relation between the elements of the equivalent circuit in Fig. 3.7b and the parameters of Coehlo´s expression: ν and n_0. Arof et al /ARO 2014/ studied the impedance response of polymer electrolytes based on lithium bis-oxalato-borate. They interpreted the Nyquist diagrams introducing a constant phase element (CPE) /MAC 1987/ instead of pure capacitances in the equivalent circuit shown in Fig. 3.7b and calculated the ion mobility ν and concentration of mobile species n_0 as derived by Bandara et al /BAN 2011/.

In the case of aqueous electrolytes solutions, Coehlo´s expression (Eq. 3.25) reflects qualitatively the main features of the experimental Nyquist diagrams as shown for instance in Fig. 3.2b: the high frequency loop and the tail at the lower frequencies. But considerable deviations in the low frequency range are observed. This points out additional effects disregarded in the theoretical analysis. At least, two aspects can a priori be considered as the main flaws hindering a better representation of experimental Nyquist diagrams:

- to consider only one charge as the moving one
- the derivation of an impedance expression regarding the ion movement as an additional polarization source of a dielectric material

Barbero and Lelidis / BAR 2008/ /LEL 2005/ presented a theoretical description of the impedance of electrolytes starting from a system of differential equations representing the transport of both ions. The final expression of the impedance was obtained by calculating the charging of the electrode due to the accumulation of ions at their surface by applying the Gauss´s law. It was found that the difference between the mobilities of the positive and negative ions predicts a new plateau of the real part of the electric impedance of the cell. Although this analysis represents a better approach to the electrolyte systems, it was conceived for very dilute systems.

3.4 Theoretical description of concentrated electrolytes

The interpretation of impedance diagrams obtained with concentrated electrolytes requires the construction of a suitable theoretical frame. After having found an electrical equivalent circuit to fit the experimental data, the searching of a physical meaning for each one of the circuit elements was pursued. Based on existing theories for dilute electrolytes, advances in the theoretical description of the impedance of concentrated electrolytes some advances are presented in this chapter. Some fundamental concepts will be introduced for a better understanding of the proposed model.

3.4.1 Fundamental concepts of transport in concentrated solutions

Concentration gradients and electric fields are considered the main driving forces for the movement of ions in classical transport equations. Thus, the flux of charged particles is described by:

$$\boldsymbol{J_i = -D_i \nabla c_i - v_i\, n_i \nabla \phi} \tag{3.29}$$

In a balanced system, the diffusion flux compensates the conduction one and thus $J_i = 0$. The distribution of ions is modulated by the solution potential according to the Boltzmann law:

$$\boldsymbol{c_i = c_i^0 e^{-\frac{z_i e}{kT}\phi}} \tag{3.30}$$

Introducing Eq.3.30 in 3.29 for $J_i = 0$, the known Einstein-Smoluchowski relation can be derived:

$$\boldsymbol{D_i = v_i \frac{kT}{z_i\, e}} \tag{3.31}$$

This relation holds provided the diffusing species is the same as that contributing the conduction. The formation of ion pairs at relative high concentrations breaks the validity of this relation. In a more general approach, the flux of charged particles is given by the gradient of the electrochemical potential:

$$\boldsymbol{J_i = -\frac{D_i^*}{kT} n_i \nabla \widetilde{\mu}_i} \tag{3.32}$$

where D_i^* is a constant with the dimensions of a diffusion coefficient, but not necessarily equal to it.

The electrochemical potential of a species i, is given by:

$$\tilde{\mu}_i = \mu_i^0 + kT \ln a_i + z_i e \nabla\phi \tag{3.33}$$

Thus, Eq. 3.32 becomes:

$$J_i = -D_i^* n_i \nabla \ln a_i - \frac{D_i^*}{kT} n_i z_i e \nabla\phi \tag{3.34}$$

Comparing this transport equation with the classical one (Eq. 3.29), one finds following relations:

$$v_i = D_i^* \frac{e}{kT} \tag{3.35}$$

$$-D_i^* c_i \nabla \ln a_i = D_i \nabla c_i \tag{3.36}$$

Since the ion activity is commonly available in a molal-basis, following conversion factors are practical:

$$c = \frac{m \rho 1000}{1000 + m M} \tag{3.37}$$

ρ: solution density [g cm^{-3}]; M: molecular weight of solution salt [g mol^{-1}]

$$\left(\frac{\partial c}{\partial z}\right) = \left(\frac{\partial c}{\partial m}\right)\left(\frac{\partial m}{\partial z}\right) = \left[\frac{\rho 1000}{1000 + m M} - \frac{m \rho 1000}{(1000 + m M)^2}\right]\left(\frac{\partial m}{\partial z}\right) \tag{3.38}$$

Accordingly, Eq. 3.36 becomes for a unidimensional case:

$$-D_i^* c_i \left[\frac{\partial \ln m_i}{\partial z} + \frac{\partial \ln \gamma_i}{\partial z}\right] = \left[\frac{1}{m_i}\left(\frac{\partial m_i}{\partial z}\right) + \frac{\partial \ln \gamma_i}{\partial m_i}\left(\frac{\partial m_i}{\partial z}\right)\right] = D_i \left(\frac{\partial c_i}{\partial m_i}\right)\left(\frac{\partial m_i}{\partial z}\right) \tag{3.39}$$

hence:

$$D_i^* = \frac{D_i\left(\frac{\partial c}{\partial m}\right)}{\left[\frac{1}{m_i} + \frac{\partial \ln \gamma_i}{\partial m_i}\right] c_i} \tag{3.40}$$

For small concentration gradients, it is expected that D_i^* becomes a constant for the specificion. In the limit $c_i \rightarrow 0$, $(\partial c_i/\partial m_i) \rightarrow 1$, $m_i(\partial \ln\gamma_i/\partial m_i) \rightarrow 0$ and hence: $D_i^* \rightarrow D_i^0$, i. e. the diffusion coefficient at infinite dilution. Thus, the concentration dependence of the diffusion coefficient is given by:

$$D_i(m_i) = D_i^0 \left[1 + m_i\left(\frac{\partial \ln \gamma_i}{\partial m_i}\right)\right]\left(\frac{\partial m_i}{\partial c_i}\right) \tag{3.41}$$

This expression allows to apply the classical transport Eq. 3.29 for concentrated electrolytes, provided the concentration dependence of the activity coefficient and the density of solutions is already known. Activity coefficients can be calculated by the Pitzer´s formalism /PIT 1991/ /BET 1996/. Confident interaction parameters for the salts of the oceanic system are compilated in the program THEREDA /MOO 2015/. For concentration until 2 mol kg^{-1}, the activity coefficient can be well represented by the expression:

$$\gamma_i(m) = \frac{1}{1+A\sqrt{m}} + B\sqrt{m} \tag{3.42}$$

Thus, the factor ($\partial \ln\gamma_i / \partial m_i$) is given by:

$$\left(\frac{\partial \ln\gamma_i}{\partial m_i}\right) = \frac{1}{\nu_i}\left(\frac{\partial \ln\gamma_i}{\partial m}\right) = \frac{1}{\nu_i}\left[\frac{1}{1+B\sqrt{m}\,(1+A\sqrt{m})}\right]\left[\frac{B\,(1+A\sqrt{m})}{2\sqrt{m}} - \frac{A}{2\sqrt{m}\,(1+A\sqrt{m})}\right] \tag{3.43}$$

Other important relation appears by combining Eq. 3.35 and 3.40:

$$\frac{v_i}{D_i} = \left(\frac{\partial\,c_i}{\partial\,m_i}\right)\frac{e}{kT}\,\frac{1}{\left[\frac{1}{m_i}+\left(\frac{\partial \ln\gamma_i}{\partial m_i}\right)\right]c_i} = \left[\frac{\rho\,1000}{1000+m\,M} - \frac{m\,\rho\,1000}{(1000+m\,M)^2}\right]\frac{e}{kT}\,\frac{1}{\left[\frac{1}{m_i}+\left(\frac{\partial \ln\gamma_i}{\partial m_i}\right)\right]\left(\frac{m\,\rho\,1000}{1000+m\,M}\right)} \tag{3.44}$$

3.4.2 Transport behavior of two mobile charges

The application of a voltage to an electrolyte contained between two blocking electrodes drives anions and cations in opposite directions. The movement is described by the transport equations:

$$J_+ = -D_i\left(\frac{\partial n_+}{\partial z}\right) - v_+\,n_+\left(\frac{\partial\phi}{\partial z}\right) \tag{3.45}$$

$$J_- = -D_i\left(\frac{\partial n_-}{\partial z}\right) + v_-\,n_-\left(\frac{\partial\phi}{\partial z}\right) \tag{3.46}$$

The concentration of charged particles is described by:

$$n_+ = \nu_+ n_0 + \Delta n_+ \tag{3.47}$$

$$n_- = \nu_- n_0 + \Delta n_- \tag{3.48}$$

Regarding that $\Delta n_\pm << \nu_\pm n_0$, Eq. 3.45 and 3.46 becomes:

$$J_+ = -D_i\left(\frac{\partial\Delta n_+}{\partial z}\right) - v_+\,\nu_+\,n_0\left(\frac{\partial\phi}{\partial z}\right) \tag{3.49}$$

$$J_- = -D_i\left(\frac{\partial\Delta n_-}{\partial z}\right) + v_-\,\nu_-\,n_0\left(\frac{\partial\phi}{\partial z}\right) \tag{3.50}$$

Temporal changes of charge concentrations are described by the continuity equation:

$$\left(\frac{\partial \Delta n_+}{\partial t}\right) = -\left(\frac{\partial J_+}{\partial z}\right);\ \left(\frac{\partial \Delta n_-}{\partial t}\right) = -\left(\frac{\partial J_-}{\partial z}\right) \qquad (3.51)$$

In the next analysis, we use the following nomenclature:

$$\Delta n_+ \equiv y_1 \quad ;\ \Delta n_- \equiv y_2;\ \left(\frac{\partial \Delta n_+}{\partial z}\right) \equiv y_1' \ ;\ \left(\frac{\partial \Delta n_-}{\partial z}\right) \equiv y_2';\ \left(\frac{\partial^2 \Delta n_+}{\partial z^2}\right) \equiv y_1'' \ ;\ \left(\frac{\partial^2 \Delta n_-}{\partial z^2}\right) \equiv y_2'' \qquad (3.52)$$

Combining Eq. 3.49 and 3.50 with 3.51, we have:

$$\left(\frac{\partial y_1}{\partial t}\right) = D_+ y_1'' + \upsilon_+ \nu_+ n_0 - \left(\frac{\partial^2 \phi}{\partial z^2}\right) \qquad (3.53)$$

$$\left(\frac{\partial y_2}{\partial t}\right) = D_- y_2'' - \upsilon_- \nu_- n_0 - \left(\frac{\partial^2 \phi}{\partial z^2}\right) \qquad (3.54)$$

The second derivative of potential is substituted by the Poisson´s equation:

$$\left(\frac{\partial^2 \phi}{\partial z^2}\right) = -\frac{e\,\Delta q}{\varepsilon\,\varepsilon_0} = y_1 z_1 - y_2 z_2\ ;\ z_1 = |z_+|\ ;\ z_2 = |z_-| \qquad (3.55)$$

Hence, Eq. 3.53 and 3.54 becomes, after Laplace transformation:

$$s\, y_1 = D_+ y_1'' - \frac{\upsilon_+ \nu_+ n_0 e}{\varepsilon\,\varepsilon_0}\left[y_1 z_1 - y_2 z_2\right] \qquad (3.56)$$

$$s\, y_2 = D_- y_2'' + \frac{\upsilon_- \nu_- n_0 e}{\varepsilon\,\varepsilon_0}\left[y_1 z_1 - y_2 z_2\right] \qquad (3.57)$$

After grouping constants and rearranging, we have:

$$y_1'' - y_1\left(\frac{s}{D_+} + \alpha_1\right) + \alpha_2\, y_2 = 0 \qquad (3.58)$$

$$y_2'' - y_2\left(\frac{s}{D_-} + \beta_2\right) + \beta_1\, y_1 = 0 \qquad (3.59)$$

where

$$\alpha_1 = \left(\frac{\upsilon_+ \nu_+ n_0 e}{\varepsilon\,\varepsilon_0}\,\frac{z_1}{D_+}\right);\ \alpha_2 = \left(\frac{\upsilon_+ \nu_+ n_0 e}{\varepsilon\,\varepsilon_0}\,\frac{z_2}{D_+}\right) \qquad (3.60)$$

$$\beta_1 = \left(\frac{\upsilon_- \nu_- n_0 e}{\varepsilon\,\varepsilon_0}\,\frac{z_1}{D_-}\right);\ \beta_2 = \left(\frac{\upsilon_- \nu_- n_0 e}{\varepsilon\,\varepsilon_0}\,\frac{z_2}{D_-}\right) \qquad (3.61)$$

Solving for y_2 from Eq. 3.58 and introducing it in Eq. 3.59, we have after some rearrangement:

$$y_1^{(4)} - y_1''\left[\left(\frac{s}{D_+} + \alpha_1\right) + \left(\frac{s}{D_-} + \beta_2\right)\right] + y_1\left[\left(\frac{s}{D_+} + \alpha_1\right)\left(\frac{s}{D_-} + \beta_2\right) - \beta_1\,\alpha_2\right] = 0 \qquad (3.62)$$

The characteristic equation of differential Eq. 3.62 is given by:

$$\boldsymbol{r^4 - a\, r^2 + b = 0} \tag{3.63}$$

with

$$\boldsymbol{a} = \left[\left(\frac{s}{D_+} + \boldsymbol{\alpha_1}\right) + \left(\frac{s}{D_-} + \boldsymbol{\beta_2}\right)\right] ; \boldsymbol{b} = \left[\left(\frac{s}{D_+} + \boldsymbol{\alpha_1}\right)\left(\frac{s}{D_-} + \boldsymbol{\beta_2}\right) - \boldsymbol{\beta_1\, \alpha_2}\right] \tag{3.64}$$

the roots of which are found by replacing $r^2 \equiv x$ and solving the resulting quadratic equation. Thus, we obtain:

$$\boldsymbol{r} = \pm\sqrt{\frac{-a \pm \sqrt{a^2 - 4\,b}}{2}} = \pm\boldsymbol{\Gamma_{1,2}} \;\; ; \boldsymbol{\Gamma_1} = \sqrt{\frac{-a + \sqrt{a^2 - 4\,b}}{2}} \; ; \boldsymbol{\Gamma_2} = \sqrt{\frac{-a - \sqrt{a^2 - 4\,b}}{2}} \tag{3.65}$$

The general solution of Eq. 3.62 is:

$$\boldsymbol{y_1} = C_1\, \mathbf{e}^{\Gamma_1 z} + C_2\, \mathbf{e}^{-\Gamma_1 z} + C_3\, \mathbf{e}^{\Gamma_2 z} + C_4\, \mathbf{e}^{-\Gamma_2 z} \tag{3.66}$$

The corresponding expression for y_2 can be obtained solving for it in Eq. 3.58:

$$\boldsymbol{y_2} = -\frac{y_1''}{\alpha_2} + \frac{y_1}{\alpha_2}\left(\frac{s}{D_+} + \boldsymbol{\alpha_1}\right) \tag{3.67}$$

Regarding that:

$$\frac{\partial^2}{\partial z^2}[C_i\, e^{\pm\Gamma_i z}] = \boldsymbol{\Gamma_i}^2 C_i\, e^{\pm\Gamma_i z} \tag{3.68}$$

and introducing the second derivate of Eq. 3.36 in Eq. 3.67, we have after some rearrangements:

$$\boldsymbol{y_2} = \boldsymbol{k_1}\,[C_1\, \mathbf{e}^{\Gamma_1 z} + C_2\, \mathbf{e}^{-\Gamma_1 z}] + \boldsymbol{k_2}\,[C_3\, \mathbf{e}^{\Gamma_2 z} + C_4\, \mathbf{e}^{-\Gamma_2 z}] \tag{3.69}$$

where

$$\boldsymbol{k_1} = \left(\frac{s}{D_+} + \boldsymbol{\alpha_1}\right)\frac{1}{\alpha_2} - \frac{\Gamma_1{}^2}{\alpha_2} \;\; ; \boldsymbol{k_2} = \left(\frac{s}{D_+} + \boldsymbol{\alpha_1}\right)\frac{1}{\alpha_2} - \frac{\Gamma_2{}^2}{\alpha_2} \tag{3.70}$$

Eq. 3.66 and 3.69 must fulfill the neutrality boundary condition, given by:

$$\int_{-L/2}^{L/2} \boldsymbol{\Delta q}\; \boldsymbol{dz} = \int_{-L/2}^{L/2} (\boldsymbol{y_1 z_1 - y_2 z_2})\, \boldsymbol{dz} = \boldsymbol{0} \tag{3.71}$$

For this to apply, $C_1 = -C_2 = C_1^0$ and $C_3 = -C_4 = C_2^0$. Hence:

$$y_1 = C_1{}^0 \sinh(\Gamma_1 z) + C_2{}^0 \sinh(\Gamma_2 z) \quad (3.72)$$

$$y_2 = k_1 C_1{}^0 \sinh(\Gamma_1 z) + k_2 C_2{}^0 \sinh(\Gamma_2 z) \quad (3.73)$$

and

$$y_1' = \Gamma_1 C_1{}^0 \cosh(\Gamma_1 z) + \Gamma_2 C_2{}^0 \cosh(\Gamma_2 z) \quad (3.74)$$

$$y_2' = k_1 \Gamma_1 C_1{}^0 \cosh(\Gamma_1 z) + k_2 \Gamma_2 C_2{}^0 \cosh(\Gamma_2 z) \quad (3.75)$$

To complete the expression of the particle fluxes (Eq.3.49 and 3.50), we integrate the Poisson´s equation:

$$\left(\frac{\partial\phi}{\partial z}\right) = -\frac{e}{\varepsilon\,\varepsilon_0}\int (y_1 z_1 - y_2 z_2)\,dz + B = -\frac{e}{\varepsilon\,\varepsilon_0}\left[\frac{(z_1 - k_1 z_2)}{\Gamma_1} C_1{}^0 \cosh(\Gamma_1 z) + \frac{(z_1 - k_2 z_2)}{\Gamma_2} C_2{}^0 \cosh(\Gamma_2 z)\right] + B \quad (3.76)$$

The solution of the system requires the evaluation of the constants C_1^0, C_2^0 and B. This can be achieved by applying the boundary conditions:

$$J_\pm\big|_{\pm L/2} = 0\,;\; \int_{-L/2}^{L/2}\left(\frac{\partial\phi}{\partial z}\right) dz = \Delta V \quad (3.77)$$

Hence, we have:

$$J_+|_{+L/2} = -D_+\left[\Gamma_1 C_1{}^0 \cosh\left(\Gamma_1 \frac{L}{2}\right) + \Gamma_2 C_2{}^0 \cosh\left(\Gamma_2 \frac{L}{2}\right)\right] + \frac{v_+ \nu_+ n_0\, e}{\varepsilon\,\varepsilon_0}\left[\frac{(z_1 - k_1 z_2)}{\Gamma_1} C_1{}^0 \cosh\left(\Gamma_1 \frac{L}{2}\right) + \frac{(z_1 - k_2 z_2)}{\Gamma_2} C_2{}^0 \cosh\left(\Gamma_2 \frac{L}{2}\right)\right] - v_+ \nu_+ n_0\, B = 0 \quad (3.78)$$

$$J_-|_{-L/2} = D_-\left[k_1 \Gamma_1 C_1{}^0 \cosh\left(\Gamma_1 \frac{L}{2}\right) + k_2 \Gamma_2 C_2{}^0 \cosh\left(\Gamma_2 \frac{L}{2}\right)\right] + \frac{v_- \nu_- n_0\, e}{\varepsilon\,\varepsilon_0}\left[\frac{(z_1 - k_1 z_2)}{\Gamma_1} C_1{}^0 \cosh\left(\Gamma_1 \frac{L}{2}\right) + \frac{(z_1 - k_2 z_2)}{\Gamma_2} C_2{}^0 \cosh\left(\Gamma_2 \frac{L}{2}\right)\right] + v_- \nu_- n_0\, B = 0 \quad (3.79)$$

$$-\frac{2\,e}{\varepsilon\,\varepsilon_0}\left[\frac{(z_1 - k_1 z_2)}{\Gamma_1{}^2} C_1{}^0 \sinh\left(\Gamma_1 \frac{L}{2}\right) + \frac{(z_1 - k_2 z_2)}{\Gamma_2{}^2} C_2{}^0 \sinh\left(\Gamma_2 \frac{L}{2}\right)\right] + B\,L = \Delta V \quad (3.80)$$

Eq. 6.78 – Eq. 6.80 conform a system of linear equations with unknowns: C_1^0, C_2^0, and B:

$$\begin{bmatrix} C_1^{0} \\ C_2^{0} \\ \boldsymbol{B} \end{bmatrix} \begin{bmatrix} a_{11} & a_{21} & a_{31} \\ a_{21} & a_{22} & a_{32} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \Delta V \end{bmatrix} \tag{3.81}$$

where

$$a_{11} = \left[\frac{(z_1 - k_1\, z_2)}{\Gamma_1} \frac{v_+ \nu_+ n_0\, e}{\varepsilon\, \varepsilon_0} - D_+ \Gamma_1\right] \cosh\left(\Gamma_1 \frac{L}{2}\right)$$

$$a_{12} = \left[\frac{(z_1 - k_2\, z_2)}{\Gamma_2} \frac{v_+ \nu_+ n_0\, e}{\varepsilon\, \varepsilon_0} - D_+ \Gamma_2\right] \cosh\left(\Gamma_2 \frac{L}{2}\right)$$

$$a_{13} = v_+ \nu_+ n_0$$

$$a_{21} = \left[\frac{(z_1 - k_2\, z_2)}{\Gamma_1} \frac{v_- \nu_- n_0\, e}{\varepsilon\, \varepsilon_0} + D_- \Gamma_1 k_1\right] \cosh\left(\Gamma_1 \frac{L}{2}\right)$$

$$a_{21} = \left[\frac{(z_1 - k_2\, z_2)}{\Gamma_2} \frac{v_- \nu_- n_0\, e}{\varepsilon\, \varepsilon_0} + D_- \Gamma_2 k_2\right] \cosh\left(\Gamma_2 \frac{L}{2}\right)$$

$$a_{23} = v_- \nu_- n_0$$

$$a_{31} = -\frac{2\, e}{\varepsilon\, \varepsilon_0} \frac{(z_1 - k_1\, z_2)}{\Gamma_1^{\,2}} \sinh\left(\Gamma_1 \frac{L}{2}\right)$$

$$a_{32} = -\frac{2\, e}{\varepsilon\, \varepsilon_0} \frac{(z_1 - k_2\, z_2)}{\Gamma_2^{\,2}} \sinh\left(\Gamma_2 \frac{L}{2}\right)$$

$$a_{33} = L$$

Applying the substitution method, we have:

$$\boldsymbol{B} = \frac{\Delta V}{L - \frac{\left[\left(\frac{a_{13}}{a_{11}}a_{21}\right) - a_{23}\right]}{\left[a_{22} - \left(\frac{a_{12}}{a_{11}}\right)a_{21}\right]}\left(\frac{a_{12}}{a_{11}}\right)a_{31} - \left(\frac{a_{13}}{a_{11}}\right)a_{31} + \frac{\left[\left(\frac{a_{13}}{a_{11}}a_{21}\right) - a_{23}\right]}{\left[a_{22} - \left(\frac{a_{12}}{a_{11}}\right)a_{21}\right]}a_{32}} \tag{3.82}$$

$$C_1^{\,0} = -\boldsymbol{B}\,\frac{\left[\left(\frac{a_{13}}{a_{11}}a_{21}\right) - a_{23}\right]}{\left[a_{22} - \left(\frac{a_{12}}{a_{11}}\right)a_{21}\right]}\left(\frac{a_{12}}{a_{11}}\right) - \boldsymbol{B}\left(\frac{a_{13}}{a_{11}}\right) \tag{3.83}$$

$$C_2^{\,0} = \boldsymbol{B}\,\frac{\left[\left(\frac{a_{13}}{a_{11}}a_{21}\right) - a_{23}\right]}{\left[a_{22} - \left(\frac{a_{12}}{a_{11}}\right)a_{21}\right]} \tag{3.84}$$

It can be demonstrated that the hyperbolic functions in the denominator of *B* cancel that contained in the numerators of coefficients a_{ij} or converted to tanh (Γ_i L/2) ≈ 1 (because Γ_i L/2 >> 1 at the investigated frequency range) on introducing coefficients C_1^0, C_2^0, and B in the equation system 3.81. In the following, a_{ij*}, C_1^{0*}, C_2^{0*}, and B* refer to these constants without the hyperbolic factors.

After having calculated the integration constants C_1^0, C_2^0, and B, we can calculate the current response of the electrolyte on applying an electric field. In the Laplace-domain, the local current can be expressed as:

$$\boldsymbol{j}(\boldsymbol{s},\boldsymbol{z}) = \boldsymbol{e}\,|\boldsymbol{z}_-|\,\boldsymbol{J}_- - \boldsymbol{e}\,|\boldsymbol{z}_+|\,\boldsymbol{J}_+ \tag{3.85}$$

The total current results from integration of Eq.3.85:

$$\boldsymbol{j}(\boldsymbol{s}) = \frac{1}{L}\int_{-L/2}^{L/2}\boldsymbol{j}(\boldsymbol{s},\boldsymbol{z})\,\boldsymbol{dz} = \frac{2\,e\,|z_+|}{L}\left\{\frac{C_1^{\,0*}\,a_{11*}}{\Gamma_1} + \frac{C_2^{\,0*}\,a_{12*}}{\Gamma_2}\right\} + \frac{2\,e\,|z_-|}{L}\left\{\frac{C_1^{\,0*}\,a_{21*}}{\Gamma_1} + \frac{C_2^{\,0*}\,a_{22*}}{\Gamma_2}\right\} + \boldsymbol{e}\,\boldsymbol{n_0}\,(\boldsymbol{\upsilon}_+\boldsymbol{\nu}_+|\boldsymbol{z}_+| + \boldsymbol{\upsilon}_-\boldsymbol{\nu}_-|\boldsymbol{z}_-|)\,\boldsymbol{B}^* \tag{3.86}$$

Defining $c_1 = C_1^{0*}/\Delta V$, $c_2 = C_2^{0*}/\Delta V$, and b = B*/ΔV, thus the admittance of the electrolyte is given by:

$$\boldsymbol{Y}(\boldsymbol{s}) = -\frac{2\,e\,|z_+|}{L}\left\{\frac{c_1\,a_{11*}}{\Gamma_1} + \frac{c_2 a_{12*}}{\Gamma_2}\right\} + \frac{2\,e\,|z_-|}{L}\left\{\frac{c_1\,a_{21*}}{\Gamma_1} + \frac{c_2\,a_{22*}}{\Gamma_2}\right\} + \boldsymbol{b}\,\boldsymbol{e}\,\boldsymbol{n_0}\,(\boldsymbol{\upsilon}_+\boldsymbol{\nu}_+|\boldsymbol{z}_+| + \boldsymbol{\upsilon}_-\boldsymbol{\nu}_-|\boldsymbol{z}_-|) \tag{3.87}$$

The frequency dispersion of the admittance Y(ω) = Y´(ω) + I Y´´(ω) can be calculated replacing s = iω in Eq.3.87. Calculations of Y(ω) for common values of parameter have shown that the two first terms of Eq.3.87 can be disregarded. Thus, the transport admittance is given by:

$$\boldsymbol{Y(\omega) = b(\omega)\, e\, n_0\, (v_+ \nu_+ |z_+| + v_- \nu_- |z_-|)} \tag{3.88}$$

Fig. 3.8 shows the Nyquist and Bode plots of the admittance Y(ω) for a series of selected parameters (the origin of these parameters is explained below). The impedance behavior shown in the Nyquist plot is akin to that of an electric series RC-circuit. The resistance is given by the conductance of the electrolyte for b(ω) → 1 for the highest frequencies. The Bode plot, on the other hand is characterized for a sigmoidal course of the real admittance and a Gaussian peak of the imaginary part.

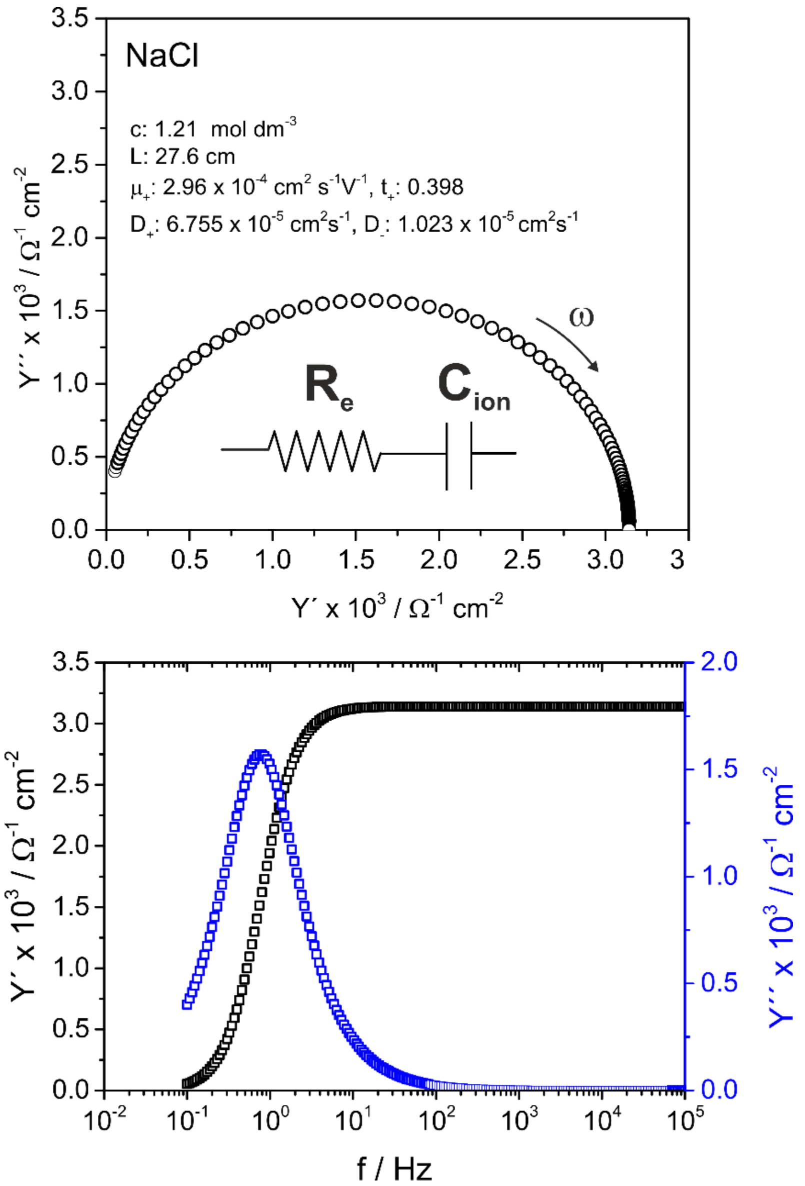

Fig. 3.8 Nyquist (top) and Bode (bottom) diagrams of the transport admittance calculated by equation 6.60. Transport parameters were obtained by equaling the theoretical transport capacitance (C_{ion}) to that obtained by fitting the low frequency impedance diagrams (see Ch. 4). C_{ion}: 6.516×10^{-4} F cm^{-2}, R_e: 318.256 Ω cm^2

3.5 Contrasting the theoretical description with experiments

Fig. 3.9 shows the bode plots of experimental admittance obtained for a selected NaCl solution. The courses of the real and imaginary parts akin to those predicted by theory, but wider and extended toward more higher frequencies. Such a spectrum can be obtained replacing the pure ion capacitance C_{ion} by a so-called leaky capacity in parallel with a resistivity $R_{ion.}$ The former considers the dielectric losses during the charging and discharging processes. The latter represents the limited mobility of ions. The impedance of the leaky-capacitance is given by:

$$\boldsymbol{Z_c(\omega)} = \frac{\boldsymbol{1}}{\boldsymbol{C\,\omega^n}} \qquad (3.89)$$

where n is the dispersion factor.

Fig. 3.10 shows the Nyquist plot for the impedance response of a 1.0 m NaCl solution and the corresponding curve obtained by fitting the experimental data by the equivalent circuit including a leaky-capacitance element.

Fig. 3.11 shows the concentration dependence of the model capacitance calculated for NaCl solutions. For fixed transport numbers, the ion capacitance changes linearly with $c^{1/2}$, suggesting that the applied voltage is compensated by the formation of a diffuse-type layer.

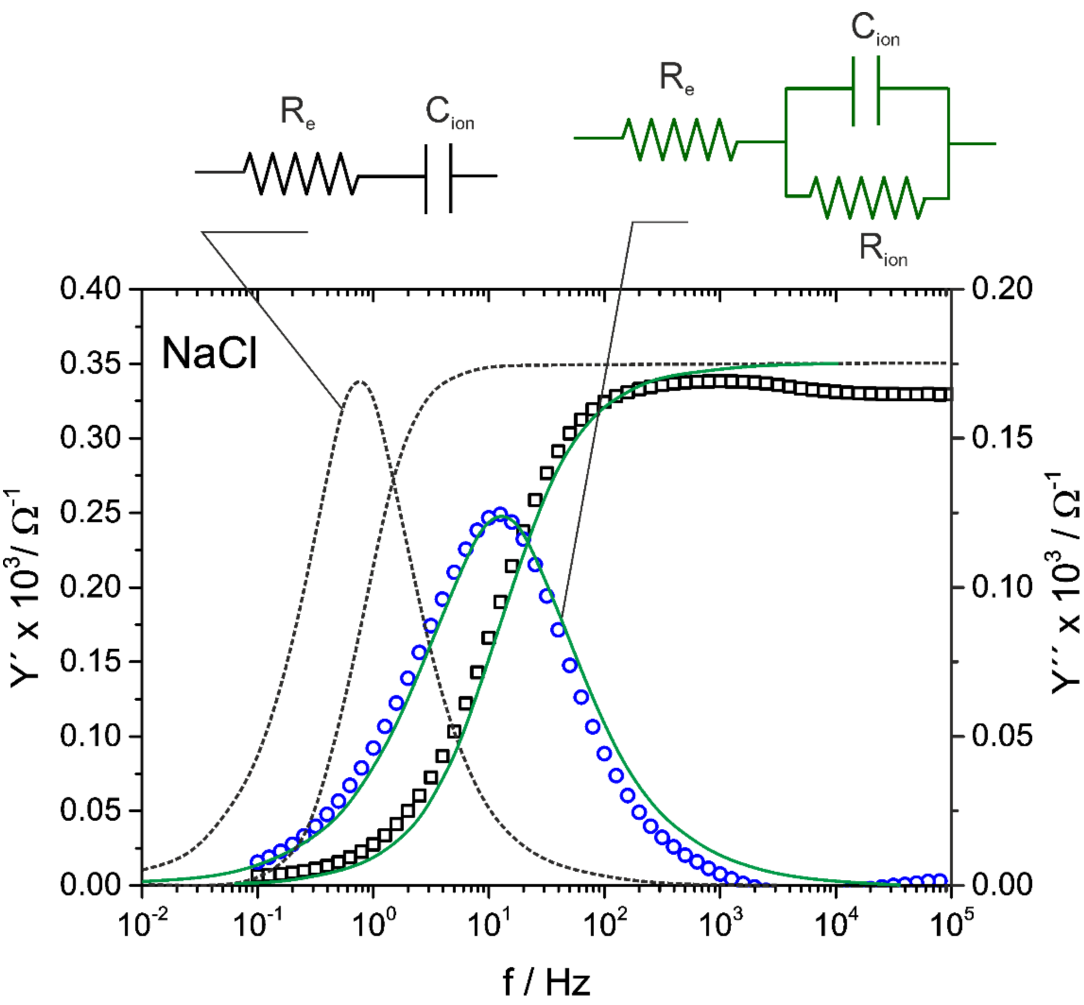

Fig. 3.9 Bode plots of the experimental admittance obtained in NaCl solution of c: 1.00 mol dm^{-3}. Cell length: 27.6 cm. Lines: theoretical calculations assuming following parameters: R_e: 2912 Ω, C_{ion}: 3.28×10^{-5} F, R_{ion}: 9.15×10^{6} Ω, n: 0.8

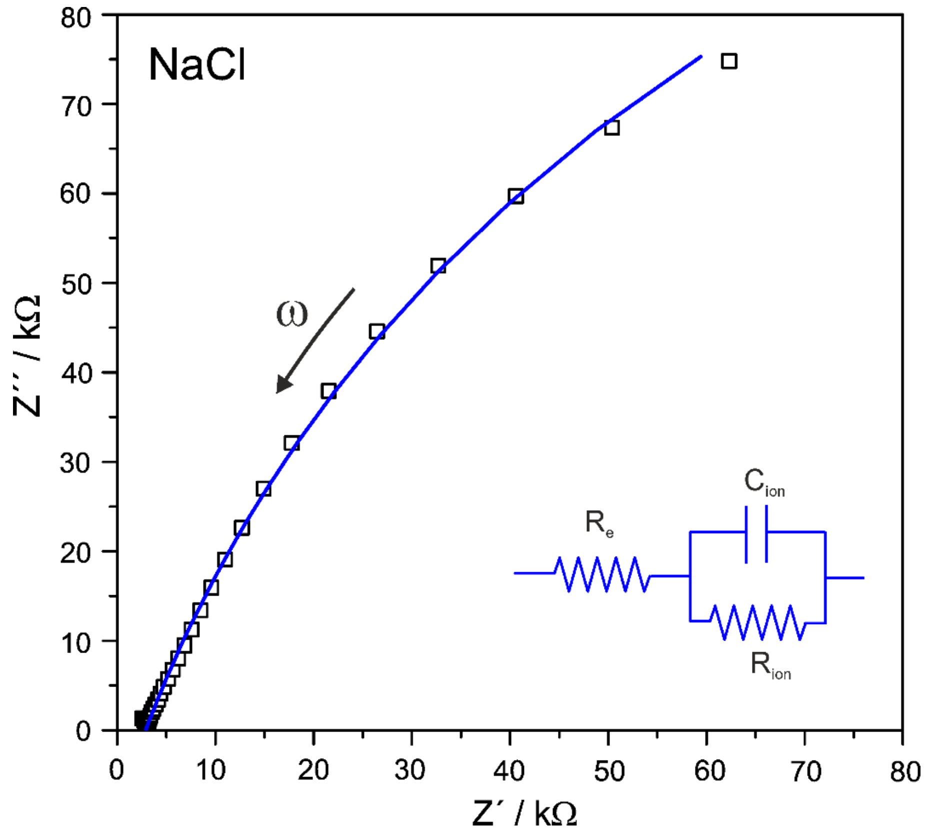

Fig. 3.10 Nyquist plot of the experimental impedance obtained in NaCl solution of c: 1.00 mol dm^{-3}. Cell length: 27.6 cm. Lines: theoretical calculations assuming following parameters: C_{ion}: 1.30 $\times 10^{-4}$ F, R_{ion}: 289.5 kΩ, R_e: 2375 Ω , n: 0.8

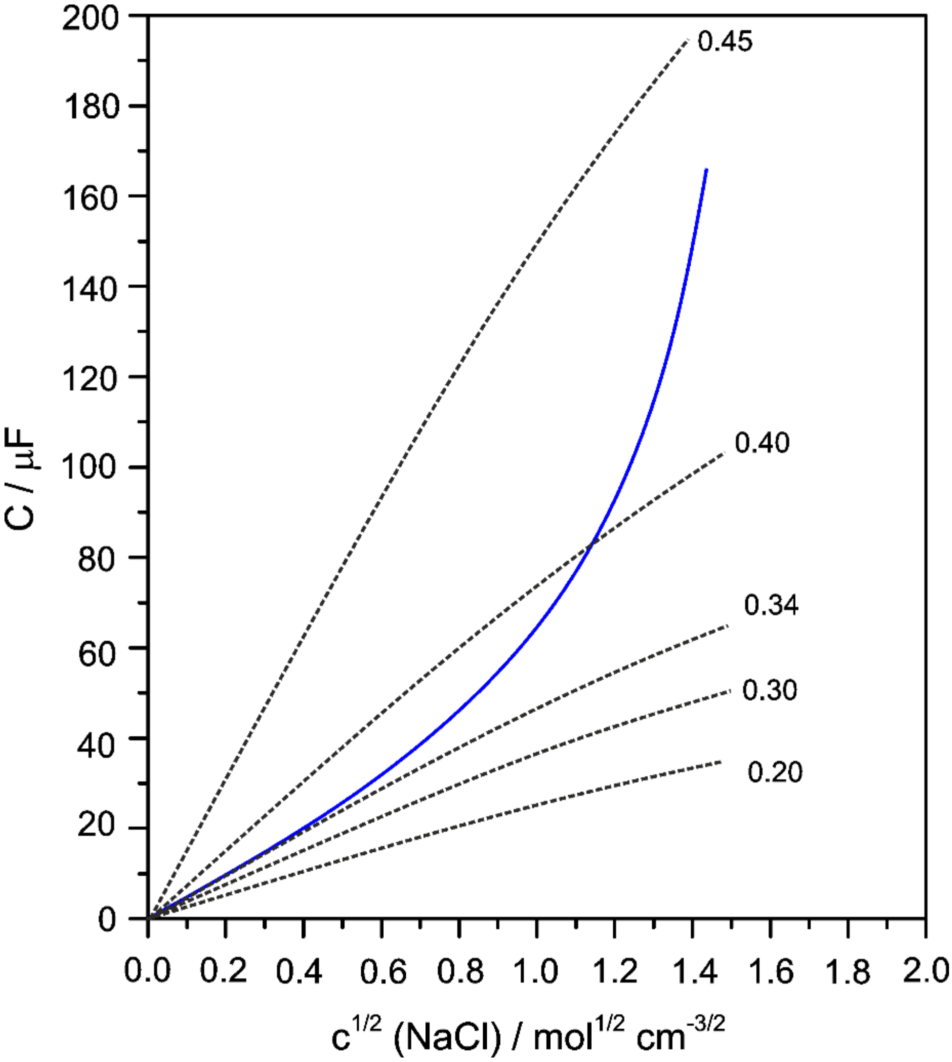

Fig. 3.11 Concentration dependence of the ionic capacitance in NaCl solutions obtained by applying our transport model fixing the cationic mobility (υ+ : 3.4 × 10^4 cm^2 $V^{-1}s^{-1}$, blue curve) and fixing the transport number t+ at different values

3.6 Method of analysis and results

According to the foregoing discussion, the following methodology for the data analysis was developed.

Step 1. Recording the impedance data in a frequency range from 10^5 Hz to 0.1 Hz.

Step 2. Fitting of the low frequency tail of the Niquist diagram with the circuit R_e (R_{ion}//C_{ion}): → $\mathbf{C_{ion}^{exp}}$

Step 3. Data input

- Concentration of salt: **c** [mol cm^{-3}]
- Density of solution: ρ [g cm^{-3}]
- Length of Cell: **L**
- Area of liquid tube: **A**
- Parameters **a**, **b** and **c** for the specific conduction of the salt expressed as: κ [Ω^{-1} cm^{-1}] = a m + b m^2 + c m^3; m [mol kg^{-1}]
- Parameters of the extended Debye-Hückel equation (6.14) for the activity coefficient of cations and anions: $\mathbf{A_+}$, $\mathbf{A_-}$, $\mathbf{B_+}$, $\mathbf{B_-}$

Step 4. Calculation of Diffusion coefficients $\mathbf{D_+}$ and $\mathbf{D_-}$ with eq. (6.16)

Step 5. Calculation of $\mathbf{R_e}$ [Ω] = L / (κ A)

Step 6. Cation mobility: υ_+^0 (first iteration value)

Step 7. Calculation of the anion mobility:

$\upsilon_-^0 = L / (R_e\, A\, z_-\, \nu_-\, c\, F /1000) - \upsilon_+^0\, (z_+\, \nu_+) / (z_-\, \nu_-)$: where $z_\pm$: ion charge, $\nu_\pm$: stoichiometric coefficient, F: Faraday`s constant: 96500 C eq^{-1}

Step 8. Calculation of **b (ω)** by eq.(6.54)

Step 9. Calculation of theoretical capacitance:

$$C_{theor} = - [(\upsilon_+^0\, z_+\, \nu_+ + \upsilon_-^0\, z_-\, \nu_-)\, n_0\, e / \omega\, L]\, [Re(b)/Im(b)]$$

Step 10. $\mathbf{C_{theor}} \neq C_{ion}^{exp}$, then repeat the iteration until equality

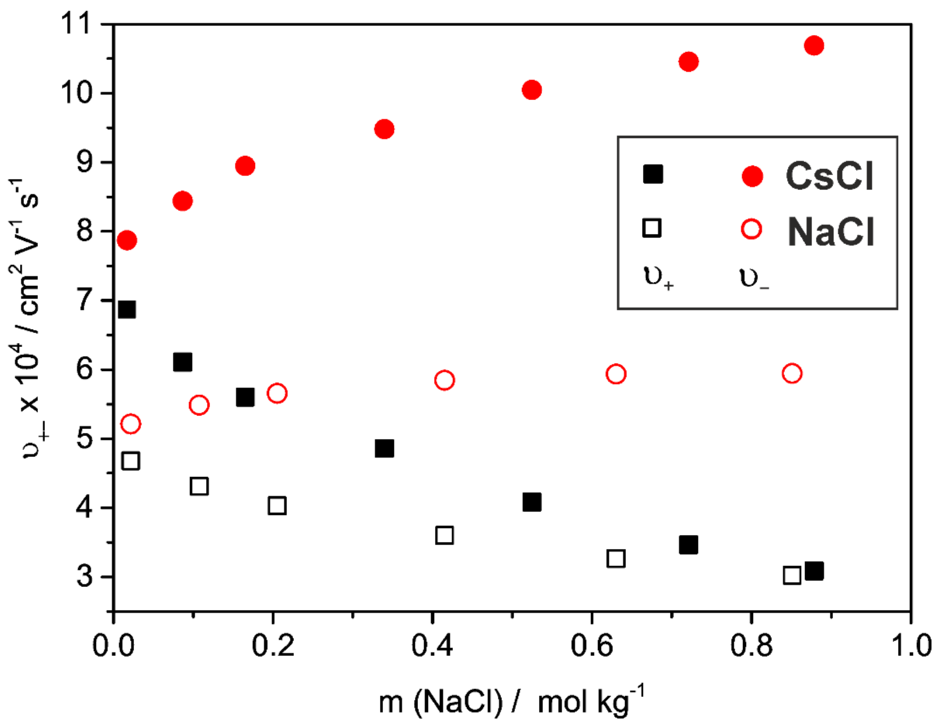

Fig. 3.12 Ionic mobilities calculated by analyzing impedance spectra using the method shown above

Fig. 3.12 shows some results of the analysis of impedance spectra after applying the above described protocol. They predict an increase of the mobility of negative charged ions and an almost symmetrical decrease of that of the positive charged ions with the concentration, a fact that is not expected. After a carefully revision of the theory developed in subchapter 3.4.2, one can arrive to the conclusion, that these deviations might originate from the fact that the number of charge carriers does not correspond exactly to the salt concentration, as supposed for the calculation of the ion mobility (see chapter 3.6). This procedure was firstly reasoned considering a mean ionic mobility embracing mobile and immobile ions. But this idea is not compatible with the transport equations, from which the impedance expressions were derived. Whereas only charged species are mobile, the diffusion coefficient is still valid also for ions forming part of ion groupings. In the data analysis presented in chapter 3.6, the variable parameter should be the product υ_{+-} n, where n is the real amount of mobile charges, being $n < n_0$. Then, the expression ($\upsilon_+ n z_+ + \upsilon_- n z_-$) in the final expression of C_{theor} should be replaced by R_e.

4 Time-Domain-Reflectometry method

The time-domain-reflectometry (TDR) is a technique used to observe the time dependent electromagnetic response of a sample to the application of a potential pulse. The electromagnetic response contains information about the dielectric behavior of the material. After an adequate mathematical treatment to transform the data from the time-domain into the frequency-domain, the dielectric dispersion of the electrolyte, i.e. the complex dielectric constant $\varepsilon^*(\omega)=\varepsilon'(\omega) + I\ \varepsilon''(\omega)$ can be obtained. This, in turn, can be transformed in its equivalent impedance spectrum of an electrolyte enclosed between two parallel electrodes using Coehlo´s expression (3.26).

First theoretical descriptions of the dielectric behavior of materials contained between two inert electrodes on applying an alternate voltage were developed by Coehlo /COE 1983//BAN 2011/. In this approach, the dielectric properties of the electrolytes are directly connected with the ionic mobility. Following this theory, one can see that the characteristic frequency range of the dielectric response increases with the concentration of the electrolyte. Therefore, a limitation of the above discussed electrochemical impedance methode (EIS) appears: typically, 1 MHz. The TDR method allows to analyze the dielectric properties of materials from 1 MHz until 2 GHz.

This technique was originally developed by Fellner-Feldegg /FEL 1969/, placing a substance into a coaxial line. Fig. 4.1 shows schematically the working principle of TDR measurement. The generator sends a voltage pulse to the coaxial cable. The pulse travels along the cable towards the termination containing the investigated sample. The reflected electromagnetic wave contains information about the pursued frequency dispersion of the dielectric behavior of the material which can be resolved after converting the time-domain response in the frequency domain by applying a Fourier transformation. The complex frequency dispersion of the electrical permittivity of several materials was evaluated in this way for solids /COL 1989/ and electrolyte solutions /BUC 1997//BUC 2003//COL 1975//COL 1982/.

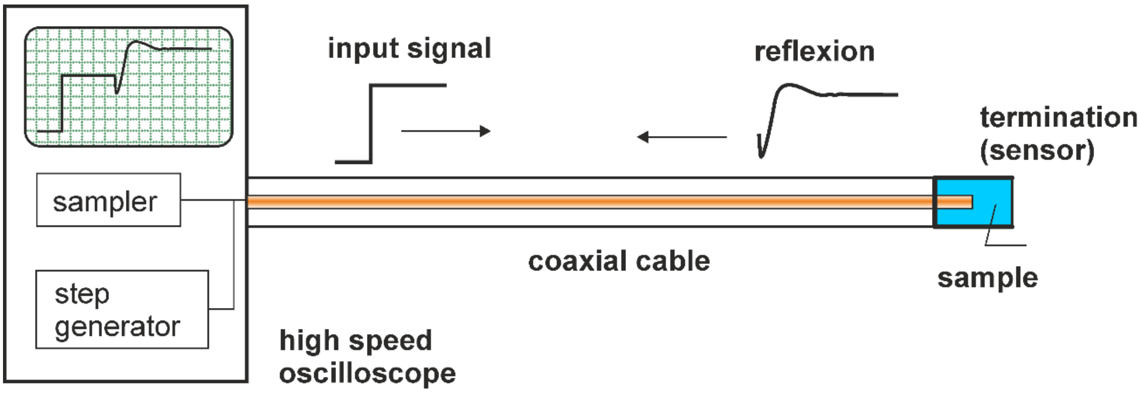

Fig. 4.1 Schematic representation of working principle of TDR-technique

4.1 TDR sensors

One of the most critical developments in a TDR measuring system is the form of termination or sensor head. In the very initial stage of this project, a design consisting of two parallel plates confined in a receptacle cut in a block of a non-conductive material of low dielectric constant (acryl glass) was realized. It was constructed starting from a SMA (SubMiniature version A) connector of 50 Ω on which two straight plates of gold were glued with conducting silver paste. The sensor was connected to the precision TDR oscilloscope with a flexible coaxial cable PE300-12. Fig. 4.2 shows a picture of the complete experimental set-up and a detail of the very first designed sensor.

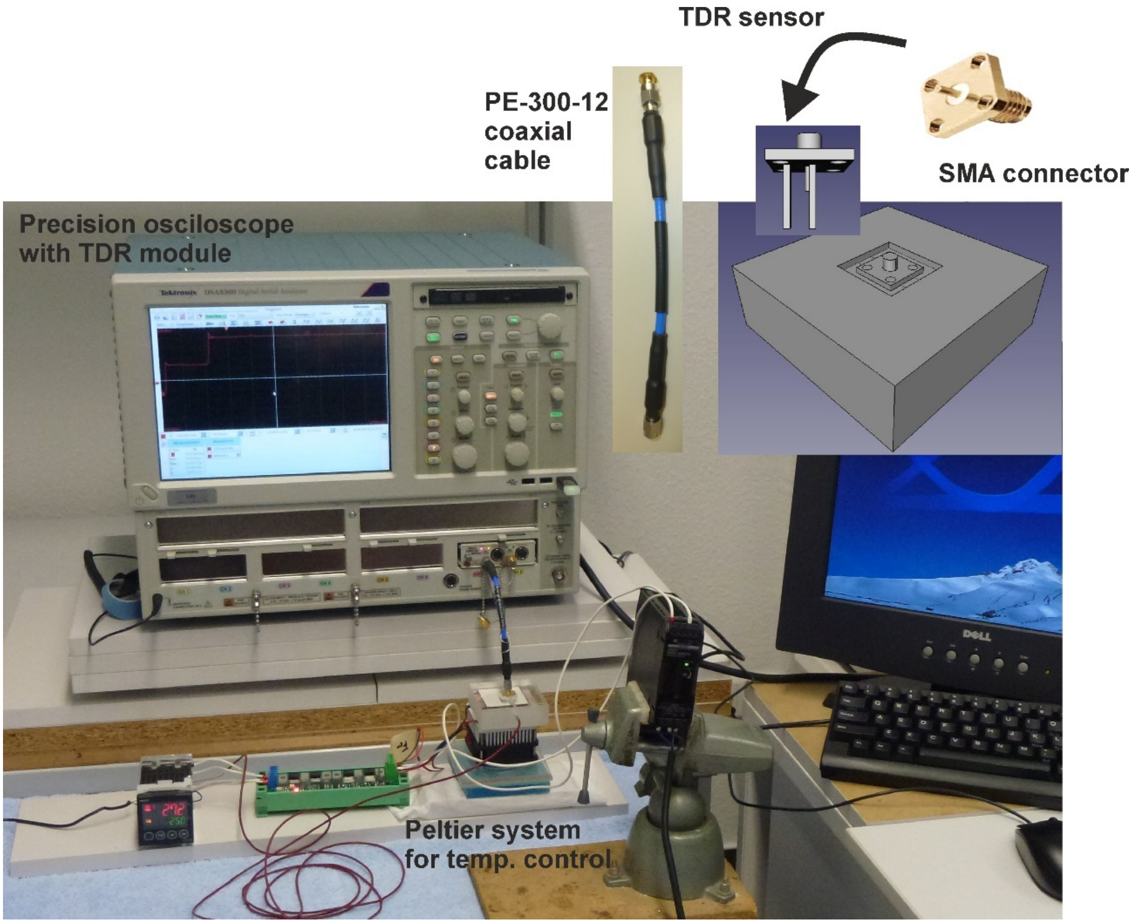

Fig. 4.2 Experimental set-up for TDR measurements

After first test measurements performed with liquids of known frequency dispersions of the dielectric constant, such as water, ethanol and isopropanol, it became clear that this design is not completely satisfactory because of the impossibility to arrive to the known frequency dispersion of these liquids after the transformation of measured time-domain data into the frequency-domain. This was probably due to the lack of an exact transmission function describing the electric field distribution for this special geometry. Therefore, we decided to test cylindrical geometries, nearer to that discussed in the literature and for which transmission functions already exist. An open-ended coaxial probe was found an adequate candidate. Some typical forms are schematized in Fig. 4.3.

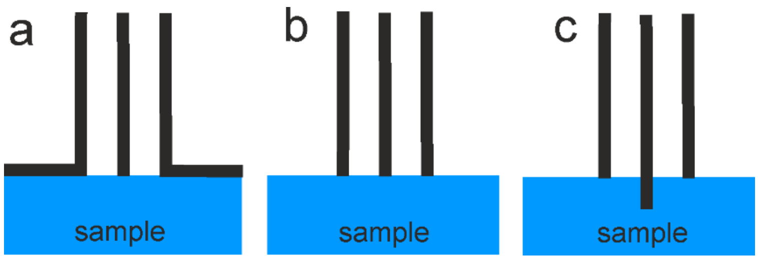

Fig. 4.3 Typical open-ended coaxial probes: a) Flanged probe, b) non-flanged probe, c) extruding center pin

Cells in the form of coaxial terminations are adaptable to a wide variety of frequency ranges by choice of the right length to conductor diameter ratios. The impedance of the cell should be matched with the coaxial line, to which the cell is connected. An impedance mismatch would produce unwanted reflections in the measurement. Therefore, dimensions of the sampling cell are very important and must be designed carefully. Flanged probe a) is more suitable for measurement of solids, gel and liquids. The flange gives a good mechanical stability and ensures that the electric fields exist only in the region where sample is located. The extruding central pin in the probes shown in c) acts like a monopole antenna /DES 1962/. This antenna structure generates uniform field lines that penetrate through the sample, thus providing a better interrogation of the sample. Non-flanged probe b), is commonly used for investigating micro emulsions /NOZ 1990//BOS 1993/, electrolytes /HAG 1994/ and vivo measurements /BUR 1980/. This configuration is not well suited for measurement of solids and semi-solids, because some fringing field appear in the region around the probe that does not penetrate in the sample and lead to inappropriate results.

The basic equation relating the relative complex permittivity (ε^*) of the sample at the end of coaxial termination with the time response measured at the oscilloscope is given by: /COL 1975//COL 1989/:

$$\boldsymbol{\varepsilon}^*(\boldsymbol{\omega}) = \frac{c}{d}\,\frac{V_0(\omega)-R(\omega)}{i\omega\,[V_0(\omega)+R(\omega)]} \qquad (4.1)$$

where c is the speed of light and d is the length of the fringing field, which can be calculated by calibration with a substance of known dielectric dispersion. V_0 (ω) and R (ω) are the Fourier transforms of the incident and the reflection in the time-domain, respectively. Despite that both V_0 (ω) and R (ω) can be solved from the signal response, it is desirable to avoid the inclusion of the incident signal V_0 (t) in the analysis because of difference of the travel time. Instead, the Fourier transforms of the reflections of a reference $R_k(t)$ and of an unknown sample $R_u(t)$ are used for calculating the complex permittivity $\epsilon*(\omega)$ /COL 1980/:

$$\varepsilon^*(\omega) = \frac{c}{d}\,\frac{R_k(\omega)-R_u(\omega)}{i\omega\,[R_k(\omega)+R_u(\omega)]} \tag{4.2}$$

Eq. (4.2) is valid only for an ideal open-ended coaxial line contacting a sample with no dc-conductivity. In the case of a sample with DC-conductivity, the time domain difference $R_k(t) – R_u(t)$ does not drop to zero even at sufficiently long time. This conducts to some instabilities in performing the Fourier transformation, which can be avoided by setting a time-window for the numerical Fourier analysis as shown below.

4.2 Experimental details

Fig. 4.4 shows a picture of the second design based on an open-ended coaxial cable as a sensor. It consists of an oscilloscope Tektronik DSA8300, a TDR module 80E04 and a rigid coaxial transmission line with its end faced up. A drop of the investigated solution is put at the end of the transmission line, which was previously grounded and polished and gold plated. This design offers a geometry which simplifies the analysis of the dielectric dispersion of electrolytes thanks to the existence of theoretical expression connecting the dielectric behavior of the material with the TDR-response for this type of geometry (see eq.(4.2)). This system has the advantage of using only a small quantity of solution. The reduction of the drop volume by evaporation does not seem to be a major problem, because of the very short time required for measurements. However, this system does not allow a simple control of the temperature. On pondering of a solution to this problem we arrived to a third design, where the rigid open-ended sensor was placed downwards and dipped in the liquid contained in a cylindrical cell. The temperature can be modified by a Peltier-heating device on the bottom of the cell in a control-loop fed by a thermocouple. All these components are described below.

Fig. 4.5 shows the different components of the TDR-system with additional control of temperature. The sampling module 80E04 is a fully integrated independent dual channel remote sampler system. It has an input impedance of 50 Ω.

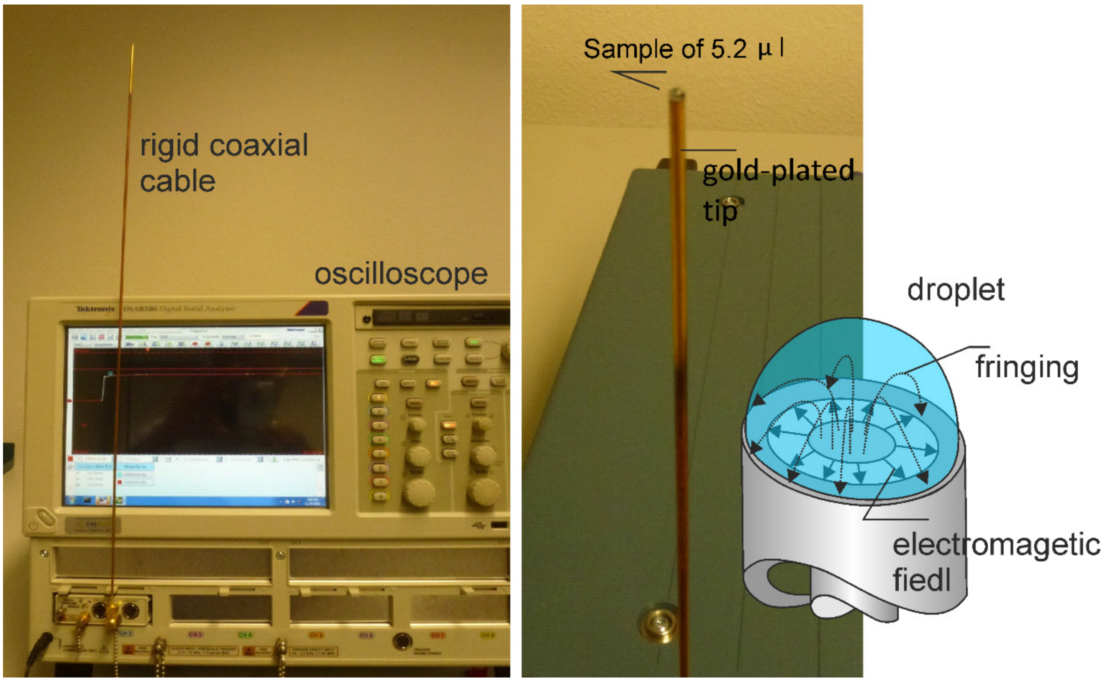

Fig. 4.4 Set-up of the TDR measuring system with a sensor based on an open-ended coaxial cable

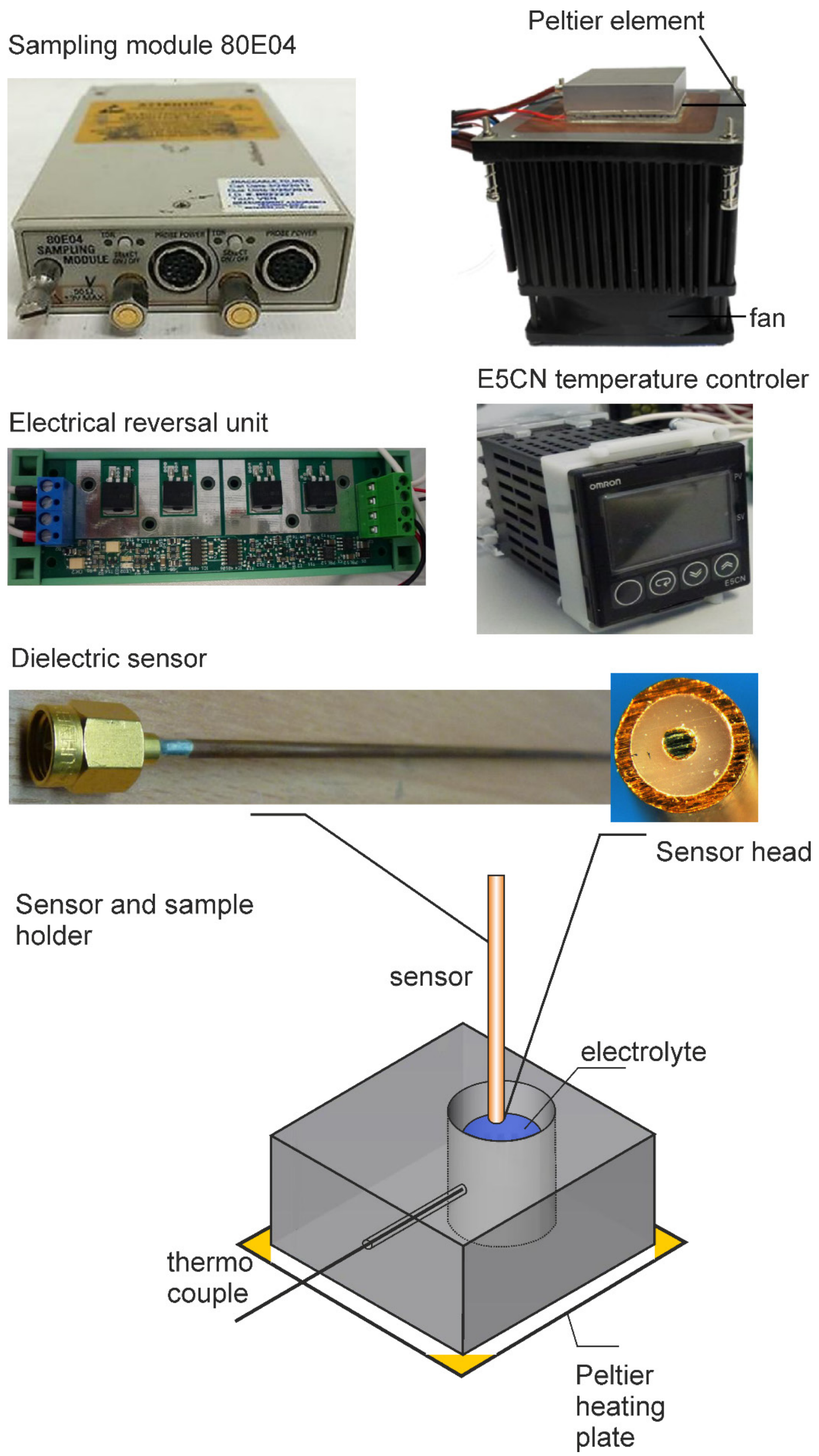

Fig. 4.5 Components of the TDR-measuring system

It has two channels, each one with its own acquisition circuitry. The sampling module generates fast rising step pulses of 250 mV with a bandwidth of 20 Ghz. The polarity of each channel steep can be chosen independently. To attain the maximum frequency limit, the incident rise time must be kept to 23 ps. The incident step generator allows true differential measurements for better measurement accuracy. The acquisition portion of the module monitors the incident and reflected pulses.

The Peltier element is an electro thermal semiconductor transducer which generates a temperature difference upon circulation of DC-current. Depending on the flow of current, the upper Peltier plate cools and the lower heats up which creates a temperature difference between the plates. To reverse the current in the Peltier element an electrical reversal unit is used. This permits a precise regulation of temperature at an ambient temperature of -10 °C to 60 °C (Figure 3.5).

The E5CN is a compact and intelligent digital temperature controller with PID controller. It is connected to an integrated temperature sensor PT100 with a measurement temperature range from -50 °C to 200 °C, which helps in setting up of set and present temperature value.

As already mentioned, the dielectric sensor used in our measuring system is an open-ended coaxial line. It is simple to construct and has reasonable accuracy over wide range of frequencies. This sensor is suitable for liquid samples, because it wets the sensor completely without air gaps. The step voltage generated in the sampling module produces a fringing field characterized by a distance d_f. A copper semi rigid flat ended coaxial probe from HUBER+SUHNER® has been used as a dielectric sensor: ∅ center conductor 0.51 mm, ∅ outer conductor 2.2 mm, dielectric material PTFE, ∅ 1.68 mm, impedance=50 Ω, length = 500 mm. The flat end of the sensor requires additional treatment, because rough and unpolished surface creates instability and timing errors in the measurement. The reflection error occurs more often due to unpolished surface of the center conductor. This creates a tiny air gap which is responsible for impedance difference between the sensor and the sample under test. The origin of the error can be identified from the amplitude of the repeated measurement reflections of the identical sample. A microscopic view of the coaxial end is shown in Fig. 4.5. The end was polished with emery paper 1000 and diamond suspensions of 6 μm and 1 μm. The complete tip was gold-plated using a commercial galvanizing set. This avoids the corrosion of sensor materials by contacting saline solutions.

4.3 Data analysis

In this section, the description of the data analysis of TDR measurements are presented. This methodology applies for sensor designs based on the contact of the open-ended 50 Ω coaxial probe with the investigated liquid, i.e. the droplet-design (Fig. 4.4) and the dipping of the coaxial probe in the liquid holder (bottom detail in Fig. 4.5). The numerical data analysis requires the introduction of the electrical length d_f characterizing the fringing field. This value can be estimated by calibrating the sensor with liquids of a known dielectric dispersion. The initial pulse $V_0(t)$ is always approximated to an ideal step function.

For the transformation from time to frequency domain, the conductive nature of the sample must be considered. Air is taken as a reference substance: $R_k(t)$ (see eq.8.2). In the case of non-conductive liquids, as pure water, the reflected signal equals that to the reflected signal in air at $t \to \infty$ (see Fig. 4.6). For conductive samples, as for instance the investigated KCl solutions, the response at $t \to \infty$ are separated by a voltage which increases with the solution conductivity.

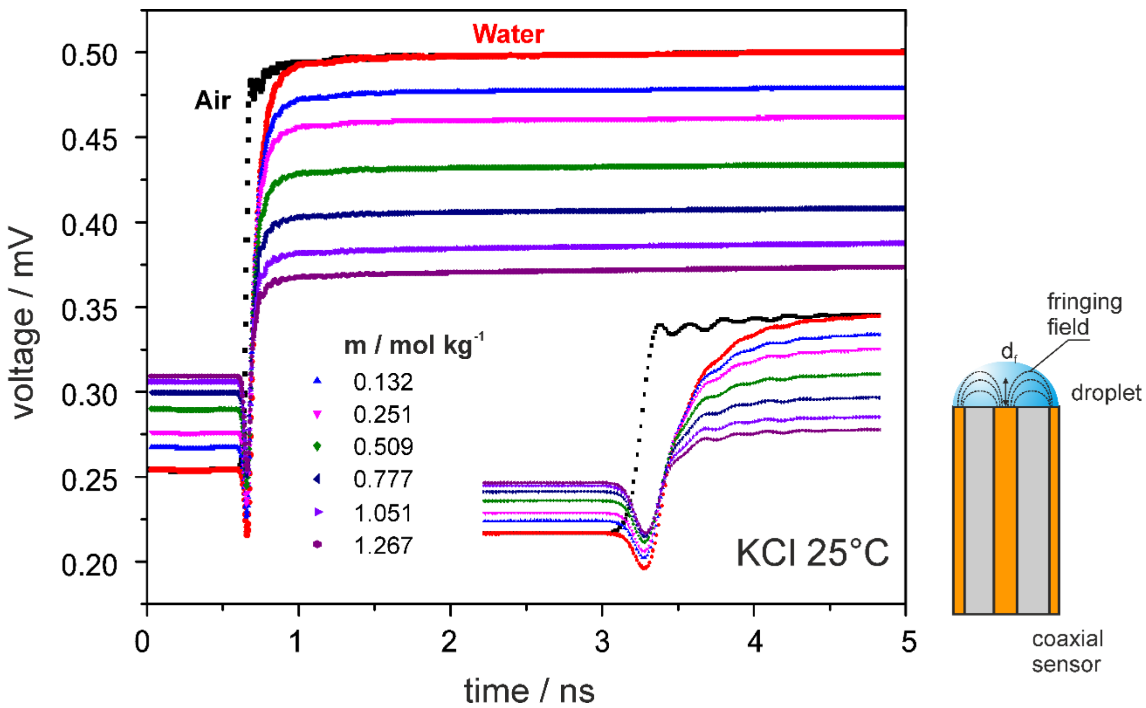

Fig. 4.6 Reflected pulses for air, water and KCl solutions of different concentrations at 25 °C obtained with a sensor design based on a droplet. Detail: magnification of the initial rising part of the reflections

For the time-to-frequency domain transformation we use a modified expression of Eq. 4.2:

$$\varepsilon^*(\omega) = \frac{c}{d}\frac{L_{i\omega}\,[R_k(t)-R_u(t)]}{i\omega\, L_{i\omega}[R_k(t)+R_u(t)]} = \frac{c}{d}\frac{L_{i\omega}P(t)}{i\omega\, L_{i\omega}Q(t)} \quad (4.3)$$

Fig. 4.7 shows an overview of the shape of the P(t) and Q(t) function. The offset shown in the reflection functions for conductive samples requires a differentiated numerical method for the Fourier transformation as described below.

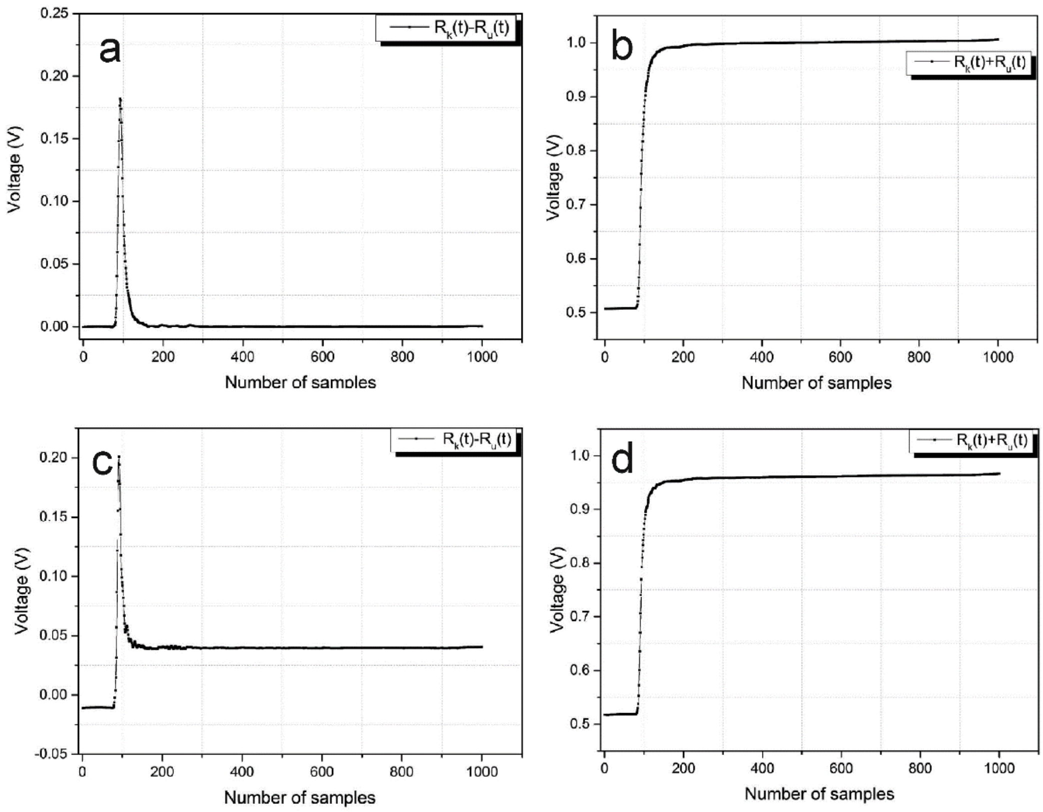

Fig. 4.7 General form of P(t) and Q(t) functions for non-conductive (a and b, respectively) and conducting samples (c and d, respectively)

For non-conductive samples, the Fourier transform of P(t) is implemented by the summation method:

$$P(\omega) = \Delta \sum_{n=0}^{N} e^{-i\omega n\Delta}\, P(n\Delta) \quad (4.4)$$

where Δ is the time-interval between two sampling points, N is total number of sampling points and ω is the angular frequency. The transform P(ω) is simply the area under the curve of P(t). It shows an initial peak and a subsequent decay towards finite limiting value. The function Q(t) rises monotonically for a long time. The summation method is not applicable in this case. Thus, Samulon´s formula is used instead /COL 1980/, /SAM 1951/:

$$\boldsymbol{Q(\omega)} = \frac{1}{i\omega}\frac{\omega\frac{\Delta}{2}}{\sin\left(\omega\frac{\Delta}{2}\right)}\mathrm{e}^{-i\omega\Delta/2}\ \sum_{n=0}^{N} e^{-i\omega\Delta}\ [\boldsymbol{Q(n\Delta+\Delta)} - \boldsymbol{Q(n\Delta)}] \qquad (4.5)$$

For a function Q(t) approaching to a constant Q(∞), the difference [Q(nΔ+Δ)−Q(nΔ)] goes to zero with increasing time. Although equation (4.5) is sensitive to fluctuations in the differences, they have not been found significant for averaged or smoothed signals.

In the case of a conducting sample, the summation method for the transformation of the function P(t) is not applicable, because the voltage does not drop to zero. This response is connected to the specific conductivity of solution, κ /COL 1980/. Final values of P(t) are finite and Q(t) is less than the expected value of 2 V_0(t). Hence, the choice of time window is critical, since too small time windows cause loss of signal whereas the selection of large time windows may incorporate unwanted reflections. The minimum and maximum observable frequencies for a correct choice of the time window can be determined by:

f_{min}=1 / (time window)

f_{max}=N/(2∗time window)

For calculation of the frequency dispersion in conducting samples, the derivate of the voltage transients are used for the Fourier transformation /BUC 1997/:

$$\boldsymbol{\varepsilon^*(\omega)} = \frac{c}{d_f\,\gamma}\ \frac{L_{i\omega}\,[\frac{d}{dt}(R_k(t)-R_u(t))]}{i\omega\ L_{i\omega}[\frac{d}{dt}(R_k(t)+R_u(t))]} \qquad (4.6)$$

where c is the speed of the light (3×10^8 m s^{-1}), d_f is the length of the fringing field which is calculated by calibration. γ = G/G_c, where G and G_c are the characteristic admittance of the coaxial cell and that of the line connecting the pulse generator to the cell, respectively. Usually the value of γ is near 1. From eq.(4.6) we obtain a complex figure, which has a real part (ε’), which represents the dielectric dispersion and the imaginary part (ε’’) which represents the dielectric absorption. The measured complex permittivity, ε*, can be analyzed in terms of the first order Debye relaxation which includes the DC-conductivity κ /WEI 1992/:

$$\boldsymbol{\varepsilon^*(\omega)} = \boldsymbol{\varepsilon_\infty} + \frac{\varepsilon_s-\varepsilon_\infty}{1+\,i\omega\,\tau_m} - \boldsymbol{i}\,\frac{\kappa}{\varepsilon_0\,\omega} \qquad (4.7)$$

Where ε_s and ε_∞ are the low and high frequency constraints of the dielectric constant respectively, ε_0 is vacuum permittivity (8.854×10^{-12} Fm^{-1}) and τ_m = 1/ 2 π f. According to this expression, the real and imaginary parts of the permittivity are given by:

$$\varepsilon'(\omega) = \varepsilon_\infty + \frac{\varepsilon_s - \varepsilon_\infty}{1+(\omega\,\tau_m)^2} \qquad (4.8)$$

$$\varepsilon''(\omega) = -\frac{(\varepsilon_s - \varepsilon_\infty)\,\omega\,\tau_m}{1+(\omega\,\tau_m)^2} - \frac{\kappa}{\varepsilon_0\,\omega} \qquad (4.9)$$

Smoothing of the reflected data can be helpful for reducing the effects of noise and other irregularities without major perturbation of the transformation. The smoothing algorithm defined for a point P(nΔ) is defined as /COL 1980/:

$$P(n\Delta) = \frac{1}{4}P(n\Delta - \Delta) + \frac{1}{2}P(n\Delta) + \frac{1}{4}P(n\Delta + \Delta) \qquad (4.10)$$

The flow chart shown in Fig. 4.8 summarizes the steps for data processing.

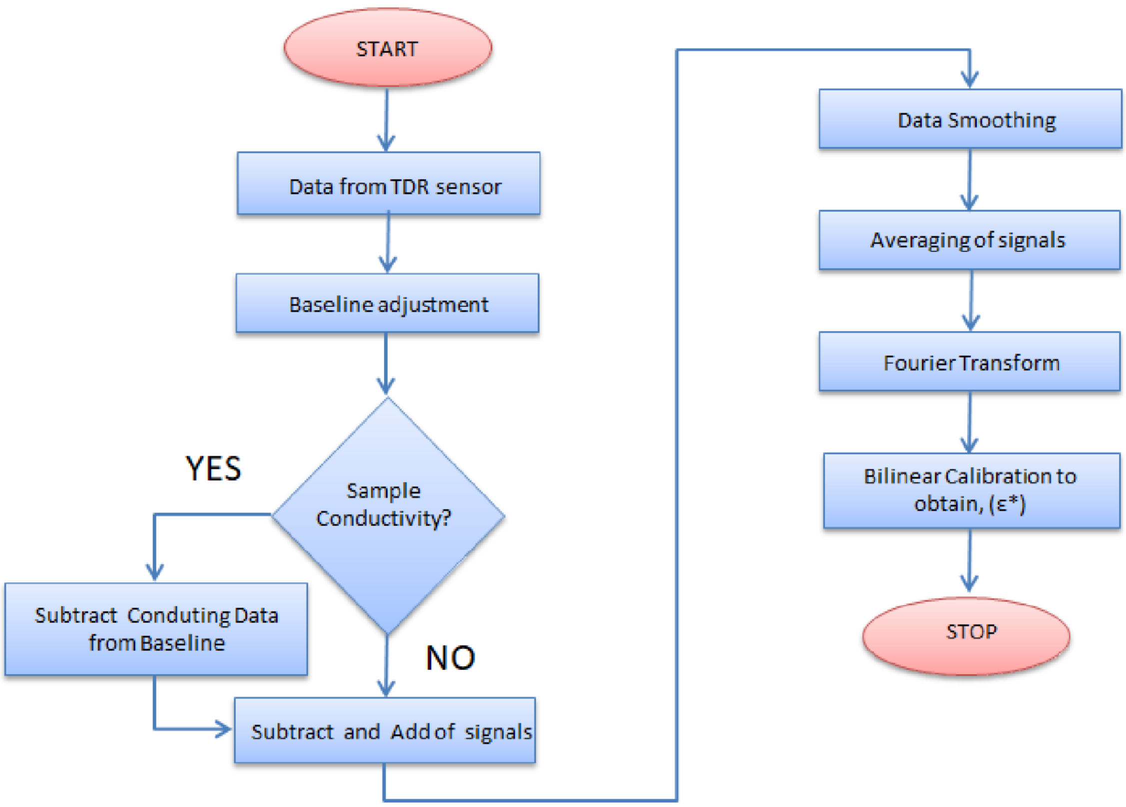

Fig. 4.8 Flow chart summarizing the data treatment

4.4 Results

According to the data processing described in the preceding chapters, some results were obtained using the droplet method for solutions of the salt of the oceanic system at 25 °C.

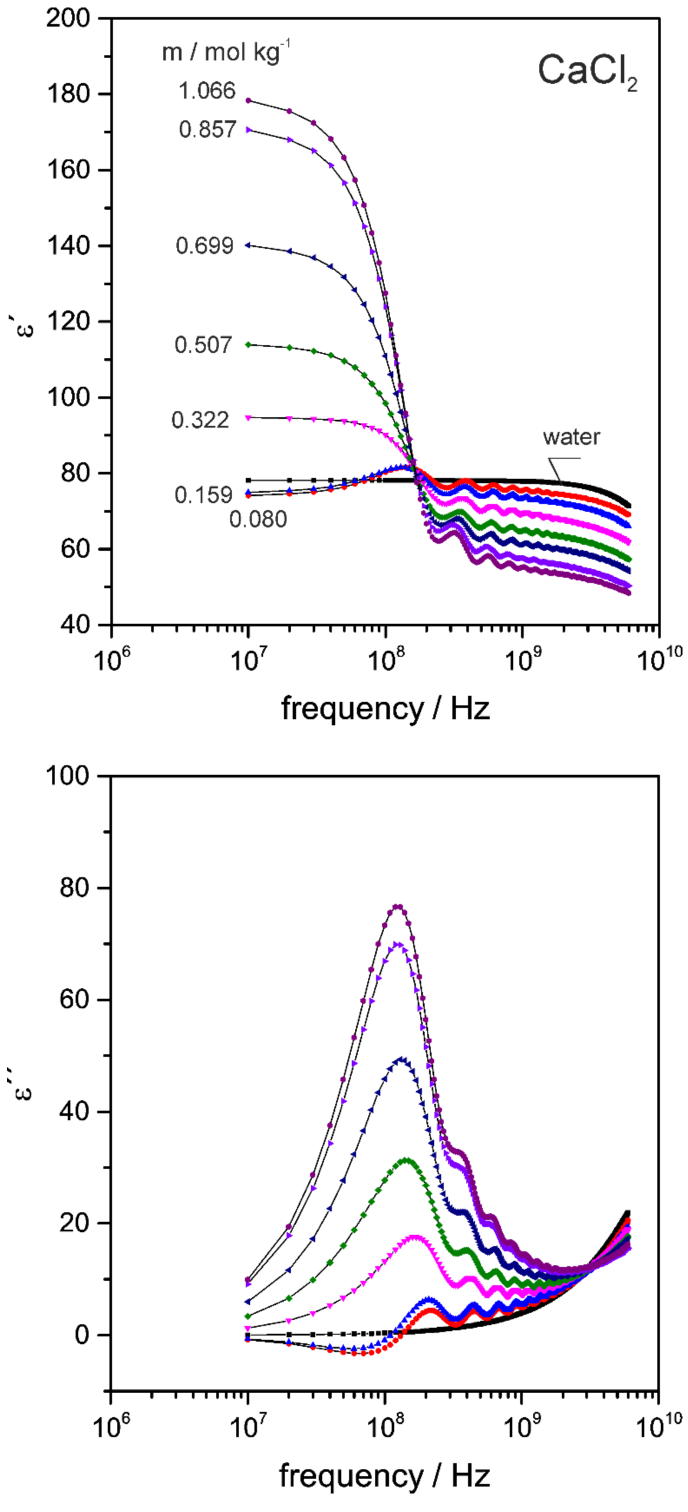

Fig. 4.9 Dielectric dispersion ε´(f) and dielectric loss ε´´(f) for $CaCl_2$ solutions and pure water

Fig. 4.9 shows, as an example, die frequency dispersion $\varepsilon'(\omega)$ and the dielectric loss $\varepsilon'(\omega)$ obtained after applying the data analysis described in Fig. 4.8. It can be observed that the curves follows a Debye-type of dispersion, described by eq. (4.7) only at frequencies higher than 0.8 MHz. By fitting eq. (4.7) to experimental values in this frequency region, one can obtain values of the low frequency dielectric constant of the solution ε_s. This value can be interpreted as that arising from the dielectric behavior of the solvent. The experimental real part of the dielectric permittivity or dielectric dispersion $\varepsilon'(\omega)$ (Fig. 4.9) rises until a constant value at lower frequencies. This value increases with solution concentration. This part of the frequency dispersion (f < 0.2 MHz) can be attributed to the reflection signal arising from the movement of ions. The imaginary part of the permittivity shows a peak at low frequencies (f < 0.2 MHz), which also increases with the salt concentration.

The dielectric behavior of electrolytes is characterized by two dynamic processes with their corresponding characteristic time constants τ_m: that one at high frequencies arises from the dipole dynamics of water, whereas that at lower frequencies can rather be attributed to the dynamics of ions. This latter phenomenon, however, requires a deeper analysis.

Fig. 4.10 shows the concentration dependence of the solvent dielectric constant for several salts. It must be noted, that they are characterized by a similar function, which is linear at low concentration and bends towards a constant value at higher concentrations.

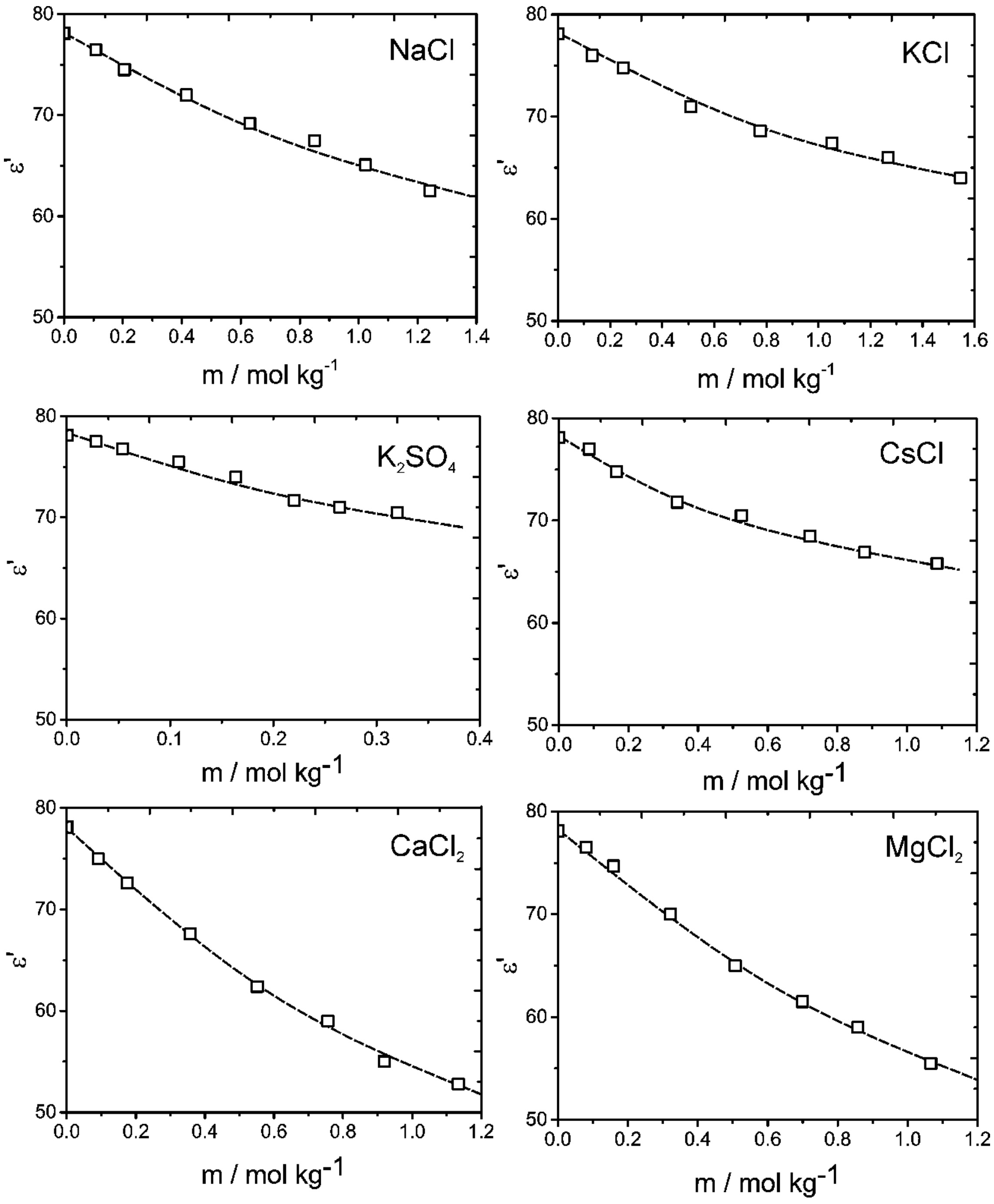

Fig. 4.10 Concentration dependence of the low frequency dielectric constant calculated by fitting the Debye expression (10.5) to dielectric dispersion of solutions of different salts

5 The Redox behavior of the U(IV)/U(VI) system

The measurement of the interfacial potentials arising at inert electrodes, such as Pt or Au, in solutions containing a redox system, is a powerful technique for determining thermodynamic properties of ions (see chapter 2.1). For classical simple redox systems as for instance Fe^{2+}/Fe^{3+}, I_3^-/I^-, Br_2/Br, $Fe(CN)_6^{4-}/\ Fe(CN)_6^{3-}$, $Ru(NH_3)_6^{3+}/Ru(NH_3)_6^{2+}$ or Ce^{3+}/Ce^{4+} the exchange from one to other redox species at an inert solid/-electrolyte interface involves a so called outer sphere charge transfer. In other words, the electron is transferred from or to the inert electrode within a molecular thermally activated process through the double layer and no adsorption processes are involved (s. Fig. 5.1). Thus, after immersion of the inert metallic sheet in a redox solution, a spontaneous electron exchange occurs. This process changes the surface potential, $\Delta\phi$, until getting a fully equalization of the reduction and oxidation partial reactions, i.e. the release and the uptake of electrons from the electrode respectively.

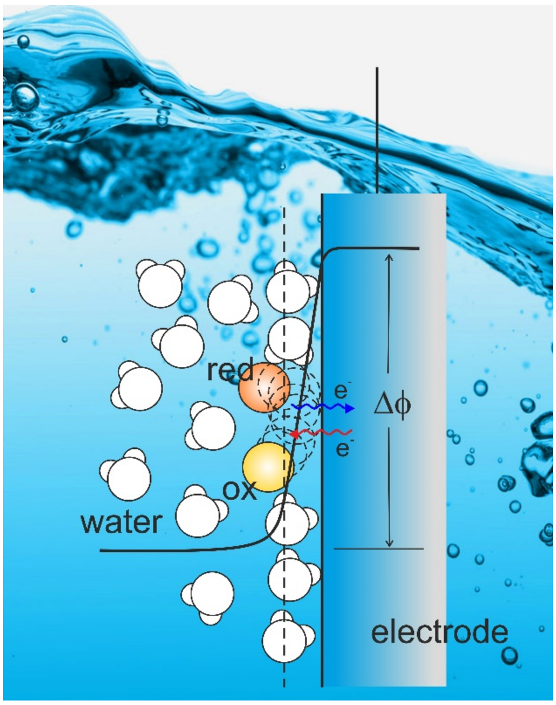

Fig. 5.1 Schematic representation of the liquid-solid interface of an electrode in a redox solution

The electron flux can be described as:

$$j_+ = \nu_+ [red]\, e^{\alpha \frac{e}{kT}\Delta\phi} = j_- = \nu_- [ox]\, e^{-\beta \frac{e}{kT}\Delta\phi} \qquad (5.1)$$

where $\nu_\pm$ is the thermal jumping frequency. α and β are the electron transfer coefficients, which represent the fraction of the potential drops surmounted by the charge particles before the electron exchange occurs. [red,ox] represents the activity of redox species. After rearranging of eq. (9.1), we have:

$$\Delta\phi = \frac{kT}{e\,(\alpha+\beta)} \ln\left(\frac{\nu_-}{\nu_+}\right) + \frac{kT}{e\,(\alpha+\beta)} \ln\frac{[ox]}{[red]} \qquad (5.2)$$

Considering a simple one-electron transfer reaction, $\alpha = (1-\beta)$, and the former expression takes the form of the Nernst equation. This relation allows to calculate the activity of the redox species by measuring the zero-current-potential of the inert electrode.

The Nernst behavior for redox reactions is not maintained, however, in situations where the electron transfer process involves several electron transfer-steps, generally including adsorption reactions. In that case, the use of equation (5.2) requires the examination of the reaction mechanism to include kinetic parameters, such as α and β.

The aim of the study presented in this chapter is to apply these concepts for the general redox reaction:

$$U(VI) + 2\, e^- \leftrightharpoons U(IV) \qquad (5.3)$$

Electrochemical techniques, such as cyclovoltammetry, chronopotentiometry and electrochemical impedance were used to investigate the partial redox reactions. These are complemented with in-situ UV-Visible spectroscopy. This study is basically focused in the system U(VI)/U(IV)-HCl-H_2O. The reason for this choice is the relative high solubility of U(IV) in acid media, which extents the concentration window of soluble species. Fig. 5.2 shows the stability diagram calculated for 0.1 M NaCl using SIT-parameters found in the literature. According to this diagram, the main species in acid media, $c_{H+} \geq 0.1$ mol l^{-1}, are UO_2^{2+}≡U(VI) and U^{4+}≡U(IV). Thus, the total redox reaction investigated in this work can be written:

$$UO_2^{2+} + 2\, e^- + 4\, H^+ \leftrightharpoons U^{4+} + 2\, H_2O \qquad (5.4)$$

These experiments were carried out by the Author in the laboratories of the Helmholtz-Center Dresden-Rossendorf.

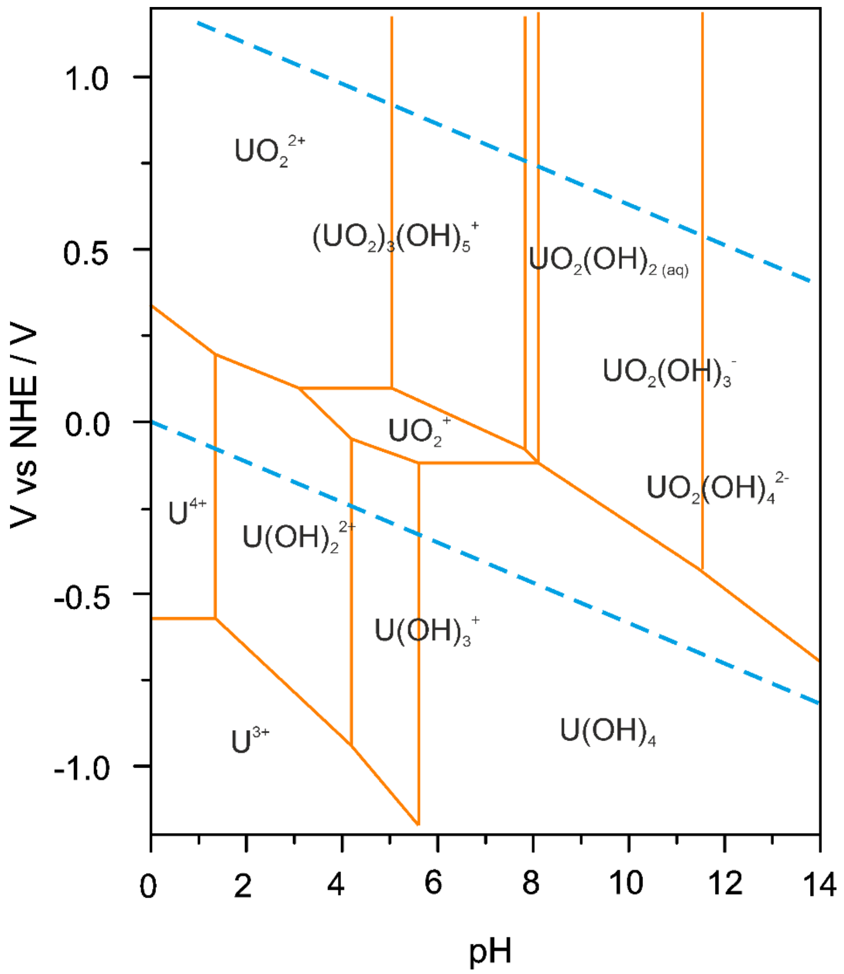

Fig. 5.2 Pourbaix diagram for uranium in 0.1 M NaCl, U concentration: 0.42 mM. Calculated by using SIT-parameters from /GUI 2013/, /NEC 2001/ and /ALT 2013/ (courtesy of X. Gaona)

5.1 Experimental details

Stock solutions of 1 M HCl + 100 mM U(VI) were prepared by dissolving $UO_3 \cdot 2.1\ H_2O$ in conc. HCl followed by dilution with pure water. The concentration of uranium was checked by ICP-OES. Stock solutions of 1 M HCl + 100 mM U(IV) were prepared by electrochemical reduction of the U(VI) stock solution in a H-cell using Pt-electrodes connected to a current source. The cathodic (reduction) and anodic (oxidation) compartments, which are separated by a tight frit glass disc, were filled with the stock solution and 1 M HCl respectively, maintaining the same liquid level to avoid mixing effects. Agitation in the reducing compartment was provided by continuous nitrogen bubbling. The reduction extended overnight. The completeness of the reduction process was checked by complete disappearance of the absorption peak of U(VI) in the UV-visible spectrum.

Electrochemical experiments were performed with the Gain-Phase Analyser Solartron 1260 connected to the electrochemical interface Solartron 1287 (see ch. 3.2.2). A three-electrode type cell from ALS®-Japan with a Pt-wire and a Ag/AgCl electrode in 3 M NaCl (V^0=0.195 V vs RHE) as counter and reference electrode respectively were used. Electrochemical studies were performed with a gold electrode (ALS-Japan). Due to its larger overvoltage for the hydrogen evolution reaction, gold substrate has been found the most adequate for these studies, especially for the evaluation of the reduction rate of U(VI). The catalytic power of Pt for the hydrogen evolution hinders using this substrate for electrochemical studies at V < 0 V vs RHE. The vitreous carbon electrode did not show any optimal electrochemical activity for this system. For redox measurements, a large Pt-gauze were used.

In-situ spectroscopic measurements were performed with a spectro-electrochemical cell connected to a Tidas®-spectrometer (s. Fig. 5.3).

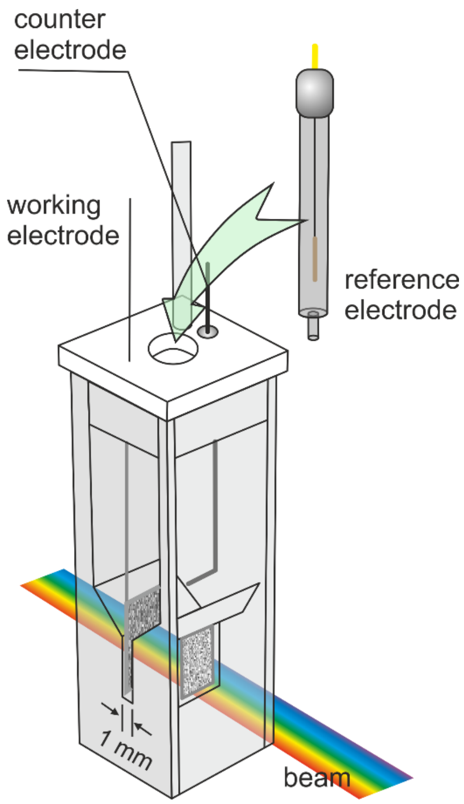

Fig. 5.3 Schematic of the spectro-electrochemical cell used for time resolved experiments

5.2 Electrochemical studies

The kinetics of the reduction of the UO_2^{2+} on a gold electrode was firstly analyzed by cyclovoltammetry. Fig. 5.4 shows the current-potential curves obtained for different concentrations of HCl. The curves show a reduction peak, for instance at -0.223 V for 0.1 M HCl, which can be attributed to the reduction of UO_2^{2+}. The marked increase of the cathodic current at more negative potentials indicates the onset of the hydrogen evolution reaction (HER). The contribution of the HER to the total current increases with the acidity of solution. The onset of the characteristic exponential current increase of the HER shifts towards more positive potentials respective of that observed in HCl solutions. This points out some catalytic side effect of the uranyl reduction on the HER. The reverse scans show an anodic peak ascribed to the oxidation of species produced during the forward scan.

Fig. 5.5 shows cyclovoltametries obtained at different scan rates for 10 mM of U(VI) in 0.1 M HCl. It can be observed, that the peak current increases linearly with the square of the scan rate. This dependence points out that the reduction occurs under a diffusion control and can be quantified by the following expression valid for an irreversible electron transfer reaction /BAR 1980/:

$$\mathbf{j}_{peak}\left[\mathbf{A\ cm^{-2}}\right] = \mathbf{2.99 \times 10^5}\ \boldsymbol{z}\ \boldsymbol{\alpha}^{1/2}\ \boldsymbol{C_0}\ \boldsymbol{D}^{1/2}\ \boldsymbol{v}^{1/2} \qquad (5.5)$$

where z is the number of total exchanged electrons, α is the transfer coefficient of the controlling reaction step, C_0 [mol cm^{-3}] is the bulk concentration of the diffusing species and D [cm^2 s^{-1}] is its diffusion coefficient. The peak potential, on the other hand, is given by:

$$\left(\frac{\mathbf{dV}_{peak}}{d\ \log v}\right) = \frac{\mathbf{0.030}}{\alpha}\ [\mathbf{V}] \qquad (5.6)$$

The anodic peak current also follows a linear dependence with the square of scan rate. It shoud be note, that the extrapolation of both lines does not go through zero and that the $j_{peak\ cathodic}$ (v=0) ≈ - $j_{peak\ anodic}$ (v=0). Fig. 5.6 shows a linear dependence of the peak potentials with log v, according with eq. (5.6). But here, two regions with different slopes can be discerned. The change of slope implies according to eq. (5.6) a change of the transfer coefficient from 1.3 to 0.68 on increasing scan rates. A value of α > 1 suggests the involvement of a chemical reaction, possibly a surface one, in the electron transfer process. The anodic peak also shows a linear dependence with log v. The slope indicates an α = 0.29.

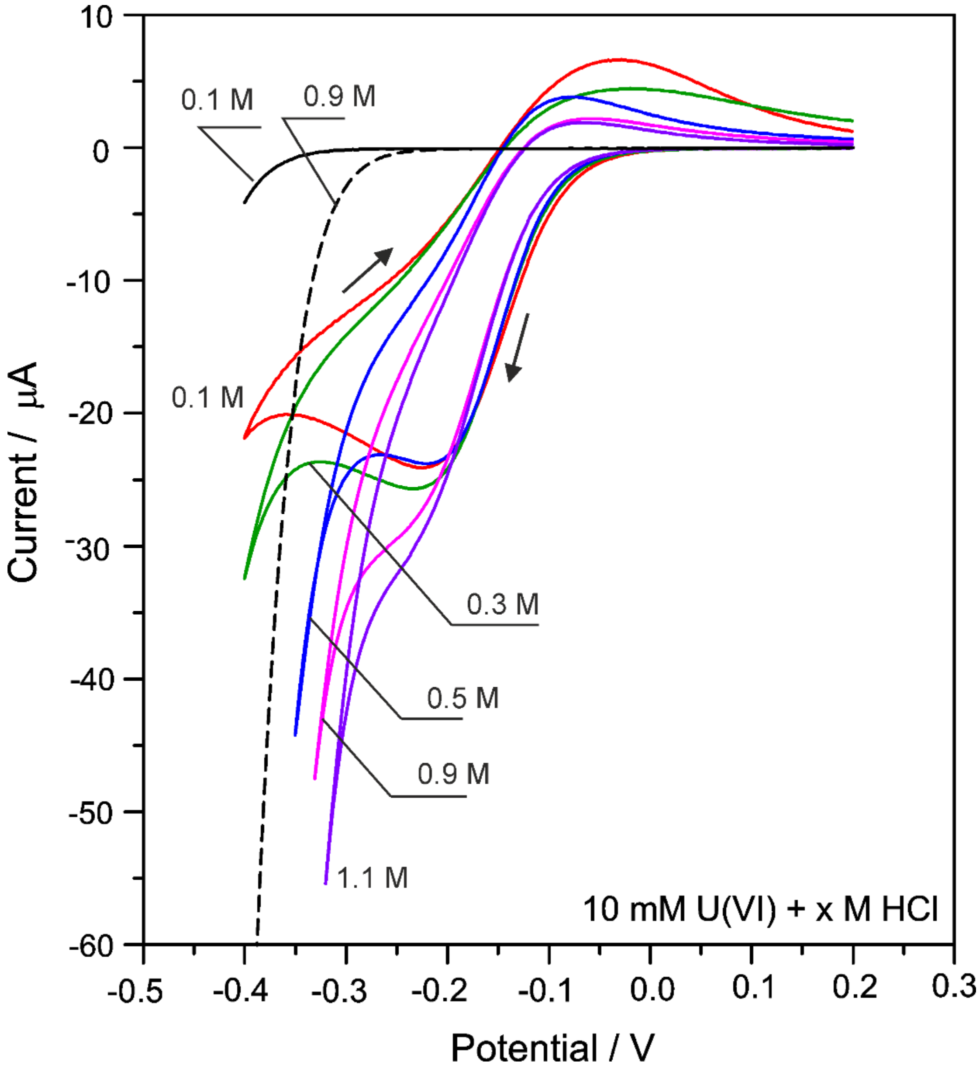

Fig. 5.4 Cyclo voltammetries of Au electrode in a 10 mM U(VI) solution with different HCl concentrations. v: 50 mV s^{-1}. V_i = 0.2 V. Black lines are blanks performed without U(VI) in solution

In contrast to the well-defined current-potential curves obtained by reduction of U(VI), a rather slow electron transfer characterizes the oxidation of U(IV) (see Fig. 5.7). Instead of a current peak, the oxidation curves show a relative constant current until 0.3 V. The presence of a cathodic peak at -0.18 V in the reverse scan, accounts for some amount of U(IV) reduced in the forward scan. At potentials higher than 0.3 V, the oxidation current start to increase exponentially. The current rise can be ascribed to the oxygen evolution reaction. Simultaneously, a rapid increase of U(VI) at the electrode surface as indicated by the corresponding reduction peak. The rapid increase of U(VI) concentration is rather caused by the chemical oxidation of U(IV) by electrochemically generated molecular oxygen.

Fig. 5.8 shows cyclovoltammograms performed at different scan rates in a 10 mM U(IV) solution. The voltammetry for 0.1 M HCl is also shown. The blank voltammetry is characterized by an elongated hysteresis cycle pointing out the charging of the surface capacitance. In the presence of U(IV) an oxidation current larger than in the blank is observed, suggesting an additional charge exchange process. A broaden peak is observed at about -0.1 V in the forward scan. This is followed by a current shoulder at about 0.2 V before a steep increase of current beyond 0.55 V.

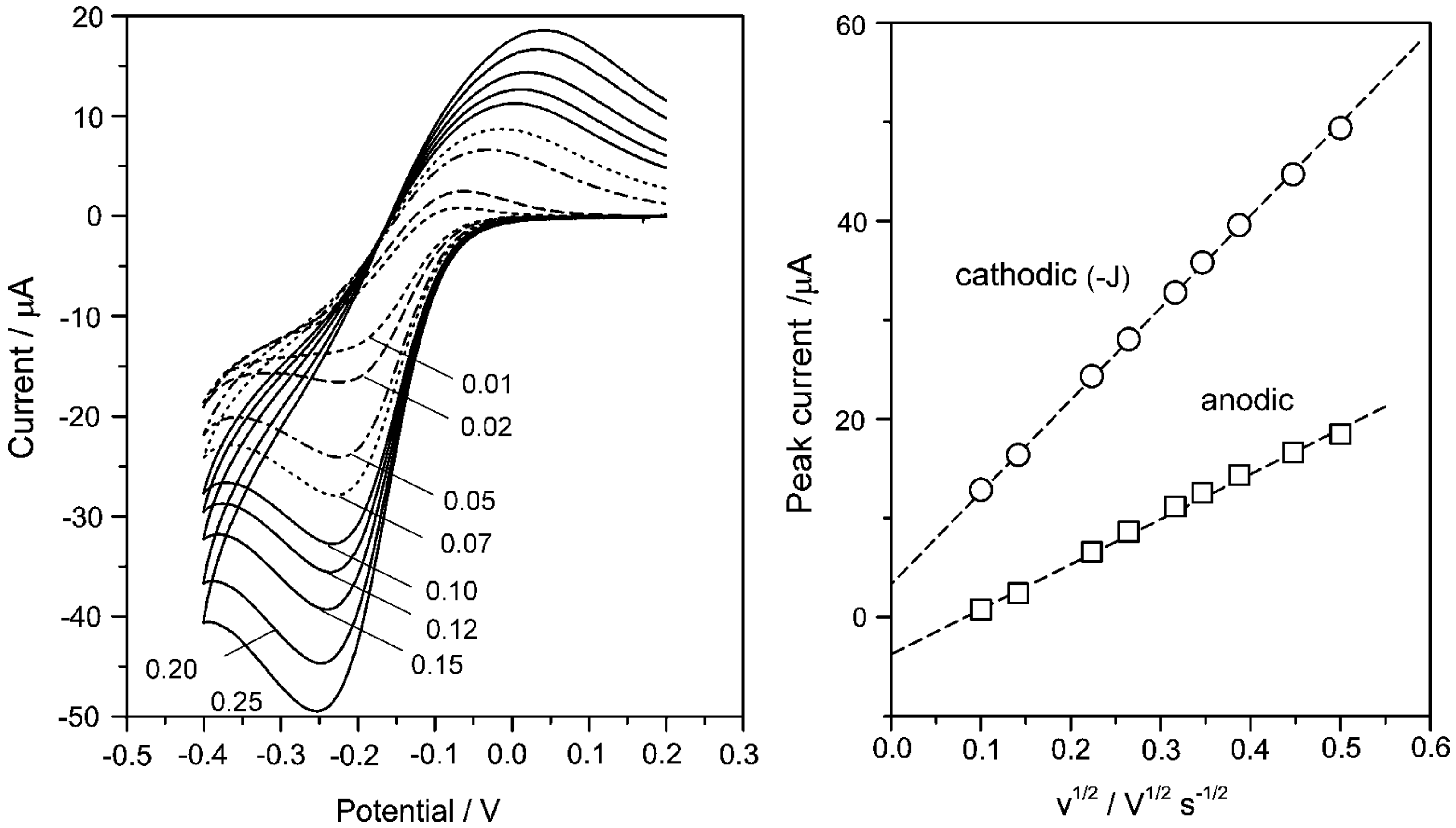

Fig. 5.5 Left: cyclo voltammetries of Au in 10 mM U(VI) + 0.1 M HCl solution at different scan rates; right: current peaks as a function of the square of scan rate

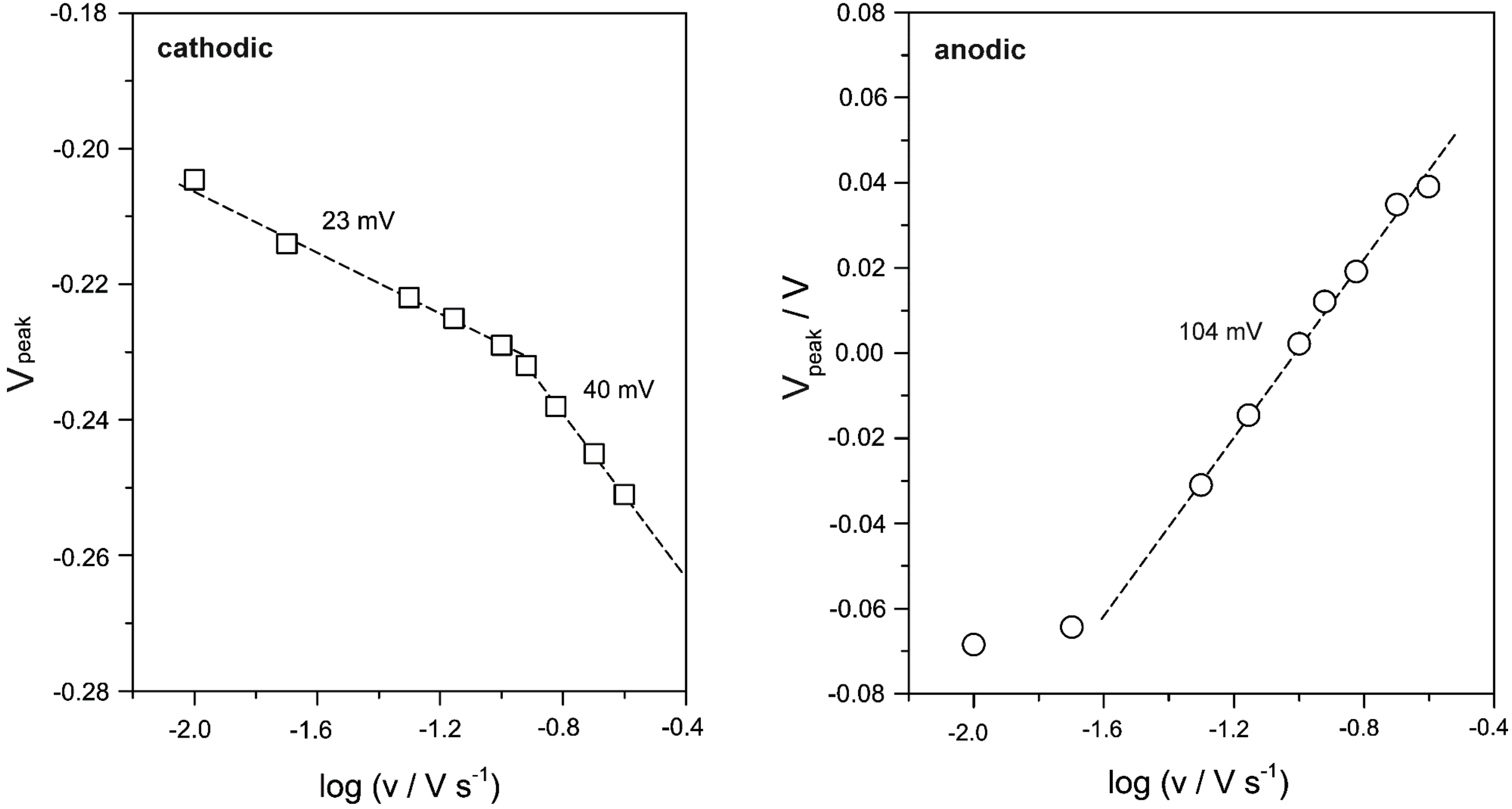

Fig. 5.6 Scan rate dependence of potentials of cathodic and anodic peaks for cyclovoltammetries of Au in 10 mM U(VI) + 0.1 M HCl

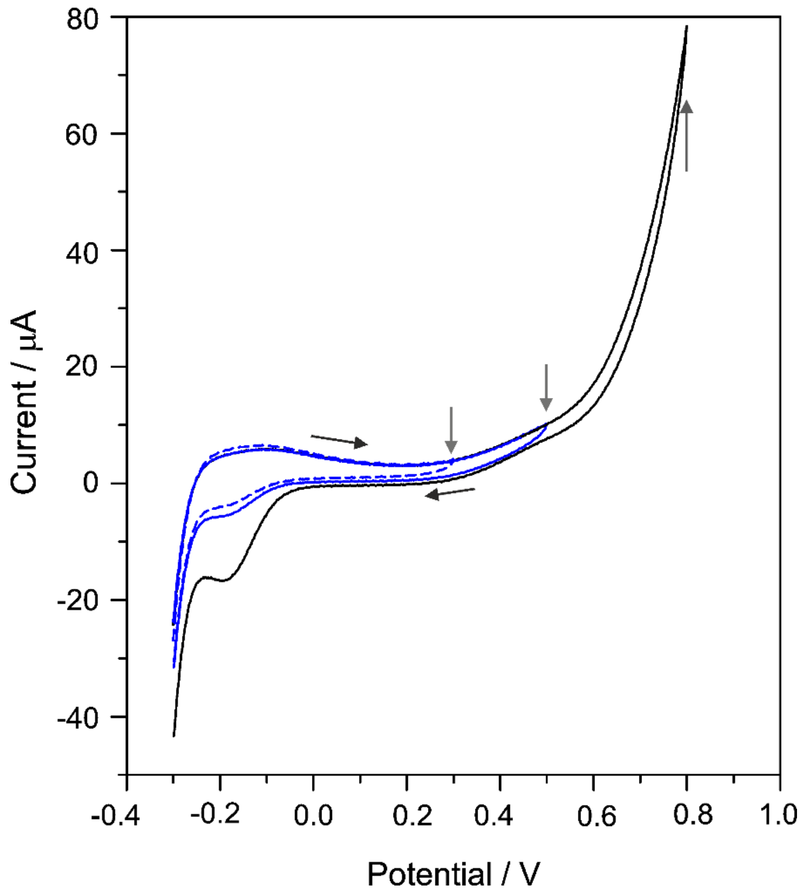

Fig. 5.7 Cyclovoltammetries of Au in a 10 mM U(IV) + 0.1 M HCl solution with different anodic limits. v: 50 mV s^{-1}. V_i = -0.3 V

The linear increase of the anodic current with the scan rate suggests that the oxidation process is controlled by a surface reaction. The rapid increase of the anodic current at V > 0.55 V can be ascribed to the onset of the oxygen evolution reaction, which seems to be catalyzed by the presence of reduced species on the Au surface (compare with the blank curve). The reaction mechanism at these potentials is still not totally understood. Probably, it deals with a concerted reaction path involving the oxidation of water.

Fig. 5.9 shows impedance diagrams obtained with Au electrode at selected potentials in solutions containing either 10 mM U(VI) or 10 mV U(IV). The left diagram, arising by reduction of U(VI), shows two semicircles. The high frequency loop can be interpreted as the faradaic resistivity, i.e. the electron transfer process, in parallel with the double layer capacitance. The low frequency loop reflects essentially the diffusion effects of the reaction process. The impedance diagram obtained in HCl solution is characterized by an almost vertical course, typical for a capacitive behavior: it reflects the double layer capacitance.

At low frequencies, the impedance shows a skewed semicircle. This type of response resembles that characteristic for a finite-length linear diffusion. A finite-length diffusion, however, can be hardly ascribed to the investigated system. This impedance behavior should be rather associated to the presence of a homogeneous reaction preceding the electron transfer step, the so called Gerischer impedance.

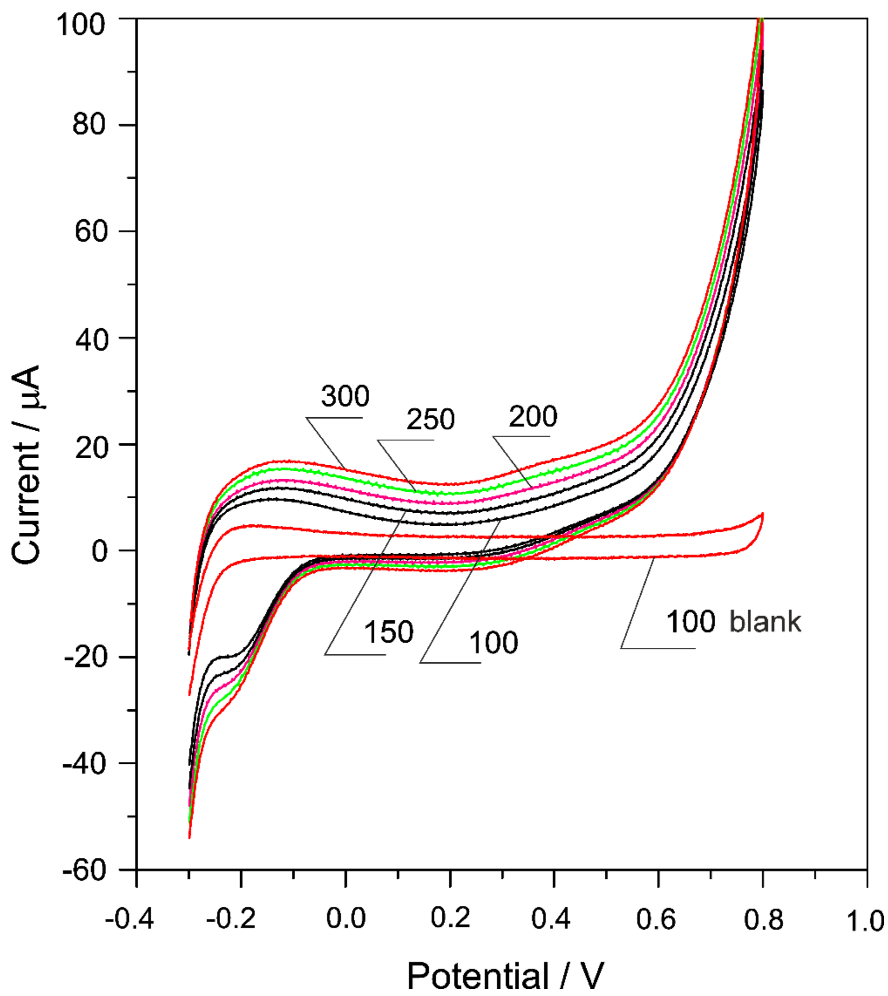

Fig. 5.8 Cyclovoltammetries of Au in a 10 mM U(IV) + 0.1 M HCl solution at different scan rates (indicated in the figure as mV s^{-1}). V_i = -0.3 V

The impedance diagrams obtained in U(IV) containing solutions show a single semicircle arising from the charge transfer reaction in parallel with the double layer capacitance.

The change of capacitance, C_s, with potential occurring during the reduction of U(VI) was investigated by measuring the electrode impedance at 500 Hz by a low potential scan.

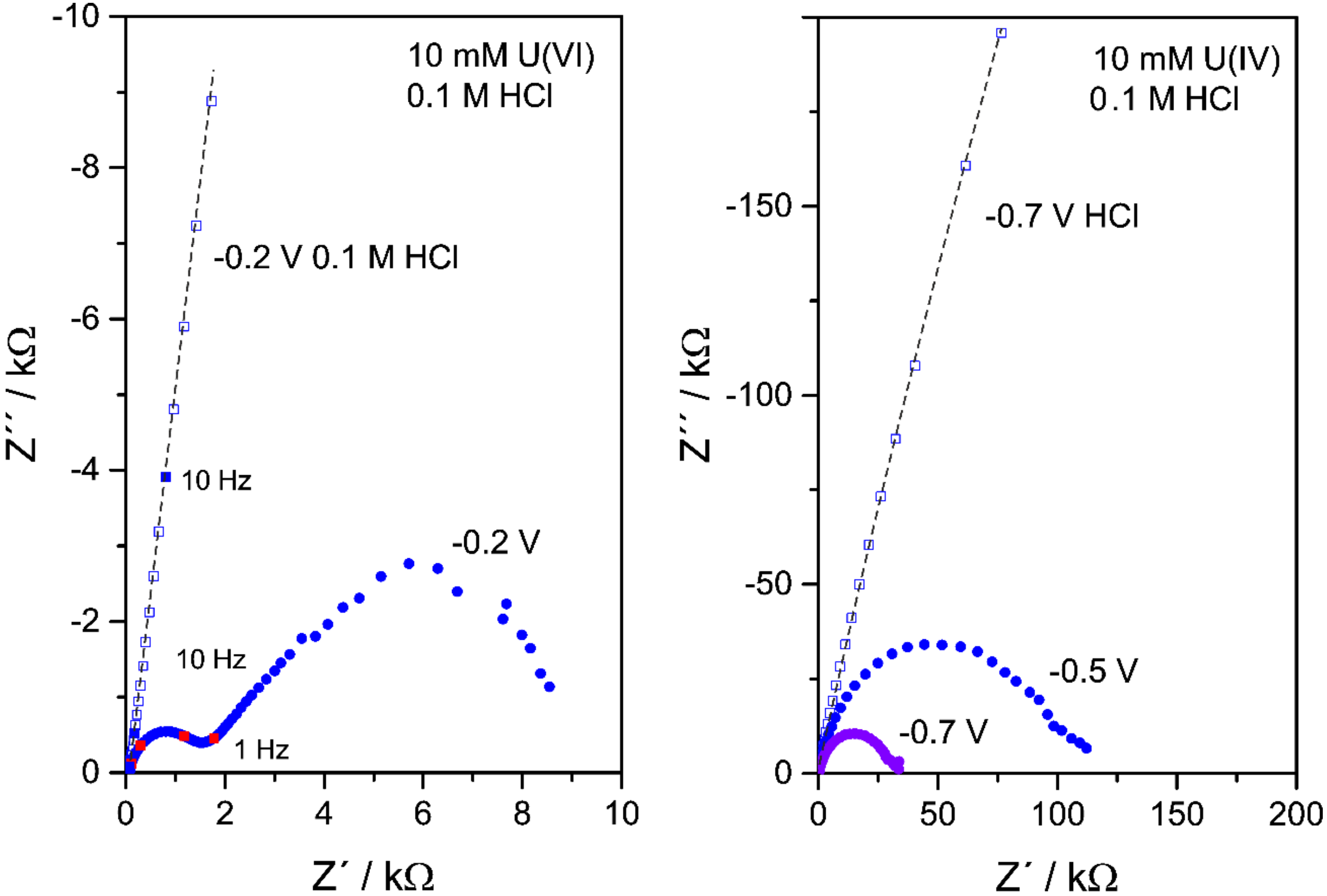

Fig. 5.9 Nyquist spectra of Au electrodes in 0.1 M HCl containing 10 mM U(VI) (left) and 10 mM U(IV) (right). Amplitude: 10 mV

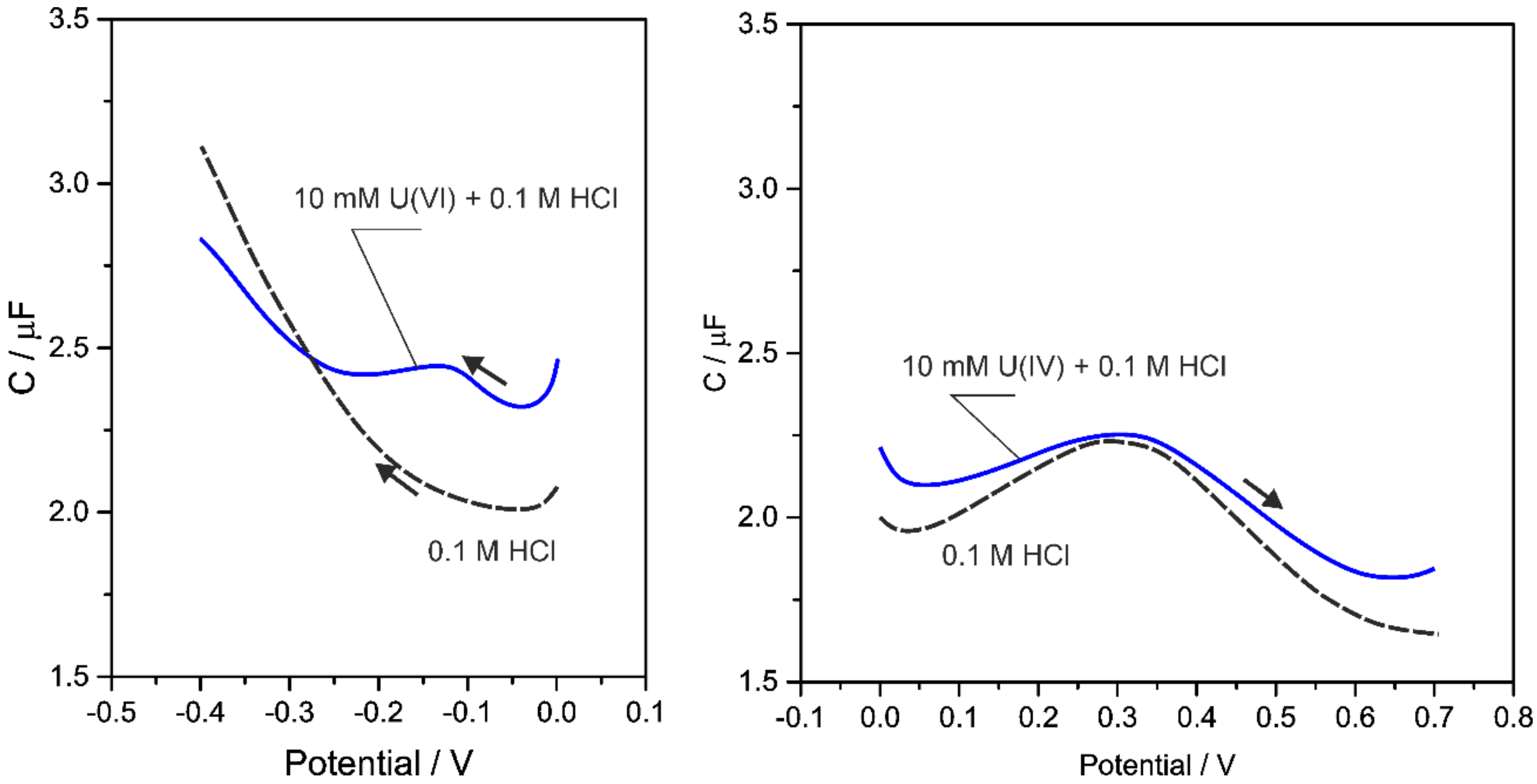

Fig. 5.10 Potential dependence of the differential capacitance of an Au electrode in 0.1 M HCl solutions containing 10 mM of U(VI) or U(IV). f = 500 Hz. Amplitude: 10 mV. Scan rate: 1 mV s^{-1}

At this frequency, the system behaves as a parallel RC-circuit. Thus, the capacity is given by:

$$\boldsymbol{C_s = (\omega\, M)^{-1}} \tag{5.7}$$

where M is the modulus of the measured impedance: M = $(Z'^2 + Z''^2)^{1/2}$.

Fig. 5.10 shows the differential capacitance obtained during the reduction of U(VI). Values of about 0.4 μF higher than those for the background solution are observed between 0.0 and -0.1 V. Both curves converge at potentials more negative than -0.3 V. This result let infer the participation of adsorbed species during the reduction of U(VI). During the oxidation of U(IV), the differential capacitance presents slightly higher values than the corresponding blank. Both curves converge at a maximum at 0.3 V.

5.3 Redox experiments

The redox behavior of the couple U(VI)/U(IV) was investigated by measuring the potential adopted by a Pt electrode of large area in 0.1 M HCl solutions containing different concentration ratios of the redox couple. Solutions were prepared by mixing stock solutions of 0.1 M HCl + 10 mM U(VI) with 0.1 M HCl + 10 mM U(IV) in different proportions. The redox potentials were registered during a lapse of time of 10 min by operating the galvanostate with zero current. Fig. 5.11 shows the measured redox potential as a function of the concentration ratio [U(VI)]/[U(IV)]. The potential shows a Nernst behavior at log [U(VI)]/[U(IV)] > 1. At lower values, the potential approaches to a constant potential of -0.084 V. This behavior implies, as already anticipated by the electrochemical investigations discussed above (see Ch. 5.2) an electron transfer process involving intermediate reactions.

According to the existing literature /DUE 1994/ /KIH 1999/, the reduction of U(VI) in acid media occurs basically in two electron transfer steps:

UO_2^{2+} (aq) + e^- → UO_2^+ (aq) (5.8)

Further reduction to U(IV) can occur by a disproportionation reaction:

2 UO_2^+ (aq) + H^+ → UO_2^{2+} (aq) + $UOOH^+$(aq) (5.9)

In weakly acidic solutions UO_2^+ is more stable and reduces to solid U(IV):

UO_2^+ (aq) + e^- → UO_2 (s) (5.10)

Based on the cyclovoltammetries and spectroscopic results (see next subchapter), the following mechanism can be proposed:

UO_2^{2+} (aq) + e^- → UO_2^+ (ads) (step 1) (5.11)

UO_2^+ (ads) + e^- H^+ → $UOOH^+$ (ads) (step 2) (5.12)

$UOOH^+$ (ads) + 3 H^+ → U^{4+} (aq) + 2 H_2O (step 3) (5.13)

The rate of the forward and reverse reaction for each step i can be expressed as k_i^d and k_i^r respectively. For the two first two electron transfer, the potential dependence of the reaction rate can be written:

$$\boldsymbol{k_i^{d,r} = k_i^{0\ d,r}\ exp\left(\mp\alpha_i{}^{d,r}\ \frac{e}{kT}\ \Delta\phi\right)} \quad (5.14)$$

where $\Delta\phi$ is the interfacial potential drop at the electrode and $\alpha_{d,r}$ is the charge transfer coefficient for the direct and reverse reaction respectively.

When the Pt-electrode is introduced in the cell containing UO_2^{2+} and U^{4+} the system reaches an equilibrium state characterized by a setoff of cathodic and anodic processes. The system is driven to its equilibrium potential. To describe the equilibrium on the basis of Eq. (5.11) – (5.13), we have to define the steady state coverage fraction of adsorbed species. Naming UO_2^+: 1 and $UOOH^+$: 2, we have:

$$\boldsymbol{\frac{d\theta_1}{dt} = k_1^d\ [U(VI)](1-\theta_1-\theta_2) - k_2^d\,\theta_1 - k_1^r\,\theta_1 + k_2^r\ \theta_2\ = 0} \quad (5.15)$$

$$\boldsymbol{\frac{d\theta_2}{dt} = k_2^d\,\theta_1 - k_2^r\ \theta_2 - k_3^d\ \theta_2 + k_3^r\ [U(IV)]\,(1-\theta_1-\theta_2) = 0} \quad (5.16)$$

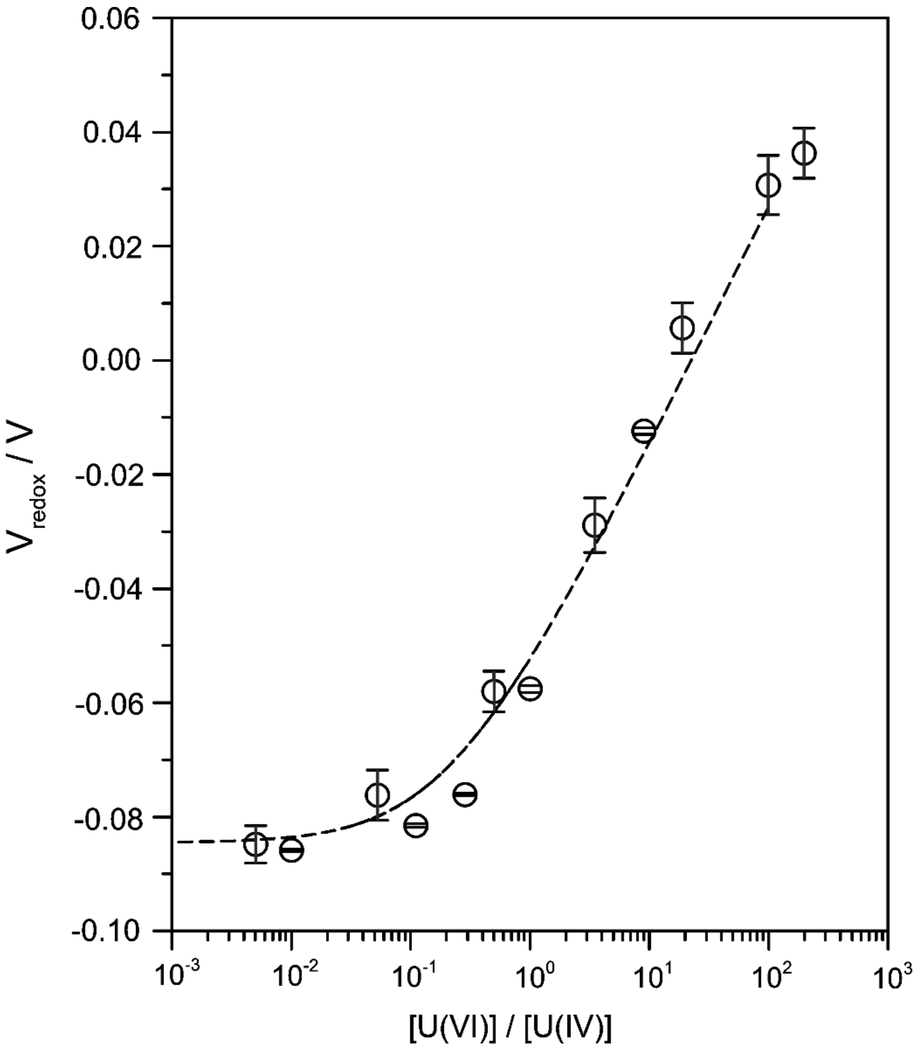

Fig. 5.11 Redox potentials at a Pt gauze in x mM U(VI) + y mM U(IV) + 0.1 HCl solutions: x + y: 10 mM. (----) theoretical prediction

Tab. 5.1 Reaction rate parameters used to fit the experimental redox potential values according to the reaction model (Eq. (5.11) – (13)).* $V_{redox} = \Delta\phi + \Delta\phi^0$

k_1^{0d}	k_1^{0r}	k_2^{0d}	k_2^{0r}	k_3^{d}	k_3^{r}
7×10^{-7}	2×10^{-7}	6×10^{-6}	8×10^{-4}	2×10^{-3}	8×10^{-5}

$\alpha_1^{\ d}$	$\alpha_1^{\ r}$	$\alpha_2^{\ d}$	$\alpha_2^{\ r}$	$\Delta\phi^0$ [V]*
0.5	0.5	0.2	0.2	-0.050

This equation system can be rearranged to:

$$\boldsymbol{k_1^d\,[U(VI)] - A\,\theta_1 - B\,\theta_2\ = 0} \tag{5.17}$$

$$\boldsymbol{k_3^r\,[U(IV)] - C\,\theta_1 - D\,\theta_2\ = 0} \tag{5.18}$$

where:

$$\boldsymbol{A = k_1^d\,[U(VI)] + k_2^d + k_1^r\,;B = k_1^d\,[U(VI)] -\ k_2^r\,;C = k_3^r\,[U(IV)] - k_2^d;} \tag{5.19}$$

$$\boldsymbol{D = k_3^r\,[U(IV)] + k_3^d\ + k_2^r}$$

The balance of current, on the other hand, can be expressed as:

$$\boldsymbol{j = \frac{d[e]}{dt} = k_1^d\,[U(VI)](1 - \theta_1 - \theta_2\,) - k_1^r\,\theta_1 + k_2^d\,\theta_2 = 0} \tag{5.20}$$

The term $k_2^d\ \theta_2$ in Eq. (5.20) represents the net forward transfer of electrons in the second reaction step, provided the coverage of $UOOH^+$ species is predominantly formed by the surface reaction 2. With this model, it was able to reproduce the main course of the V_{redox} vs [U(VI)/U(IV)] data (see Fig. 5.11), taking the values for reaction rate parameters shown in Tab. 5.1. The fitting procedure takes also account the dependence of the V_{redox} with the individual concentrations of U(VI) and U(IV) as shown in Fig. 5.12.

The reaction mechanism in HCl solutions is shown schematically in Fig. 5.13. The disproportionation reaction, indicated as step 4 (reaction 5.9), occurs with adsorbed (V) species where the substrate enables the electron transfer. This step is a combination of the reverse reaction of step 1 and forward reaction of step 2.

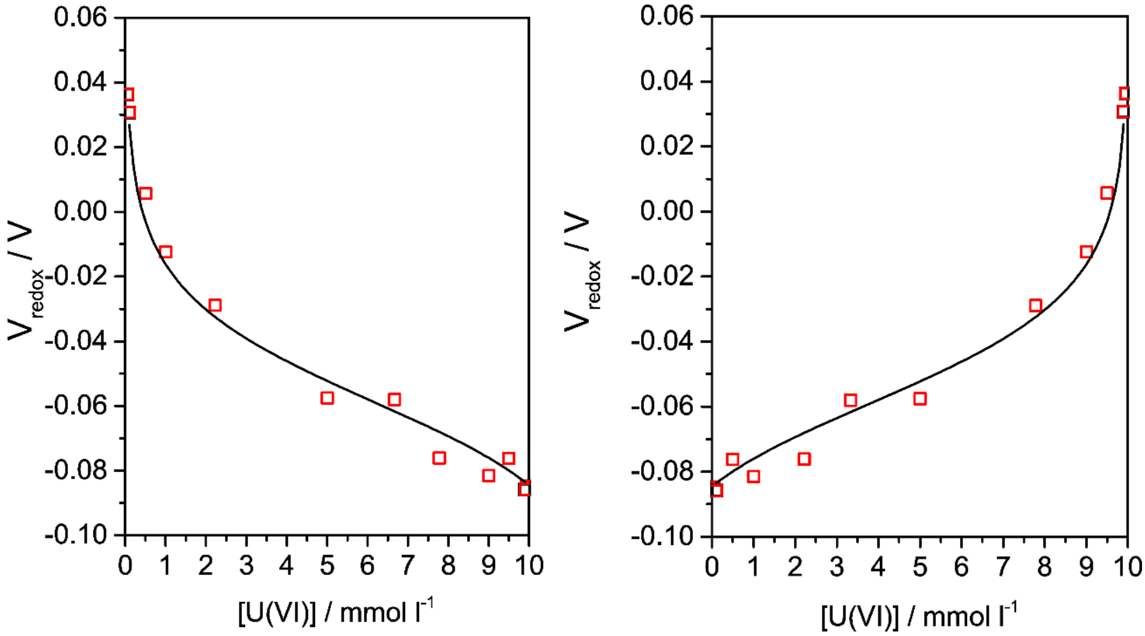

Fig. 5.12 Dependence of redox potential with the concentration of the U(VI) and U(IV) for mix solutions. Squares: experimental data; line: calculated using parameters shown in Tab. 5.1

The rate of the consumed of adsorbed U(V) by a disproportionation reaction increases with the proton concentration (see reaction 12.9) /HOW 1988/. This fact can be related with the decrease of the anodic peak in voltammetries of Au in solutions containing UO_2^{2+} with increasing acidity (see Fig. 5.4). This result supports the formulation of a redox mechanism with adsorbed U(V) species as reaction intermediates.

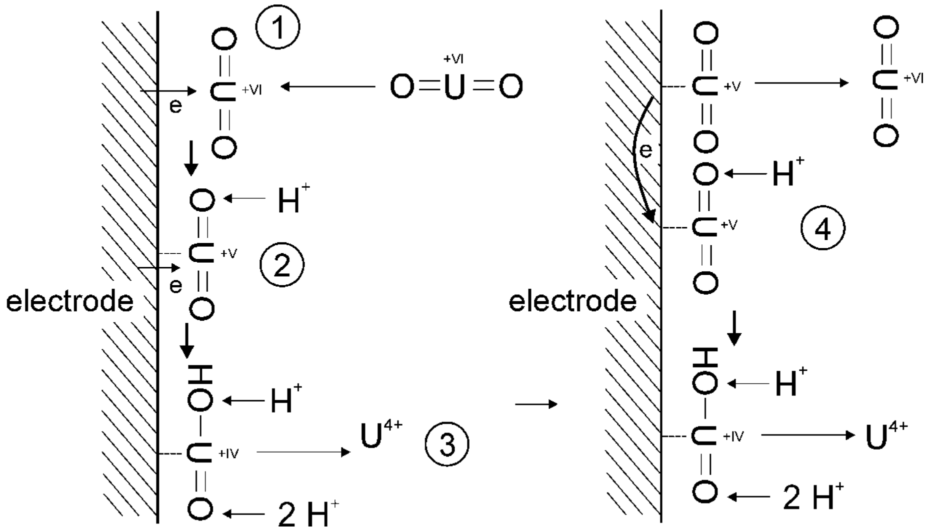

Fig. 5.13 Reaction mechanism of the reduction of U(VI) at the metal electrode in HCl solutions

The redox behavior was also investigated in acidified concentrated solutions of $MgCl_2$. Fig. 5.14 shows the variation of the redox potential measured at a Pt gauze with the ratio [U(VI)]/[U(IV)]. The results are compared with the corresponding values measured in 0.1 M HCl. It can be observed that the concentration dependences show the same course in both solutions, but that for the $MgCl_2$ solution is shifted towards more positive potentials. Also, the slope of the Nernst region increases from 39 mV dec^{-1} to 109 mV dec^{-1} in the presence of a large concentration of $MgCl_2$. This implies a central role of the reaction kinetics on the redox behavior /PEI 1992/. The change on the electrode kinetics is also reflected in the cyclovoltammetries performed at Au electrodes as shown in Fig. 5.15. The reduction peak decreases from 57.6 μA in the 0.1 HCl solution to 38.3 μA in the acidified $MgCl_2$ solution. According to the voltammetric equations for an irreversible system, the diffusion coefficient of the electroactive species UO_2^{2+} in the $MgCl_2$ solution is 0.44 times that in the 0.1 M HCl solution.

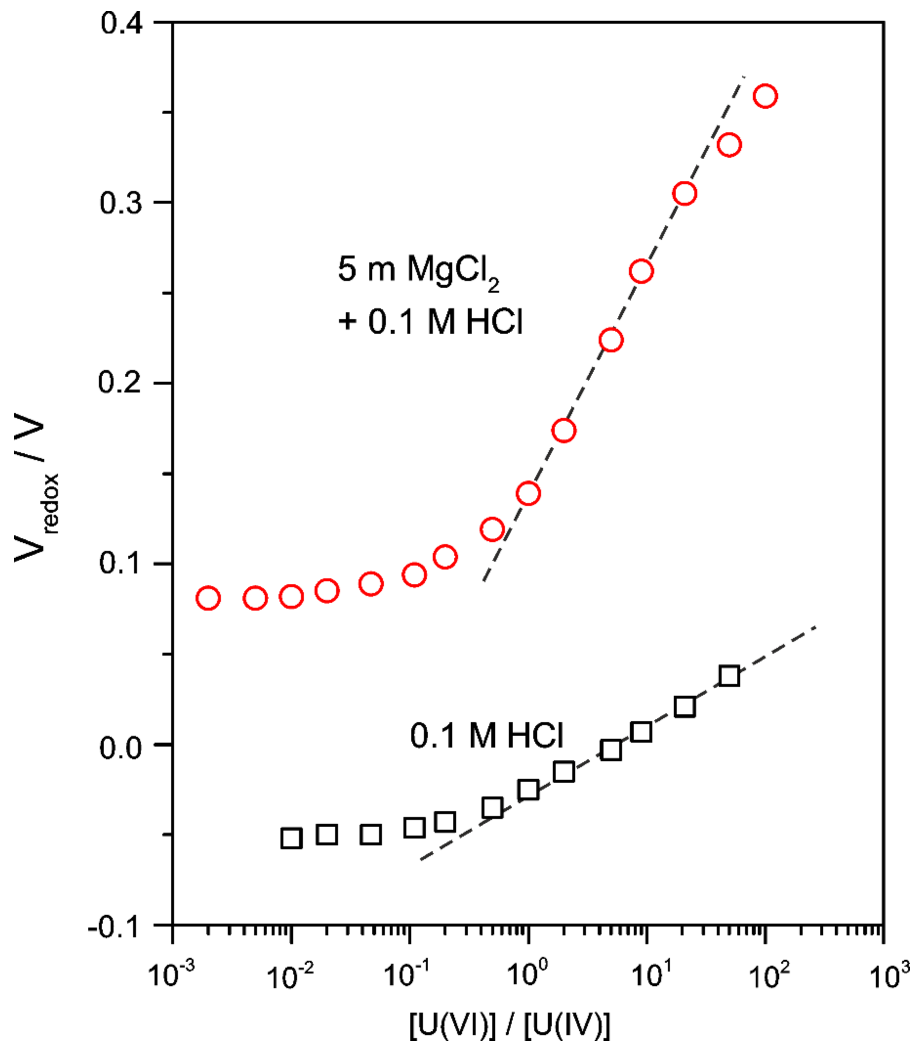

Fig. 5.14 Redox potentials at a Pt gauze in x mM U(VI) + y mM U(IV) + 0.1 HCl and x mM U(VI) + y mM U(IV) + 0.1 HCl + 5 m $MgCl_2$ solutions: x + y=10 mM

The vanishing of the anodic peak in the $MgCl_2$ solution implies a low surface coverage of adsorbed U(V). This is the consequence of acceleration of the second electron-transfer step (reaction 5.12 and 5.13) or an increase of the rate of the disproportionation reaction due to the enhanced proton activity.

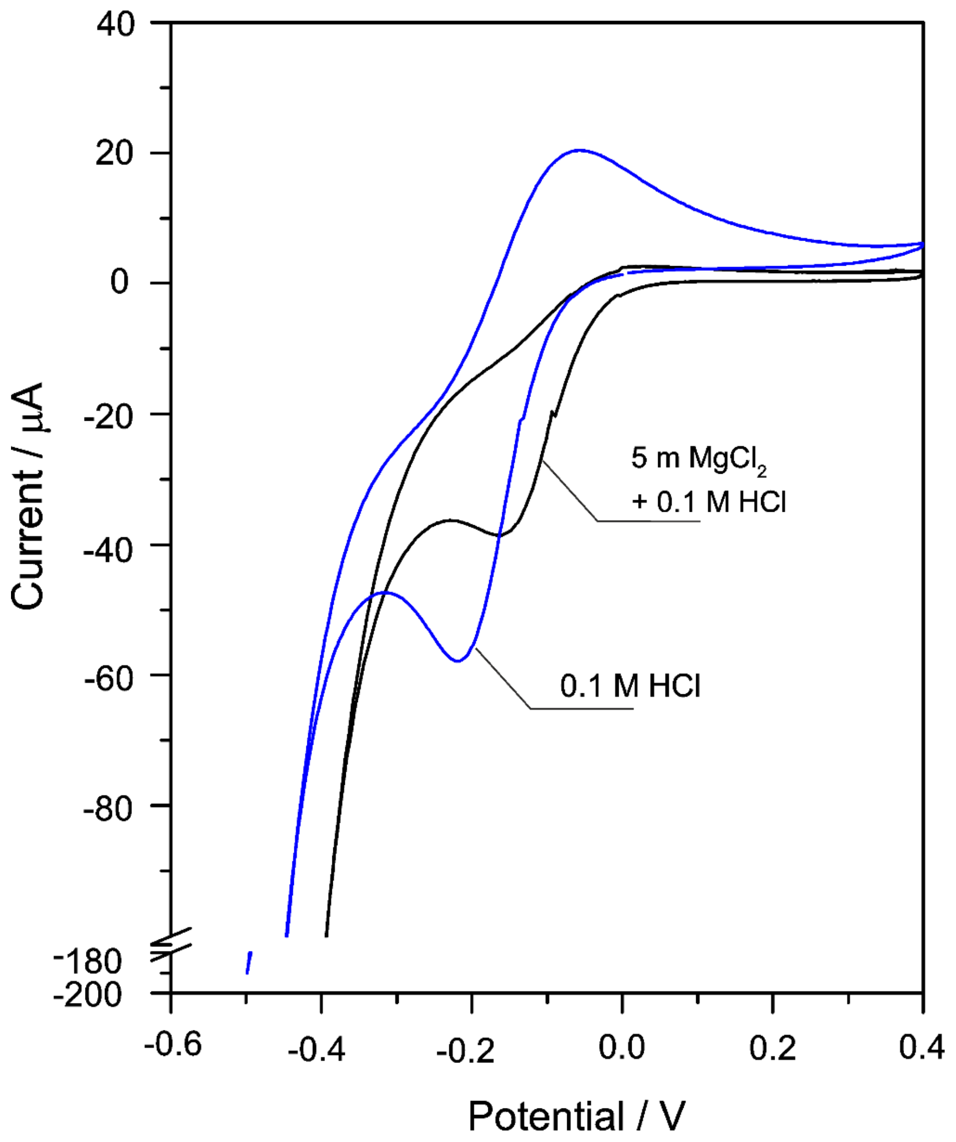

Fig. 5.15 Cyclovoltammetries of Au in 10 mM U(VI) solution in 0.1 M HCl and 5m $MgCl_2$ + 0.1 M HCl background solutions. Scan rate: 20 mV s^{-1}

5.4 Spectroscopic measurements

UV-Vis spectroscopy was used to obtain information about the formation of complexes and the changes of species concentration during the electrochemical experiments. Fig. 5.16 shows the spectral changes on increasing the HCl concentration. This is characterized by an increase of the peaks at 456 nm and 471 nm. Similar results were found by Paviet-Hartmann et al /PAV 1999/ by studying the spectral behavior of U(VI) in mixtures of NaCl and $NaClO_4$ solutions. For instance, the spectrum for 1.1 M HCl is almost identical to that found by these authors for 1.035 m NaCl. For this case, the fraction of UO_2Cl^+ was found 0.282.

In contrast to U(VI), the formation of U(IV) chloro-complexes occurs at chloride concentrations larger than 3 M /HEN 2005/. The spectra of U(IV) in HCl and $HClO_4$ show practically no differences for a 1 M concentration (see Fig. 5.17). The spectrum obtained in 0.1 M HCl, however, shows a shoulder appearing at the left side of peaks at 650 nm, 550 nm and 490 nm. This is probably due to the formation of the $U(OH)_2^{2+}$ species.

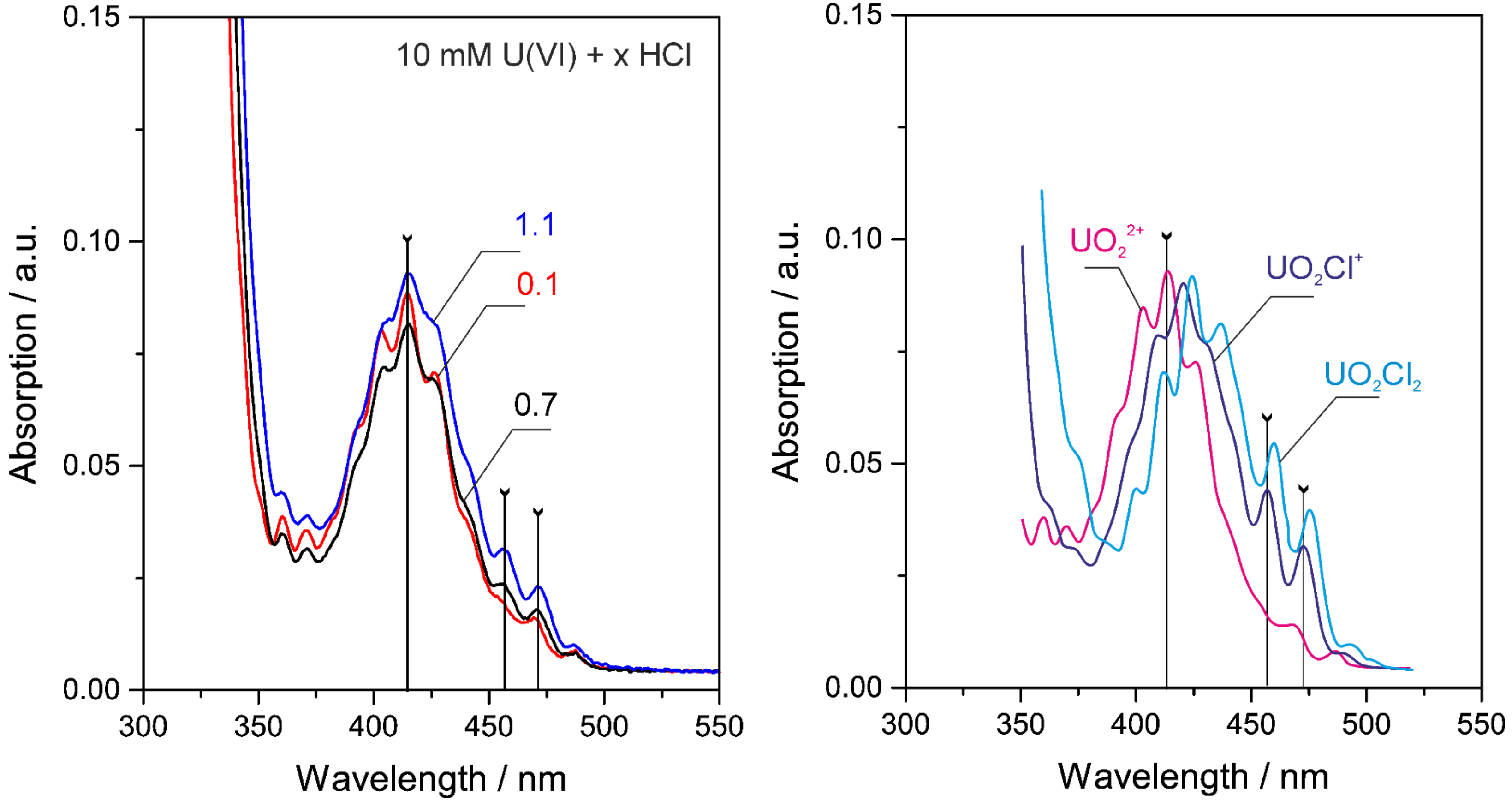

Fig. 5.16 Left: UV-Vis spectra of U(VI) in HCl solutions of different concentrations; right: reference spectra for uranyl and its chloro-complexes /PAV 1999/

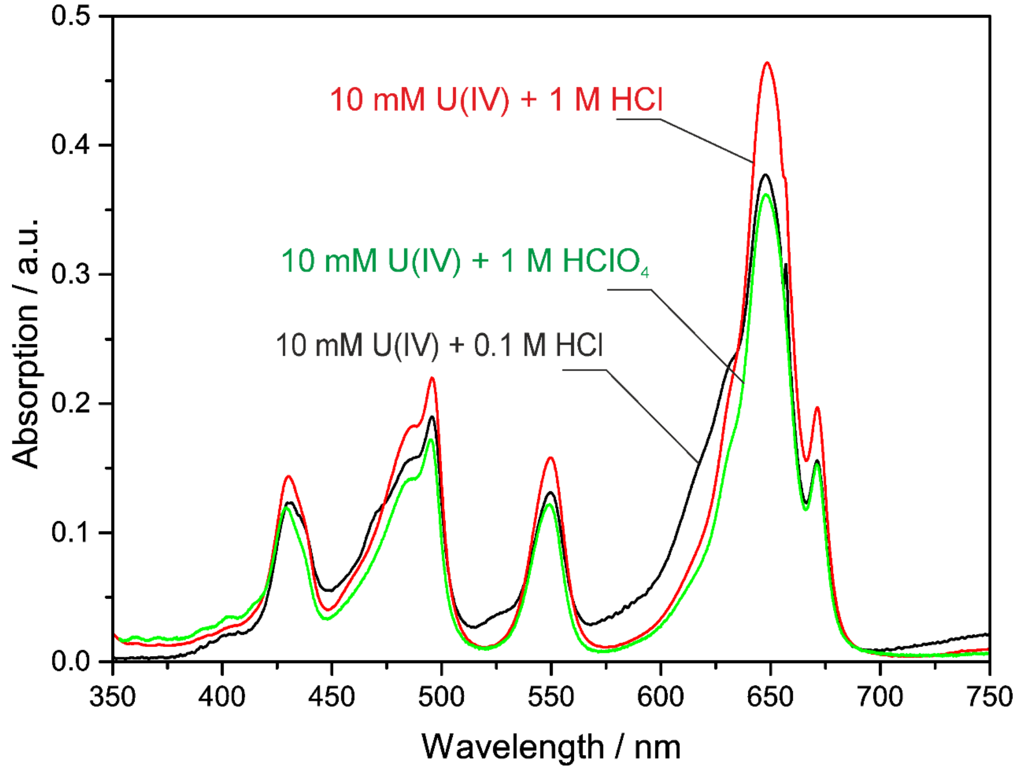

Fig. 5.17 UV-Vis spectra of U(IV) solutions in different background electrolytes

The spectroscopic characterization of U(VI) and U(IV) in HCl solutions constitutes the basis for the monitoring of uranium species during electrochemical experiments performed with the cell shown in Fig. 5.3. Fig. 5.18 shows the temporal evolution (b) of the spectra during the reductive potential scan (a) performed with a Pt-gauze electrode in 100 mM U(VI) + 1 M HCl. Initially, a typical spectrum for a mixture UO_2^{2+} and UO_2Cl^+ species is observed. It transforms during the experiment running in a spectrum dominated by the U^{4+} signal. The concentration of U(VI) and U(IV) species was determined by the signal intensity at 403.5 nm and 648.5 nm respectively. It should be noted, that the concentration of U^{4+} turns visible at potentials by 100 mV more negative than the onset of reduction current at about 0 V. This fact can be related to the initially formation of adsorbed U(V) species, which cannot be detected due to the large absorption of U(VI) in the UV region.

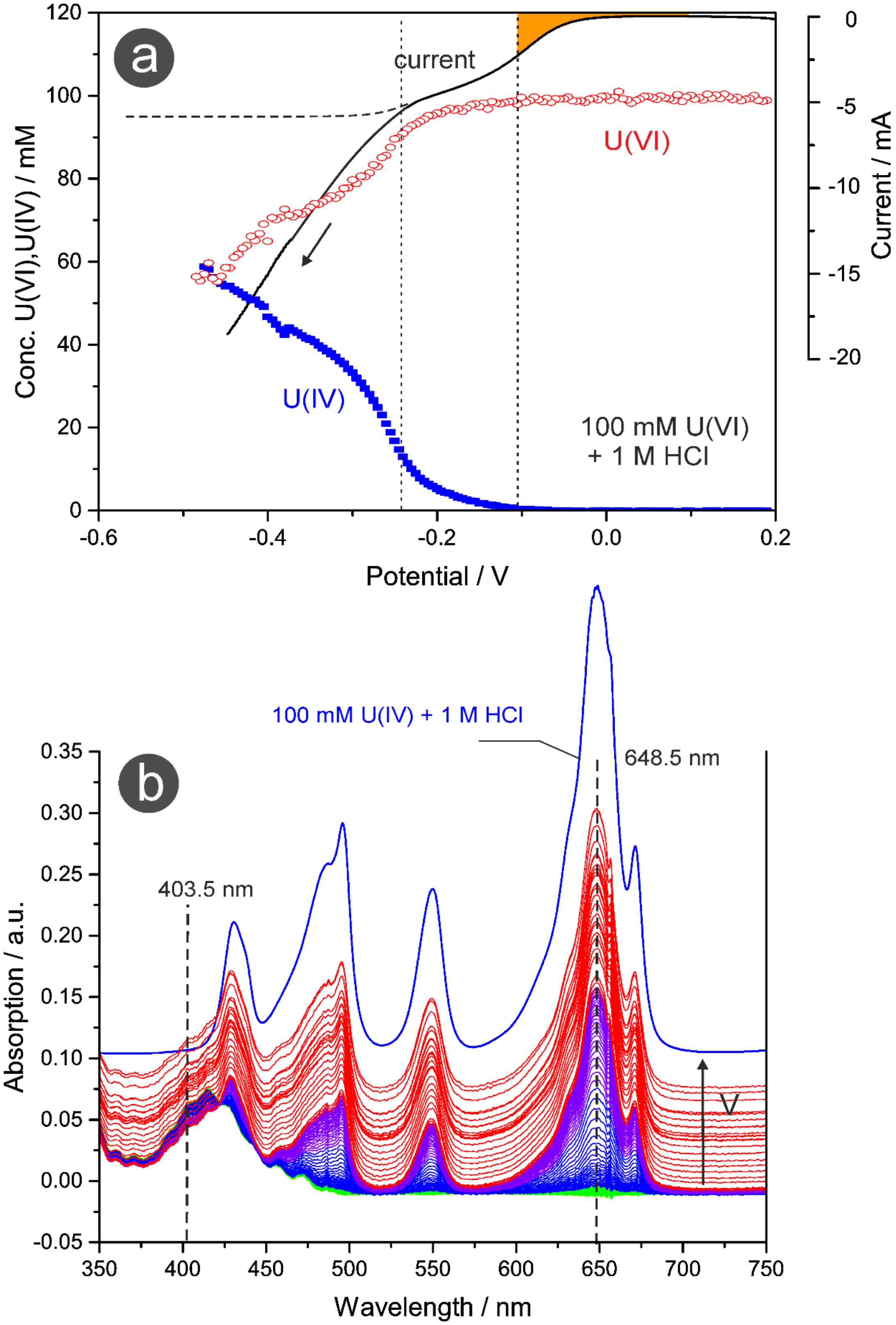

Fig. 5.18 a) time dependence of concentration of uranium species during the potentiodynamic reduction of a 100 mM U(VI) + 1 M HCl solution; b) UV-vis spectra taken at equally spaced time intervals during the reduction process. Scan rate: 2.5 mV s^{-1}

6 Conclusions and Outlook

The horizon of this part of the project EDUKEM was set at the development and validation of a complementary electrochemical technique for the determination of activity coefficients of uranium species in dilute to highly saline solutions of salts of the oceanic system. This constitutes the Achilles heel for an extension of the thermodynamic database of uranium. This is an essential issue for reliable evaluations of processes in a repository system triggered upon contact of loaded waste containers with aqueous solutions and their subsequent failure.

The implementation of the potentiometry was inspired in their inherent precision arising from the high variance of ion activities upon minute variation of voltage. The possibility of a direct and accelerated measurement of ion activities avoiding excessive long equilibration times of solution with solid minerals in solubility experiments turns electrochemistry-based methods very attractive. On considering a universal application of this technique for the measurement of the activity of uranium species in salt solutions, the existence of two still unresolved obstacles were identified: a) the junction-potential introduced by the reference electrode and b) the mechanism of the redox-reaction. The former introduces a voltage uncertainty. The latter is necessary for the processing of experimental data in non-Nernstian systems.

Historically, the solution for the problem of the junction-potential was circumvented either by smart combinations of cell systems or by its calculation. The first option is only applicable in few cases, i.e., it is not universal. The second option, on the other hand requires transport numbers or their equivalent ion mobility data in a wide range of concentration.

After identifying the research requirements to build a universal method for determination of activity coefficients of uranium species, tasks were planed and organized in three work packages: WP.1: building of a method for measuring transport of ions based on modern electrodynamic effects: electrochemical impedance spectroscopy and time-domain reflectometry, WP.2: systematic measurements of solutions of the oceanic system including CsCl as a reference, WP.3: processing of experimental data obtained in the second work package and WP.4: testing of redox measurements.

The major part of the project activities was focused on the accomplishment of the work packages WP.1-3. The high degree of novelty found upon application of electrodynamic techniques exceeded our initial expectations. Firstly, the WP.3 demanded a tedious development of an adequate theoretical background to be applied to the electrochemical impedance data for calculating the ion mobilities in a large concentration range. This was made within an iterative work modality with WP.1 and WP.2 by optimizing the cell geometry.

The work has achieved a large advancement in the interpretation of the observed results, which is expected to have considerable impact in the fields of the electrodynamic of salt solutions and redox measurements. In the case of EIS-technique, it was demonstrated that the main source of information concerning the movement of ions is contained at the low frequency response of impedance diagrams. This is contrary to interpretations offered in a few scientific articles discussing the application of this technique for dilute systems and conducting polymers. Moreover, it was possible to show that the use of this technique is feasible for measuring ion mobilities and their related transport number. A final calculation, however, still requires some numerical refinements that can be carried out by using the set of experimental data at 25 °C attached to this inform (see appendix A.1) and will be published soon. This process was long and involved a review and discussion of existent complex theories on ion mobilities and electromagnetic interaction of ions with external applied alternating electric fields. This included the revision of theories proposed for the calculation of ion mobilities in concentrated electrolytes /DUF 2005/.

The main achievement concerning the TDR technique consists in the development of an original method for measuring the dielectric response of electrolytes in two variants: the droplet and the pool method. Both arrangements have shown a very good performance. The former requires just only microliters of the investigated solution, but its application is limited to room temperature. The pool method includes a temperature control by means of a Peltier-system.

The development of this technique also included-- the creation of a computer program for converting the time-domain data in useful frequency-domain spectra and the design and construction of an adequate sensor. The droplet method provided reliable data of the complex electrical permittivity of a series of electrolytes in a wide range of concentrations.

The development of the TDR method has shown, that this technique offers information about the concentration dependence of the dielectric constant of water in salt solution. These data are essential for the analysis of experimental spectra obtained with the electrochemical impedance technique. The method also offers information about the dielectric behavior of ions. This issue, however, still requires a more precise interpretation.

Concerning the WP.4, it was possible to combine classical electrochemical techniques with in-situ and ex-situ UV-vis spectroscopy. These investigations have thrown light on the redox behavior of uranium solutions at Pt and Au electrode surfaces. These experiments have shown that the interpretation of the concentration-voltage curves cannot be made based on the Nernst equation, as usually made and believed. These experiments also provided interesting information about the charge transfer behavior of U(VI) and (IV) which can find application on evaluating the influence of dissolving iron-based materials on the conversion of soluble U(VI) species into slightly soluble U(IV).

Overall, this project has achieved a large advance in the development of several new techniques providing useful information concerning the ion transport and redox-reaction mechanisms of uranium in solution. Tab. 2 presents an overview of these techniques and the type of information provided by each of them. These data, that appears at first glance to be disconnected, converge like puzzle pieces in the building of a universal potentiometric method for measuring activity coefficients of uranium species in saline solutions.

Developed techniques	**Provided information**
Electrochemical-Impedance-Spectroscopy	• Ion mobility • Concentration of mobile ions / formation of ion-groups
Time-Domain-Reflectometry	• Dielectric dispersion
Electrochemistry + Spectroscopy	• Redox-reaction mechanism • Universal Redox-Potentiometry

Tab. 6.1 Achievements of the project EDUKEM

The particular EIS and TRD methods were developed in the frame of this project in view of the measuring ion mobility and dielectric dispersion of solutions of salts of the oceanic system. A better knowledge of the dynamic behavior of ions in an alternating electric field was also gained during the development process. These achievements could also be extended to other systems, thus enlarging the experimental database of ion mobilities, transport numbers and dielectric constants. These data are not only of interest for the processing of redox-related data but also for other research fields involving ionic processes, e.g. electrochemical energy storage systems.

The instrumental structure left by the accomplishment of this project, on the other hand may find applications in other areas of the of repository research as the study of mass transport of actinides and fission products in porous media, the determination of redox potentials in highly saline solutions, or the investigation of corrosion processes on metals and reinforced concrete.

Dissemination of the work

The progress of this project was presented in intern seminars of the GRS and regular meetings of the project partners. Specially the international dissemination of this work is worthy to be mention:

- R. Pattnaik, A.G. Muñoz, Ion mobility in concentrated electrolytes studied by AC-impedance: An experimental approach for measuring membrane potentials, 229th ECS Meeting, 29th May – 2nd June, San Diego, CA / Oral presentation.
- Paper: ECS Transactions, 72 (36) 1-10 (2016).
- A. G. Muñoz, S. Lehman, A. Ikeda-Ohno, S. Weiss, Redox stability of Uranium in high ionic strength media. An electrochemical and spectroscopic study, 230th ECS PRIME Meeting, 2nd - 7th October, Honolulu, Hawaii / Oral presentation.

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A Experimental impedance data for solutions of CsCl and salts of the oceanic system at 25°C: cell length: 27.3 cm, amplitude ΔV: 100 mV

Tab. A.1 Concentration and density of solutions used for measuring the frequency dispersion

Sol. Nr.	CsCl		NaCl	
	m / mol kg^{-1}	ρ / g cm^{-3}	m / mol kg^{-1}	ρ / g cm^{-3}
02	2.0472	1.23427	2.1623	1.07800
03	1.8808	1.21686	2.0126	1.07302
04	1.7524	1.20295	1.8955	1.06869
05	1.5824	1.18461	1.7359	1.06317
06	1.3878	1.16290	1.5464	1.05640
07	1.2243	1.14441	1.3834	1.05042
08	1.0864	1.12883	1.2423	1.04539
09	0.8783	1.10468	1.0228	1.03721
10	0.7210	1.08604	0.8507	1.03075
11	0.5246	1.06251	0.6303	1.02226
12	0.3398	1.03985	0.4151	1.01384
13	0.1652	1.01818	0.2050	1.00545
14	0.0866	1.00816	0.1075	1.00149
15	0.0170	0.99938	0.0213	0.99793

Sol. Nr.	KCl		$CaCl_2$	
	m / mol kg^{-1}	ρ / g cm^{-3}	m / mol kg^{-1}	ρ / g cm^{-3}
02	2.7186	1.08642	2.1111	1.15591
03	2.5254	1.08068	1.9436	1.14468
04	2.3746	1.07612	1.8140	1.13655
05	2.1704	1.06986	1.6421	1.12534
06	1.9295	1.06230	1.6424	1.11151
07	1.7216	1.05580	1.2755	1.09997
08	1.5450	1.05024	1.1339	1.08952
09	1.2670	1.04111	0.9195	1.07357
10	1.0516	1.03397	0.7560	1.06104
11	0.7767	1.02464	0.5515	1.04465
12	0.5097	1.01536	0.3578	1.02854
13	0.2513	1.00624	0.1747	1.01282
14	0.1316	1.00191	0.0907	1.00533
15	0.0258	0.99801	0.0181	0.99876

Sol. Nr.	$MgCl_2$		Na_2SO_4	
	m / mol kg^{-1}	ρ / g cm^{-3}	m / mol kg^{-1}	ρ / g cm^{-3}
02	2.0614	1.1159	2.1483	1.22476
03	1.8854	1.1082	1.9781	1.20943
04	1.7522	1.1022	1.8470	1.19732
05	1.5746	1.0938	1.6721	1.18060
06	1.3724	1.0836	1.4696	1.16077
07	1.2061	1.075	1.2998	1.14374
08	1.0663	1.0675	1.1558	1.12889
09	0.8579	1.0554	0.9374	1.10589
10	0.6991	1.0459	0.7707	1.08781
11	0.5069	1.0336	0.5629	1.06453
12	0.3220	1.021	0.3657	1.04182
13	0.1592	1.0093	0.1781	1.01939
14	0.0807	1.0034	0.0925	1.00882
15	0.0162	0.9984	0.0181	0.99956

Sol. Nr.	K_2SO_4	
	m / mol kg^{-1}	ρ / g cm^{-3}
02	0.55079	1.06846
03	0.51375	1.06387
04	0.48443	1.06033
05	0.44456	1.05533
06	0.39702	1.04943
07	0.35581	1.04418
08	0.32004	1.03965
09	0.26424	1.03247
10	0.22034	1.02679
11	0.16368	1.01933
12	0.10809	1.01192
13	0.05354	1.00456
14	0.02806	1.00101
15	0.00553	0.99786

Tab. A.2 Frequency dispersion of CsCl solutions

	15		14	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	1.22E+02	-7.04E+03	1.65E+03	-6.25E+03
3.97E+06	5.28E+02	-8.55E+03	2.54E+03	-7.21E+03
3.15E+06	1.15E+03	-1.05E+04	3.80E+03	-8.28E+03
2.51E+06	1.91E+03	-1.28E+04	5.19E+03	-9.27E+03
1.99E+06	3.17E+03	-1.56E+04	7.23E+03	-1.01E+04
1.58E+06	4.84E+03	-1.89E+04	9.37E+03	-1.07E+04
1.26E+06	7.05E+03	-2.28E+04	1.18E+04	-1.08E+04
9.98E+05	1.08E+04	-2.67E+04	1.43E+04	-1.01E+04
7.92E+05	1.48E+04	-3.14E+04	1.64E+04	-9.40E+03
6.29E+05	2.02E+04	-3.64E+04	1.81E+04	-8.40E+03
5.00E+05	2.70E+04	-4.12E+04	1.95E+04	-7.29E+03
3.97E+05	3.55E+04	-4.51E+04	2.04E+04	-6.14E+03
3.15E+05	4.55E+04	-4.75E+04	2.11E+04	-5.06E+03
2.51E+05	5.61E+04	-4.81E+04	2.16E+04	-4.15E+03
1.99E+05	6.66E+04	-4.66E+04	2.20E+04	-3.38E+03
1.58E+05	7.59E+04	-4.31E+04	2.22E+04	-2.72E+03
1.26E+05	8.37E+04	-3.83E+04	2.23E+04	-2.18E+03
9.98E+04	8.97E+04	-3.30E+04	2.24E+04	-1.74E+03
7.92E+04	9.42E+04	-2.77E+04	2.25E+04	-1.38E+03
6.29E+04	9.72E+04	-2.31E+04	2.25E+04	-1.12E+03
5.00E+04	9.94E+04	-1.88E+04	2.26E+04	-8.79E+02
3.97E+04	1.01E+05	-1.52E+04	2.26E+04	-6.79E+02
3.15E+04	1.02E+05	-1.22E+04	2.26E+04	-5.27E+02
2.51E+04	1.03E+05	-9.60E+03	2.26E+04	-3.77E+02
1.99E+04	1.03E+05	-7.47E+03	2.26E+04	-2.53E+02
1.58E+04	1.03E+05	-5.69E+03	2.26E+04	-1.45E+02
1.26E+04	1.03E+05	-4.25E+03	2.26E+04	-4.31E+01
9.98E+03	1.03E+05	-2.99E+03	2.26E+04	5.13E+01
7.92E+03	1.03E+05	-1.95E+03	2.25E+04	1.34E+02
6.29E+03	1.03E+05	-1.11E+03	2.25E+04	1.99E+02
5.00E+03	1.03E+05	-3.96E+02	2.24E+04	2.56E+02
3.97E+03	1.02E+05	9.14E+01	2.23E+04	2.91E+02
3.15E+03	1.02E+05	3.82E+02	2.22E+04	3.06E+02
2.51E+03	1.02E+05	6.39E+02	2.22E+04	2.90E+02
1.99E+03	1.01E+05	5.91E+02	2.21E+04	2.64E+02
1.58E+03	1.01E+05	6.08E+02	2.21E+04	2.22E+02
1.26E+03	1.01E+05	4.93E+02	2.20E+04	1.74E+02
9.98E+02	1.01E+05	4.16E+02	2.20E+04	1.27E+02
7.92E+02	1.01E+05	3.20E+02	2.20E+04	8.95E+01
6.29E+02	1.01E+05	1.07E+02	2.20E+04	5.98E+01
5.00E+02	1.01E+05	1.18E+02	2.20E+04	5.25E+00
3.97E+02	1.01E+05	4.96E+01	2.20E+04	-2.23E+01
3.15E+02	1.01E+05	1.61E+01	2.20E+04	-6.37E+01

f / Hz	15		14	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
2.51E+02	1.01E+05	-1.93E+02	2.20E+04	-1.33E+02
1.99E+02	1.01E+05	-1.76E+02	2.20E+04	-1.72E+02
1.58E+02	1.01E+05	-2.40E+02	2.20E+04	-2.10E+02
1.26E+02	1.01E+05	-3.00E+02	2.20E+04	-2.72E+02
9.98E+01	1.01E+05	-3.15E+02	2.20E+04	-3.21E+02
7.92E+01	1.01E+05	-4.62E+02	2.21E+04	-4.13E+02
6.29E+01	1.01E+05	-5.70E+02	2.21E+04	-5.03E+02
5.00E+01	1.00E+05	-8.16E+02	2.20E+04	-6.73E+02
3.97E+01	1.01E+05	-8.20E+02	2.22E+04	-7.49E+02
3.15E+01	1.01E+05	-9.78E+02	2.22E+04	-8.95E+02
2.51E+01	1.01E+05	-1.12E+03	2.23E+04	-1.08E+03
1.99E+01	1.01E+05	-1.35E+03	2.24E+04	-1.30E+03
1.58E+01	1.01E+05	-1.59E+03	2.25E+04	-1.55E+03
1.26E+01	1.02E+05	-1.93E+03	2.26E+04	-1.86E+03
9.98E+00	1.02E+05	-2.30E+03	2.28E+04	-2.21E+03
7.92E+00	1.02E+05	-2.67E+03	2.30E+04	-2.63E+03
6.29E+00	1.02E+05	-3.24E+03	2.32E+04	-3.14E+03
5.00E+00	1.02E+05	-3.81E+03	2.35E+04	-3.72E+03
3.97E+00	1.03E+05	-4.51E+03	2.38E+04	-4.41E+03
3.15E+00	1.03E+05	-5.31E+03	2.42E+04	-5.21E+03
2.51E+00	1.04E+05	-6.20E+03	2.46E+04	-6.17E+03
1.99E+00	1.04E+05	-7.41E+03	2.51E+04	-7.28E+03
1.58E+00	1.05E+05	-8.78E+03	2.57E+04	-8.60E+03
1.26E+00	1.06E+05	-1.04E+04	2.64E+04	-1.02E+04
9.98E-01	1.07E+05	-1.24E+04	2.72E+04	-1.21E+04
7.92E-01	1.07E+05	-1.46E+04	2.82E+04	-1.45E+04
6.29E-01	1.09E+05	-1.73E+04	2.94E+04	-1.72E+04
5.00E-01	1.10E+05	-2.07E+04	3.08E+04	-2.05E+04
3.97E-01	1.12E+05	-2.46E+04	3.26E+04	-2.43E+04
3.15E-01	1.15E+05	-2.92E+04	3.49E+04	-2.90E+04
2.51E-01	1.18E+05	-3.44E+04	3.79E+04	-3.46E+04
1.99E-01	1.22E+05	-4.06E+04	4.16E+04	-4.11E+04
1.58E-01	1.27E+05	-4.82E+04	4.64E+04	-4.86E+04
1.26E-01	1.32E+05	-5.64E+04	5.27E+04	-5.71E+04
1.00E-01	1.40E+05	-6.57E+04	6.01E+04	-6.64E+04

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.58E+03	-5.26E+03	3.23E+03	-3.38E+03
3.97E+06	3.58E+03	-5.71E+03	3.88E+03	-3.24E+03
3.15E+06	4.80E+03	-6.00E+03	4.52E+03	-2.96E+03
2.51E+06	6.01E+03	-6.14E+03	5.01E+03	-2.66E+03
1.99E+06	7.38E+03	-5.93E+03	5.43E+03	-2.25E+03
1.58E+06	8.58E+03	-5.52E+03	5.73E+03	-1.89E+03
1.26E+06	9.58E+03	-4.99E+03	5.93E+03	-1.56E+03
9.98E+05	1.05E+04	-4.01E+03	6.08E+03	-1.10E+03
7.92E+05	1.11E+04	-3.42E+03	6.17E+03	-8.96E+02
6.29E+05	1.15E+04	-2.84E+03	6.23E+03	-7.22E+02
5.00E+05	1.18E+04	-2.34E+03	6.27E+03	-5.82E+02
3.97E+05	1.20E+04	-1.90E+03	6.29E+03	-4.66E+02
3.15E+05	1.21E+04	-1.52E+03	6.31E+03	-3.70E+02
2.51E+05	1.22E+04	-1.23E+03	6.32E+03	-2.97E+02
1.99E+05	1.22E+04	-9.94E+02	6.33E+03	-2.42E+02
1.58E+05	1.23E+04	-7.93E+02	6.33E+03	-1.93E+02
1.26E+05	1.23E+04	-6.30E+02	6.34E+03	-1.50E+02
9.98E+04	1.23E+04	-4.97E+02	6.35E+03	-1.16E+02
7.92E+04	1.23E+04	-3.92E+02	6.35E+03	-9.14E+01
6.29E+04	1.23E+04	-3.21E+02	6.35E+03	-7.54E+01
5.00E+04	1.24E+04	-2.45E+02	6.36E+03	-5.52E+01
3.97E+04	1.24E+04	-1.84E+02	6.36E+03	-3.78E+01
3.15E+04	1.24E+04	-1.37E+02	6.36E+03	-2.54E+01
2.51E+04	1.24E+04	-8.57E+01	6.36E+03	-8.50E+00
1.99E+04	1.24E+04	-4.06E+01	6.36E+03	5.45E+00
1.58E+04	1.24E+04	-2.09E+00	6.35E+03	1.98E+01
1.26E+04	1.24E+04	3.25E+01	6.35E+03	3.34E+01
9.98E+03	1.23E+04	7.10E+01	6.35E+03	4.53E+01
7.92E+03	1.23E+04	1.09E+02	6.34E+03	6.23E+01
6.29E+03	1.23E+04	1.37E+02	6.32E+03	7.80E+01
5.00E+03	1.23E+04	1.63E+02	6.30E+03	8.64E+01
3.97E+03	1.22E+04	1.70E+02	6.28E+03	8.56E+01
3.15E+03	1.22E+04	1.77E+02	6.26E+03	7.91E+01
2.51E+03	1.21E+04	1.67E+02	6.24E+03	7.53E+01
1.99E+03	1.21E+04	1.43E+02	6.22E+03	6.69E+01
1.58E+03	1.21E+04	1.16E+02	6.20E+03	4.96E+01
1.26E+03	1.20E+04	8.71E+01	6.19E+03	3.23E+01
9.98E+02	1.20E+04	5.66E+01	6.18E+03	1.65E+01
7.92E+02	1.20E+04	2.85E+01	6.18E+03	-5.01E+00
6.29E+02	1.20E+04	8.25E+00	6.19E+03	-2.61E+01
5.00E+02	1.20E+04	-2.45E+01	6.18E+03	-4.37E+01
3.97E+02	1.20E+04	-5.51E+01	6.19E+03	-6.79E+01
3.15E+02	1.20E+04	-8.66E+01	6.20E+03	-9.50E+01
2.51E+02	1.20E+04	-1.27E+02	6.22E+03	-1.27E+02

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.20E+04	-1.60E+02	6.22E+03	-1.59E+02
1.58E+02	1.21E+04	-2.08E+02	6.23E+03	-1.98E+02
1.26E+02	1.21E+04	-2.54E+02	6.24E+03	-2.43E+02
9.98E+01	1.21E+04	-3.03E+02	6.26E+03	-2.93E+02
7.92E+01	1.21E+04	-3.86E+02	6.27E+03	-3.60E+02
6.29E+01	1.21E+04	-4.77E+02	6.30E+03	-4.35E+02
5.00E+01	1.21E+04	-6.54E+02	6.35E+03	-4.95E+02
3.97E+01	1.22E+04	-6.98E+02	6.36E+03	-6.40E+02
3.15E+01	1.22E+04	-8.39E+02	6.41E+03	-7.74E+02
2.51E+01	1.23E+04	-1.02E+03	6.46E+03	-9.33E+02
1.99E+01	1.24E+04	-1.23E+03	6.53E+03	-1.12E+03
1.58E+01	1.25E+04	-1.46E+03	6.61E+03	-1.35E+03
1.26E+01	1.26E+04	-1.76E+03	6.71E+03	-1.62E+03
9.98E+00	1.27E+04	-2.11E+03	6.82E+03	-1.94E+03
7.92E+00	1.29E+04	-2.53E+03	6.97E+03	-2.33E+03
6.29E+00	1.31E+04	-3.01E+03	7.15E+03	-2.79E+03
5.00E+00	1.33E+04	-3.59E+03	7.37E+03	-3.32E+03
3.97E+00	1.37E+04	-4.26E+03	7.62E+03	-3.96E+03
3.15E+00	1.40E+04	-5.06E+03	7.93E+03	-4.73E+03
2.51E+00	1.44E+04	-5.99E+03	8.28E+03	-5.64E+03
1.99E+00	1.49E+04	-7.10E+03	8.68E+03	-6.71E+03
1.58E+00	1.54E+04	-8.41E+03	9.16E+03	-8.01E+03
1.26E+00	1.61E+04	-1.00E+04	9.77E+03	-9.59E+03
9.98E-01	1.69E+04	-1.18E+04	1.05E+04	-1.14E+04
7.92E-01	1.79E+04	-1.42E+04	1.13E+04	-1.37E+04
6.29E-01	1.90E+04	-1.68E+04	1.24E+04	-1.64E+04
5.00E-01	2.04E+04	-2.02E+04	1.37E+04	-1.97E+04
3.97E-01	2.21E+04	-2.40E+04	1.53E+04	-2.35E+04
3.15E-01	2.43E+04	-2.87E+04	1.74E+04	-2.82E+04
2.51E-01	2.71E+04	-3.43E+04	2.01E+04	-3.37E+04
1.99E-01	3.07E+04	-4.06E+04	2.36E+04	-4.02E+04
1.58E-01	3.55E+04	-4.82E+04	2.80E+04	-4.75E+04
1.26E-01	4.15E+04	-5.69E+04	3.37E+04	-5.63E+04
1.00E-01	4.89E+04	-6.61E+04	4.09E+04	-6.59E+04

	11		10	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	3.04E+03	-2.17E+03	2.66E+03	-1.37E+03
3.97E+06	3.38E+03	-1.93E+03	2.82E+03	-1.16E+03
3.15E+06	3.67E+03	-1.64E+03	2.95E+03	-9.50E+02
2.51E+06	3.88E+03	-1.39E+03	3.03E+03	-7.83E+02
1.99E+06	4.02E+03	-1.12E+03	3.09E+03	-6.15E+02
1.58E+06	4.12E+03	-9.10E+02	3.13E+03	-4.86E+02
1.26E+06	4.19E+03	-7.22E+02	3.14E+03	-3.80E+02
9.98E+05	4.22E+03	-4.65E+02	3.15E+03	-2.18E+02
7.92E+05	4.25E+03	-3.75E+02	3.16E+03	-1.76E+02
6.29E+05	4.26E+03	-3.00E+02	3.16E+03	-1.40E+02
5.00E+05	4.27E+03	-2.41E+02	3.16E+03	-1.12E+02
3.97E+05	4.28E+03	-1.92E+02	3.17E+03	-8.89E+01
3.15E+05	4.28E+03	-1.51E+02	3.17E+03	-6.95E+01
2.51E+05	4.28E+03	-1.22E+02	3.17E+03	-5.59E+01
1.99E+05	4.29E+03	-9.98E+01	3.17E+03	-4.61E+01
1.58E+05	4.29E+03	-7.82E+01	3.17E+03	-3.64E+01
1.26E+05	4.29E+03	-6.06E+01	3.17E+03	-2.78E+01
9.98E+04	4.30E+03	-4.69E+01	3.18E+03	-2.12E+01
7.92E+04	4.30E+03	-3.71E+01	3.18E+03	-1.67E+01
6.29E+04	4.30E+03	-3.04E+01	3.18E+03	-1.38E+01
5.00E+04	4.30E+03	-2.11E+01	3.18E+03	-8.79E+00
3.97E+04	4.30E+03	-1.28E+01	3.18E+03	-4.04E+00
3.15E+04	4.30E+03	-7.39E+00	3.18E+03	-1.37E+00
2.51E+04	4.30E+03	1.34E+00	3.18E+03	3.82E+00
1.99E+04	4.30E+03	9.16E+00	3.18E+03	9.05E+00
1.58E+04	4.29E+03	1.66E+01	3.18E+03	1.32E+01
1.26E+04	4.29E+03	2.46E+01	3.17E+03	1.81E+01
9.98E+03	4.29E+03	3.26E+01	3.18E+03	2.19E+01
7.92E+03	4.28E+03	4.09E+01	3.17E+03	2.92E+01
6.29E+03	4.27E+03	4.91E+01	3.16E+03	3.73E+01
5.00E+03	4.26E+03	5.25E+01	3.15E+03	3.58E+01
3.97E+03	4.25E+03	5.53E+01	3.15E+03	3.66E+01
3.15E+03	4.23E+03	5.08E+01	3.13E+03	3.97E+01
2.51E+03	4.22E+03	4.52E+01	3.13E+03	3.03E+01
1.99E+03	4.20E+03	3.97E+01	3.11E+03	2.42E+01
1.58E+03	4.19E+03	2.50E+01	3.11E+03	1.42E+01
1.26E+03	4.19E+03	1.24E+01	3.10E+03	1.07E+00
9.98E+02	4.18E+03	-2.32E+00	3.11E+03	-1.29E+01
7.92E+02	4.18E+03	-1.92E+01	3.10E+03	-2.54E+01
6.29E+02	4.19E+03	-3.47E+01	3.10E+03	-3.97E+01
5.00E+02	4.19E+03	-5.62E+01	3.10E+03	-5.45E+01
3.97E+02	4.19E+03	-7.31E+01	3.11E+03	-7.26E+01
3.15E+02	4.19E+03	-9.99E+01	3.11E+03	-9.77E+01
2.51E+02	4.20E+03	-1.20E+02	3.13E+03	-1.29E+02

f / Hz	11		10	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	4.21E+03	-1.50E+02	3.14E+03	-1.57E+02
1.58E+02	4.22E+03	-1.83E+02	3.15E+03	-1.91E+02
1.26E+02	4.22E+03	-2.35E+02	3.16E+03	-2.32E+02
9.98E+01	4.23E+03	-2.72E+02	3.17E+03	-2.79E+02
7.92E+01	4.26E+03	-3.49E+02	3.19E+03	-3.40E+02
6.29E+01	4.28E+03	-4.31E+02	3.21E+03	-4.11E+02
5.00E+01	4.29E+03	-5.00E+02	3.26E+03	-5.01E+02
3.97E+01	4.35E+03	-6.22E+02	3.27E+03	-6.00E+02
3.15E+01	4.39E+03	-7.51E+02	3.31E+03	-7.23E+02
2.51E+01	4.44E+03	-9.05E+02	3.36E+03	-8.69E+02
1.99E+01	4.50E+03	-1.10E+03	3.42E+03	-1.05E+03
1.58E+01	4.59E+03	-1.30E+03	3.50E+03	-1.26E+03
1.26E+01	4.68E+03	-1.57E+03	3.59E+03	-1.51E+03
9.98E+00	4.80E+03	-1.88E+03	3.69E+03	-1.81E+03
7.92E+00	4.94E+03	-2.27E+03	3.83E+03	-2.17E+03
6.29E+00	5.10E+03	-2.69E+03	3.98E+03	-2.59E+03
5.00E+00	5.30E+03	-3.21E+03	4.17E+03	-3.09E+03
3.97E+00	5.54E+03	-3.82E+03	4.37E+03	-3.71E+03
3.15E+00	5.80E+03	-4.58E+03	4.64E+03	-4.42E+03
2.51E+00	6.12E+03	-5.46E+03	4.96E+03	-5.30E+03
1.99E+00	6.50E+03	-6.53E+03	5.28E+03	-6.34E+03
1.58E+00	6.94E+03	-7.81E+03	5.72E+03	-7.61E+03
1.26E+00	7.49E+03	-9.38E+03	6.25E+03	-9.16E+03
9.98E-01	8.16E+03	-1.13E+04	6.87E+03	-1.10E+04
7.92E-01	8.95E+03	-1.36E+04	7.67E+03	-1.32E+04
6.29E-01	9.95E+03	-1.62E+04	8.61E+03	-1.59E+04
5.00E-01	1.12E+04	-1.95E+04	9.83E+03	-1.92E+04
3.97E-01	1.28E+04	-2.34E+04	1.14E+04	-2.30E+04
3.15E-01	1.48E+04	-2.81E+04	1.34E+04	-2.76E+04
2.51E-01	1.73E+04	-3.37E+04	1.59E+04	-3.31E+04
1.99E-01	2.06E+04	-4.02E+04	1.92E+04	-3.94E+04
1.58E-01	2.49E+04	-4.78E+04	2.34E+04	-4.68E+04
1.26E-01	3.04E+04	-5.65E+04	2.88E+04	-5.54E+04
1.00E-01	3.74E+04	-6.64E+04	3.56E+04	-6.49E+04

f / Hz	09		08	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.37E+03	-1.01E+03	2.06E+03	-7.21E+02
3.97E+06	2.46E+03	-8.39E+02	2.11E+03	-5.93E+02
3.15E+06	2.54E+03	-6.76E+02	2.15E+03	-4.73E+02
2.51E+06	2.58E+03	-5.51E+02	2.17E+03	-3.80E+02
1.99E+06	2.61E+03	-4.27E+02	2.18E+03	-2.94E+02
1.58E+06	2.63E+03	-3.35E+02	2.19E+03	-2.27E+02
1.26E+06	2.64E+03	-2.59E+02	2.19E+03	-1.75E+02
9.98E+05	2.64E+03	-1.35E+02	2.19E+03	-7.88E+01
7.92E+05	2.64E+03	-1.09E+02	2.19E+03	-6.42E+01
6.29E+05	2.64E+03	-8.72E+01	2.19E+03	-5.11E+01
5.00E+05	2.64E+03	-7.00E+01	2.19E+03	-4.14E+01
3.97E+05	2.65E+03	-5.54E+01	2.19E+03	-3.23E+01
3.15E+05	2.65E+03	-4.31E+01	2.19E+03	-2.51E+01
2.51E+05	2.65E+03	-3.51E+01	2.19E+03	-2.09E+01
1.99E+05	2.65E+03	-2.94E+01	2.19E+03	-1.79E+01
1.58E+05	2.65E+03	-2.30E+01	2.19E+03	-1.38E+01
1.26E+05	2.65E+03	-1.74E+01	2.20E+03	-1.05E+01
9.98E+04	2.65E+03	-1.30E+01	2.20E+03	-7.67E+00
7.92E+04	2.65E+03	-1.03E+01	2.20E+03	-6.08E+00
6.29E+04	2.65E+03	-8.45E+00	2.20E+03	-5.05E+00
5.00E+04	2.66E+03	-5.10E+00	2.20E+03	-2.63E+00
3.97E+04	2.66E+03	-1.69E+00	2.20E+03	-6.60E-02
3.15E+04	2.66E+03	4.11E-02	2.20E+03	9.36E-01
2.51E+04	2.66E+03	3.97E+00	2.20E+03	3.74E+00
1.99E+04	2.65E+03	7.67E+00	2.20E+03	6.24E+00
1.58E+04	2.65E+03	1.09E+01	2.20E+03	8.84E+00
1.26E+04	2.65E+03	1.47E+01	2.19E+03	1.13E+01
9.98E+03	2.65E+03	1.84E+01	2.19E+03	1.44E+01
7.92E+03	2.64E+03	2.22E+01	2.19E+03	1.66E+01
6.29E+03	2.64E+03	2.41E+01	2.18E+03	1.83E+01
5.00E+03	2.63E+03	2.60E+01	2.18E+03	1.93E+01
3.97E+03	2.62E+03	2.51E+01	2.17E+03	1.81E+01
3.15E+03	2.62E+03	2.27E+01	2.17E+03	1.51E+01
2.51E+03	2.61E+03	1.82E+01	2.16E+03	1.20E+01
1.99E+03	2.60E+03	9.11E+00	2.16E+03	3.47E+00
1.58E+03	2.60E+03	1.07E-01	2.15E+03	-3.54E+00
1.26E+03	2.60E+03	-9.63E+00	2.15E+03	-1.38E+01
9.98E+02	2.60E+03	-2.13E+01	2.15E+03	-2.39E+01
7.92E+02	2.60E+03	-3.29E+01	2.15E+03	-3.54E+01
6.29E+02	2.60E+03	-4.91E+01	2.15E+03	-4.93E+01
5.00E+02	2.60E+03	-6.31E+01	2.16E+03	-6.28E+01
3.97E+02	2.61E+03	-8.12E+01	2.16E+03	-7.99E+01
3.15E+02	2.61E+03	-1.01E+02	2.17E+03	-1.00E+02
2.51E+02	2.62E+03	-1.26E+02	2.18E+03	-1.22E+02

	09		08	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	2.63E+03	-1.55E+02	2.18E+03	-1.49E+02
1.58E+02	2.64E+03	-1.89E+02	2.19E+03	-1.83E+02
1.26E+02	2.65E+03	-2.30E+02	2.20E+03	-2.24E+02
9.98E+01	2.67E+03	-2.78E+02	2.22E+03	-2.70E+02
7.92E+01	2.68E+03	-3.37E+02	2.24E+03	-3.27E+02
6.29E+01	2.70E+03	-4.07E+02	2.26E+03	-3.95E+02
5.00E+01	2.71E+03	-4.95E+02	2.30E+03	-4.76E+02
3.97E+01	2.77E+03	-5.93E+02	2.32E+03	-5.75E+02
3.15E+01	2.81E+03	-7.15E+02	2.36E+03	-6.92E+02
2.51E+01	2.86E+03	-8.58E+02	2.41E+03	-8.32E+02
1.99E+01	2.92E+03	-1.03E+03	2.47E+03	-9.99E+02
1.58E+01	3.00E+03	-1.24E+03	2.54E+03	-1.20E+03
1.26E+01	3.08E+03	-1.48E+03	2.63E+03	-1.43E+03
9.98E+00	3.20E+03	-1.77E+03	2.73E+03	-1.71E+03
7.92E+00	3.33E+03	-2.12E+03	2.86E+03	-2.05E+03
6.29E+00	3.48E+03	-2.53E+03	3.00E+03	-2.44E+03
5.00E+00	3.66E+03	-3.02E+03	3.17E+03	-2.92E+03
3.97E+00	3.89E+03	-3.61E+03	3.37E+03	-3.50E+03
3.15E+00	4.11E+03	-4.30E+03	3.58E+03	-4.19E+03
2.51E+00	4.40E+03	-5.16E+03	3.88E+03	-5.02E+03
1.99E+00	4.74E+03	-6.20E+03	4.19E+03	-6.04E+03
1.58E+00	5.16E+03	-7.45E+03	4.60E+03	-7.28E+03
1.26E+00	5.69E+03	-8.96E+03	5.09E+03	-8.80E+03
9.98E-01	6.33E+03	-1.08E+04	5.73E+03	-1.06E+04
7.92E-01	7.17E+03	-1.30E+04	6.57E+03	-1.27E+04
6.29E-01	8.21E+03	-1.56E+04	7.56E+03	-1.53E+04
5.00E-01	9.52E+03	-1.88E+04	8.90E+03	-1.84E+04
3.97E-01	1.13E+04	-2.25E+04	1.06E+04	-2.21E+04
3.15E-01	1.35E+04	-2.69E+04	1.28E+04	-2.64E+04
2.51E-01	1.64E+04	-3.20E+04	1.57E+04	-3.14E+04
1.99E-01	2.02E+04	-3.79E+04	1.94E+04	-3.71E+04
1.58E-01	2.51E+04	-4.44E+04	2.42E+04	-4.35E+04
1.26E-01	3.13E+04	-5.18E+04	3.04E+04	-5.04E+04
1.00E-01	3.89E+04	-5.94E+04	3.80E+04	-5.77E+04

f / Hz	07 Z´ / Ω	 Z´´/ Ω	06 Z´/ Ω	 Z´´/ Ω
5.00E+06	1.89E+03	-5.92E+02	1.72E+03	-4.74E+02
3.97E+06	1.92E+03	-4.83E+02	1.74E+03	-3.84E+02
3.15E+06	1.95E+03	-3.83E+02	1.75E+03	-3.03E+02
2.51E+06	1.96E+03	-3.06E+02	1.76E+03	-2.41E+02
1.99E+06	1.97E+03	-2.34E+02	1.77E+03	-1.83E+02
1.58E+06	1.98E+03	-1.80E+02	1.77E+03	-1.40E+02
1.26E+06	1.98E+03	-1.38E+02	1.77E+03	-1.05E+02
9.98E+05	1.97E+03	-5.55E+01	1.76E+03	-3.57E+01
7.92E+05	1.97E+03	-4.51E+01	1.76E+03	-2.93E+01
6.29E+05	1.97E+03	-3.56E+01	1.76E+03	-2.28E+01
5.00E+05	1.97E+03	-2.84E+01	1.76E+03	-1.82E+01
3.97E+05	1.97E+03	-2.20E+01	1.76E+03	-1.39E+01
3.15E+05	1.97E+03	-1.70E+01	1.76E+03	-1.08E+01
2.51E+05	1.97E+03	-1.44E+01	1.76E+03	-9.17E+00
1.99E+05	1.97E+03	-1.24E+01	1.76E+03	-8.44E+00
1.58E+05	1.97E+03	-9.64E+00	1.76E+03	-6.36E+00
1.26E+05	1.97E+03	-7.03E+00	1.76E+03	-4.58E+00
9.98E+04	1.97E+03	-5.29E+00	1.76E+03	-3.15E+00
7.92E+04	1.98E+03	-4.18E+00	1.77E+03	-2.99E+00
6.29E+04	1.97E+03	-3.31E+00	1.76E+03	-2.04E+00
5.00E+04	1.98E+03	-1.53E+00	1.76E+03	-5.55E-01
3.97E+04	1.98E+03	4.81E-01	1.77E+03	1.03E+00
3.15E+04	1.98E+03	1.05E+00	1.77E+03	1.51E+00
2.51E+04	1.97E+03	3.43E+00	1.76E+03	3.23E+00
1.99E+04	1.97E+03	5.80E+00	1.76E+03	4.92E+00
1.58E+04	1.97E+03	7.74E+00	1.76E+03	6.68E+00
1.26E+04	1.97E+03	9.56E+00	1.76E+03	8.23E+00
9.98E+03	1.97E+03	1.21E+01	1.76E+03	1.04E+01
7.92E+03	1.97E+03	1.42E+01	1.76E+03	1.17E+01
6.29E+03	1.96E+03	1.50E+01	1.75E+03	1.22E+01
5.00E+03	1.96E+03	1.56E+01	1.75E+03	1.25E+01
3.97E+03	1.95E+03	1.49E+01	1.75E+03	1.14E+01
3.15E+03	1.95E+03	1.18E+01	1.74E+03	8.38E+00
2.51E+03	1.94E+03	6.75E+00	1.74E+03	3.36E+00
1.99E+03	1.94E+03	3.27E-01	1.73E+03	-1.97E+00
1.58E+03	1.94E+03	-6.81E+00	1.73E+03	-9.76E+00
1.26E+03	1.94E+03	-1.59E+01	1.73E+03	-1.75E+01
9.98E+02	1.94E+03	-2.55E+01	1.73E+03	-2.67E+01
7.92E+02	1.94E+03	-3.72E+01	1.73E+03	-3.76E+01
6.29E+02	1.94E+03	-4.98E+01	1.74E+03	-5.01E+01
5.00E+02	1.94E+03	-6.35E+01	1.74E+03	-6.33E+01
3.97E+02	1.95E+03	-8.03E+01	1.74E+03	-7.92E+01
3.15E+02	1.95E+03	-9.88E+01	1.75E+03	-9.83E+01
2.51E+02	1.96E+03	-1.21E+02	1.76E+03	-1.17E+02

f / Hz	07		06	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.97E+03	-1.47E+02	1.76E+03	-1.45E+02
1.58E+02	1.98E+03	-1.80E+02	1.77E+03	-1.76E+02
1.26E+02	1.99E+03	-2.21E+02	1.78E+03	-2.15E+02
9.98E+01	2.01E+03	-2.66E+02	1.80E+03	-2.61E+02
7.92E+01	2.02E+03	-3.23E+02	1.82E+03	-3.15E+02
6.29E+01	2.04E+03	-3.91E+02	1.84E+03	-3.79E+02
5.00E+01	2.07E+03	-4.57E+02	1.87E+03	-4.50E+02
3.97E+01	2.10E+03	-5.66E+02	1.90E+03	-5.52E+02
3.15E+01	2.14E+03	-6.82E+02	1.94E+03	-6.64E+02
2.51E+01	2.19E+03	-8.18E+02	1.98E+03	-7.97E+02
1.99E+01	2.25E+03	-9.82E+02	2.04E+03	-9.55E+02
1.58E+01	2.32E+03	-1.18E+03	2.11E+03	-1.14E+03
1.26E+01	2.41E+03	-1.41E+03	2.19E+03	-1.37E+03
9.98E+00	2.50E+03	-1.68E+03	2.29E+03	-1.64E+03
7.92E+00	2.62E+03	-2.01E+03	2.40E+03	-1.96E+03
6.29E+00	2.76E+03	-2.41E+03	2.54E+03	-2.35E+03
5.00E+00	2.94E+03	-2.87E+03	2.69E+03	-2.81E+03
3.97E+00	3.12E+03	-3.44E+03	2.89E+03	-3.36E+03
3.15E+00	3.36E+03	-4.12E+03	3.08E+03	-4.03E+03
2.51E+00	3.63E+03	-4.96E+03	3.35E+03	-4.85E+03
1.99E+00	3.93E+03	-5.96E+03	3.65E+03	-5.84E+03
1.58E+00	4.33E+03	-7.19E+03	4.04E+03	-7.05E+03
1.26E+00	4.82E+03	-8.67E+03	4.51E+03	-8.52E+03
9.98E-01	5.42E+03	-1.05E+04	5.08E+03	-1.03E+04
7.92E-01	6.19E+03	-1.26E+04	5.85E+03	-1.24E+04
6.29E-01	7.27E+03	-1.52E+04	6.87E+03	-1.50E+04
5.00E-01	8.52E+03	-1.83E+04	8.13E+03	-1.80E+04
3.97E-01	1.02E+04	-2.19E+04	9.77E+03	-2.16E+04
3.15E-01	1.24E+04	-2.62E+04	1.19E+04	-2.58E+04
2.51E-01	1.53E+04	-3.11E+04	1.47E+04	-3.07E+04
1.99E-01	1.90E+04	-3.68E+04	1.85E+04	-3.63E+04
1.58E-01	2.39E+04	-4.31E+04	2.32E+04	-4.25E+04
1.26E-01	3.00E+04	-5.00E+04	2.93E+04	-4.94E+04
1.00E-01	3.74E+04	-5.72E+04	3.66E+04	-5.64E+04

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.56E+03	-3.75E+02	1.45E+03	-3.15E+02
3.97E+06	1.57E+03	-3.04E+02	1.45E+03	-2.56E+02
3.15E+06	1.58E+03	-2.38E+02	1.46E+03	-2.00E+02
2.51E+06	1.58E+03	-1.89E+02	1.46E+03	-1.57E+02
1.99E+06	1.58E+03	-1.42E+02	1.46E+03	-1.18E+02
1.58E+06	1.58E+03	-1.07E+02	1.46E+03	-8.77E+01
1.26E+06	1.58E+03	-7.97E+01	1.46E+03	-6.50E+01
9.98E+05	1.57E+03	-2.04E+01	1.45E+03	-1.19E+01
7.92E+05	1.57E+03	-1.69E+01	1.45E+03	-1.01E+01
6.29E+05	1.57E+03	-1.32E+01	1.45E+03	-7.85E+00
5.00E+05	1.57E+03	-1.05E+01	1.45E+03	-6.40E+00
3.97E+05	1.57E+03	-7.85E+00	1.45E+03	-4.60E+00
3.15E+05	1.57E+03	-5.92E+00	1.45E+03	-3.20E+00
2.51E+05	1.57E+03	-5.12E+00	1.45E+03	-2.97E+00
1.99E+05	1.57E+03	-5.26E+00	1.45E+03	-3.36E+00
1.58E+05	1.57E+03	-3.74E+00	1.45E+03	-2.41E+00
1.26E+05	1.57E+03	-2.68E+00	1.45E+03	-1.41E+00
9.98E+04	1.58E+03	-1.52E+00	1.45E+03	-7.79E-01
7.92E+04	1.58E+03	-1.65E+00	1.45E+03	-1.05E+00
6.29E+04	1.58E+03	-1.11E+00	1.45E+03	-5.53E-01
5.00E+04	1.58E+03	5.01E-02	1.45E+03	4.19E-01
3.97E+04	1.58E+03	1.21E+00	1.45E+03	1.39E+00
3.15E+04	1.58E+03	1.52E+00	1.45E+03	1.50E+00
2.51E+04	1.58E+03	2.98E+00	1.45E+03	2.60E+00
1.99E+04	1.57E+03	4.08E+00	1.45E+03	3.79E+00
1.58E+04	1.57E+03	5.47E+00	1.45E+03	4.70E+00
1.26E+04	1.57E+03	6.85E+00	1.45E+03	5.77E+00
9.98E+03	1.57E+03	7.76E+00	1.45E+03	6.74E+00
7.92E+03	1.57E+03	9.56E+00	1.44E+03	8.14E+00
6.29E+03	1.57E+03	1.00E+01	1.44E+03	8.44E+00
5.00E+03	1.56E+03	9.90E+00	1.44E+03	7.50E+00
3.97E+03	1.56E+03	8.39E+00	1.44E+03	6.18E+00
3.15E+03	1.56E+03	6.26E+00	1.43E+03	3.22E+00
2.51E+03	1.55E+03	1.57E+00	1.43E+03	-9.27E-01
1.99E+03	1.55E+03	-4.68E+00	1.43E+03	-5.86E+00
1.58E+03	1.55E+03	-1.14E+01	1.43E+03	-1.32E+01
1.26E+03	1.55E+03	-1.91E+01	1.43E+03	-2.00E+01
9.98E+02	1.55E+03	-2.83E+01	1.43E+03	-2.83E+01
7.92E+02	1.55E+03	-3.80E+01	1.43E+03	-3.92E+01
6.29E+02	1.55E+03	-4.99E+01	1.43E+03	-5.00E+01
5.00E+02	1.56E+03	-6.28E+01	1.43E+03	-6.30E+01
3.97E+02	1.56E+03	-7.74E+01	1.44E+03	-7.77E+01
3.15E+02	1.57E+03	-9.56E+01	1.44E+03	-9.65E+01
2.51E+02	1.58E+03	-1.15E+02	1.45E+03	-1.14E+02

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.58E+03	-1.40E+02	1.46E+03	-1.40E+02
1.58E+02	1.59E+03	-1.70E+02	1.47E+03	-1.70E+02
1.26E+02	1.60E+03	-2.06E+02	1.48E+03	-2.07E+02
9.98E+01	1.62E+03	-2.48E+02	1.50E+03	-2.48E+02
7.92E+01	1.64E+03	-2.98E+02	1.51E+03	-3.00E+02
6.29E+01	1.66E+03	-3.61E+02	1.53E+03	-3.61E+02
5.00E+01	1.68E+03	-4.45E+02	1.55E+03	-4.29E+02
3.97E+01	1.71E+03	-5.21E+02	1.59E+03	-5.21E+02
3.15E+01	1.75E+03	-6.24E+02	1.63E+03	-6.25E+02
2.51E+01	1.79E+03	-7.48E+02	1.67E+03	-7.49E+02
1.99E+01	1.85E+03	-8.96E+02	1.73E+03	-8.97E+02
1.58E+01	1.91E+03	-1.07E+03	1.79E+03	-1.07E+03
1.26E+01	1.99E+03	-1.28E+03	1.87E+03	-1.28E+03
9.98E+00	2.08E+03	-1.53E+03	1.95E+03	-1.54E+03
7.92E+00	2.18E+03	-1.83E+03	2.06E+03	-1.84E+03
6.29E+00	2.31E+03	-2.19E+03	2.18E+03	-2.20E+03
5.00E+00	2.46E+03	-2.61E+03	2.33E+03	-2.63E+03
3.97E+00	2.63E+03	-3.14E+03	2.50E+03	-3.15E+03
3.15E+00	2.81E+03	-3.77E+03	2.70E+03	-3.78E+03
2.51E+00	3.07E+03	-4.53E+03	2.93E+03	-4.56E+03
1.99E+00	3.34E+03	-5.47E+03	3.23E+03	-5.50E+03
1.58E+00	3.71E+03	-6.60E+03	3.59E+03	-6.63E+03
1.26E+00	4.13E+03	-7.98E+03	4.02E+03	-8.02E+03
9.98E-01	4.71E+03	-9.62E+03	4.60E+03	-9.66E+03
7.92E-01	5.42E+03	-1.16E+04	5.33E+03	-1.17E+04
6.29E-01	6.36E+03	-1.40E+04	6.26E+03	-1.41E+04
5.00E-01	7.56E+03	-1.69E+04	7.44E+03	-1.70E+04
3.97E-01	9.14E+03	-2.03E+04	9.02E+03	-2.04E+04
3.15E-01	1.12E+04	-2.43E+04	1.11E+04	-2.44E+04
2.51E-01	1.39E+04	-2.90E+04	1.38E+04	-2.90E+04
1.99E-01	1.74E+04	-3.43E+04	1.73E+04	-3.42E+04
1.58E-01	2.21E+04	-4.02E+04	2.19E+04	-4.01E+04
1.26E-01	2.80E+04	-4.64E+04	2.77E+04	-4.64E+04
1.00E-01	3.51E+04	-5.28E+04	3.48E+04	-5.28E+04

	03		02	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	1.37E+03	-2.80E+02	1.29E+03	-2.41E+02
3.97E+06	1.37E+03	-2.27E+02	1.29E+03	-1.95E+02
3.15E+06	1.38E+03	-1.77E+02	1.29E+03	-1.52E+02
2.51E+06	1.38E+03	-1.40E+02	1.29E+03	-1.19E+02
1.99E+06	1.38E+03	-1.04E+02	1.29E+03	-8.76E+01
1.58E+06	1.38E+03	-7.73E+01	1.29E+03	-6.47E+01
1.26E+06	1.38E+03	-5.73E+01	1.28E+03	-4.73E+01
9.98E+05	1.37E+03	-7.42E+00	1.28E+03	-2.17E+00
7.92E+05	1.37E+03	-6.78E+00	1.28E+03	-2.40E+00
6.29E+05	1.37E+03	-5.17E+00	1.28E+03	-1.73E+00
5.00E+05	1.37E+03	-4.28E+00	1.27E+03	-1.55E+00
3.97E+05	1.37E+03	-2.98E+00	1.27E+03	-7.48E-01
3.15E+05	1.37E+03	-1.91E+00	1.27E+03	-6.92E-02
2.51E+05	1.37E+03	-2.00E+00	1.27E+03	-6.42E-01
1.99E+05	1.37E+03	-2.41E+00	1.27E+03	-1.28E+00
1.58E+05	1.37E+03	-1.73E+00	1.27E+03	-7.68E-01
1.26E+05	1.37E+03	-9.98E-01	1.28E+03	-2.22E-01
9.98E+04	1.37E+03	-5.05E-01	1.28E+03	-1.63E-02
7.92E+04	1.37E+03	-7.38E-01	1.28E+03	-3.86E-01
6.29E+04	1.37E+03	-2.40E-01	1.28E+03	5.80E-02
5.00E+04	1.37E+03	5.30E-01	1.28E+03	6.96E-01
3.97E+04	1.37E+03	1.37E+00	1.28E+03	1.36E+00
3.15E+04	1.37E+03	1.37E+00	1.28E+03	1.37E+00
2.51E+04	1.37E+03	2.59E+00	1.28E+03	2.08E+00
1.99E+04	1.37E+03	3.24E+00	1.27E+03	2.97E+00
1.58E+04	1.37E+03	4.39E+00	1.27E+03	3.50E+00
1.26E+04	1.37E+03	4.91E+00	1.27E+03	4.34E+00
9.98E+03	1.37E+03	6.88E+00	1.27E+03	4.93E+00
7.92E+03	1.36E+03	6.89E+00	1.27E+03	5.34E+00
6.29E+03	1.36E+03	7.00E+00	1.27E+03	5.77E+00
5.00E+03	1.36E+03	7.11E+00	1.27E+03	4.50E+00
3.97E+03	1.36E+03	5.17E+00	1.26E+03	3.59E+00
3.15E+03	1.35E+03	1.22E+00	1.26E+03	5.45E-01
2.51E+03	1.35E+03	-2.68E+00	1.26E+03	-4.10E+00
1.99E+03	1.35E+03	-6.84E+00	1.26E+03	-8.91E+00
1.58E+03	1.35E+03	-1.35E+01	1.26E+03	-1.41E+01
1.26E+03	1.35E+03	-2.07E+01	1.26E+03	-2.22E+01
9.98E+02	1.35E+03	-2.96E+01	1.26E+03	-3.05E+01
7.92E+02	1.35E+03	-3.89E+01	1.26E+03	-3.99E+01
6.29E+02	1.35E+03	-4.94E+01	1.26E+03	-4.95E+01
5.00E+02	1.35E+03	-6.34E+01	1.26E+03	-6.36E+01
3.97E+02	1.36E+03	-7.84E+01	1.27E+03	-7.87E+01
3.15E+02	1.36E+03	-9.61E+01	1.27E+03	-9.63E+01
2.51E+02	1.37E+03	-1.14E+02	1.28E+03	-1.14E+02

	03		02	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
1.99E+02	1.38E+03	-1.40E+02	1.29E+03	-1.40E+02
1.58E+02	1.39E+03	-1.69E+02	1.30E+03	-1.70E+02
1.26E+02	1.40E+03	-2.05E+02	1.31E+03	-2.04E+02
9.98E+01	1.42E+03	-2.48E+02	1.33E+03	-2.46E+02
7.92E+01	1.43E+03	-2.98E+02	1.34E+03	-2.97E+02
6.29E+01	1.46E+03	-3.59E+02	1.36E+03	-3.56E+02
5.00E+01	1.47E+03	-4.38E+02	1.39E+03	-4.19E+02
3.97E+01	1.51E+03	-5.17E+02	1.42E+03	-5.14E+02
3.15E+01	1.55E+03	-6.21E+02	1.46E+03	-6.16E+02
2.51E+01	1.59E+03	-7.43E+02	1.50E+03	-7.38E+02
1.99E+01	1.65E+03	-8.90E+02	1.56E+03	-8.82E+02
1.58E+01	1.71E+03	-1.06E+03	1.62E+03	-1.06E+03
1.26E+01	1.79E+03	-1.27E+03	1.70E+03	-1.26E+03
9.98E+00	1.87E+03	-1.52E+03	1.78E+03	-1.50E+03
7.92E+00	1.98E+03	-1.82E+03	1.89E+03	-1.79E+03
6.29E+00	2.10E+03	-2.17E+03	2.00E+03	-2.14E+03
5.00E+00	2.24E+03	-2.60E+03	2.15E+03	-2.57E+03
3.97E+00	2.41E+03	-3.12E+03	2.31E+03	-3.08E+03
3.15E+00	2.60E+03	-3.76E+03	2.51E+03	-3.70E+03
2.51E+00	2.84E+03	-4.52E+03	2.76E+03	-4.45E+03
1.99E+00	3.13E+03	-5.46E+03	3.02E+03	-5.37E+03
1.58E+00	3.48E+03	-6.59E+03	3.38E+03	-6.48E+03
1.26E+00	3.93E+03	-7.96E+03	3.82E+03	-7.84E+03
9.98E-01	4.50E+03	-9.60E+03	4.34E+03	-9.45E+03
7.92E-01	5.20E+03	-1.16E+04	5.05E+03	-1.14E+04
6.29E-01	6.14E+03	-1.40E+04	5.99E+03	-1.38E+04
5.00E-01	7.34E+03	-1.68E+04	7.15E+03	-1.66E+04
3.97E-01	8.90E+03	-2.02E+04	8.73E+03	-2.00E+04
3.15E-01	1.10E+04	-2.42E+04	1.07E+04	-2.38E+04
2.51E-01	1.37E+04	-2.88E+04	1.35E+04	-2.83E+04
1.99E-01	1.72E+04	-3.39E+04	1.69E+04	-3.35E+04
1.58E-01	2.17E+04	-3.97E+04	2.14E+04	-3.90E+04
1.26E-01	2.75E+04	-4.59E+04	2.71E+04	-4.51E+04
1.00E-01	3.44E+04	-5.23E+04	3.39E+04	-5.11E+04

Tab. A.3 Frequency dispersion of NaCl solutions

	15		14	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	1.49E+02	-6.98E+03	1.72E+03	-6.30E+03
3.97E+06	5.71E+02	-8.49E+03	2.65E+03	-7.24E+03
3.15E+06	1.14E+03	-1.04E+04	3.83E+03	-8.23E+03
2.51E+06	2.00E+03	-1.26E+04	5.27E+03	-9.13E+03
1.99E+06	3.22E+03	-1.54E+04	7.18E+03	-1.00E+04
1.58E+06	4.85E+03	-1.86E+04	9.24E+03	-1.06E+04
1.26E+06	6.90E+03	-2.23E+04	1.15E+04	-1.08E+04
9.98E+05	1.07E+04	-2.62E+04	1.40E+04	-1.02E+04
7.92E+05	1.46E+04	-3.09E+04	1.61E+04	-9.63E+03
6.29E+05	1.98E+04	-3.59E+04	1.80E+04	-8.73E+03
5.00E+05	2.66E+04	-4.08E+04	1.94E+04	-7.68E+03
3.97E+05	3.50E+04	-4.46E+04	2.05E+04	-6.54E+03
3.15E+05	4.49E+04	-4.71E+04	2.13E+04	-5.44E+03
2.51E+05	5.55E+04	-4.76E+04	2.19E+04	-4.48E+03
1.99E+05	6.58E+04	-4.61E+04	2.23E+04	-3.67E+03
1.58E+05	7.49E+04	-4.26E+04	2.26E+04	-2.97E+03
1.26E+05	8.26E+04	-3.79E+04	2.28E+04	-2.39E+03
9.98E+04	8.85E+04	-3.28E+04	2.29E+04	-1.90E+03
7.92E+04	9.29E+04	-2.77E+04	2.30E+04	-1.51E+03
6.29E+04	9.59E+04	-2.33E+04	2.30E+04	-1.23E+03
5.00E+04	9.82E+04	-1.92E+04	2.31E+04	-9.67E+02
3.97E+04	9.99E+04	-1.57E+04	2.31E+04	-7.48E+02
3.15E+04	1.01E+05	-1.28E+04	2.31E+04	-5.79E+02
2.51E+04	1.02E+05	-1.02E+04	2.31E+04	-4.18E+02
1.99E+04	1.02E+05	-8.07E+03	2.31E+04	-2.88E+02
1.58E+04	1.03E+05	-6.26E+03	2.31E+04	-1.68E+02
1.26E+04	1.03E+05	-4.74E+03	2.31E+04	-6.06E+01
9.98E+03	1.03E+05	-3.45E+03	2.30E+04	3.46E+01
7.92E+03	1.03E+05	-2.35E+03	2.30E+04	1.20E+02
6.29E+03	1.03E+05	-1.50E+03	2.29E+04	1.88E+02
5.00E+03	1.02E+05	-7.43E+02	2.29E+04	2.41E+02
3.97E+03	1.02E+05	-2.14E+02	2.28E+04	2.72E+02
3.15E+03	1.02E+05	1.50E+02	2.27E+04	2.76E+02
2.51E+03	1.01E+05	4.13E+02	2.26E+04	2.55E+02
1.99E+03	1.01E+05	4.13E+02	2.25E+04	2.30E+02
1.58E+03	1.01E+05	4.17E+02	2.25E+04	1.89E+02
1.26E+03	1.01E+05	3.60E+02	2.25E+04	1.44E+02
9.98E+02	1.01E+05	2.92E+02	2.24E+04	1.02E+02
7.92E+02	1.01E+05	2.27E+02	2.24E+04	5.73E+01
6.29E+02	1.00E+05	2.88E+01	2.24E+04	1.99E+01
5.00E+02	1.01E+05	6.04E+01	2.24E+04	-2.69E+01
3.97E+02	1.01E+05	6.99E+00	2.24E+04	-6.33E+01
3.15E+02	1.01E+05	-4.80E+01	2.24E+04	-1.11E+02

f / Hz	15		14	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
2.51E+02	1.01E+05	-2.42E+02	2.24E+04	-2.00E+02
1.99E+02	1.01E+05	-2.58E+02	2.24E+04	-2.39E+02
1.58E+02	1.01E+05	-3.30E+02	2.24E+04	-3.01E+02
1.26E+02	1.01E+05	-4.27E+02	2.25E+04	-3.68E+02
9.98E+01	1.01E+05	-4.70E+02	2.25E+04	-4.54E+02
7.92E+01	1.01E+05	-6.02E+02	2.25E+04	-5.61E+02
6.29E+01	1.01E+05	-7.45E+02	2.25E+04	-6.93E+02
5.00E+01	1.01E+05	-6.10E+02	2.26E+04	-8.29E+02
3.97E+01	1.01E+05	-1.06E+03	2.26E+04	-1.03E+03
3.15E+01	1.01E+05	-1.31E+03	2.27E+04	-1.26E+03
2.51E+01	1.01E+05	-1.59E+03	2.28E+04	-1.53E+03
1.99E+01	1.01E+05	-1.86E+03	2.29E+04	-1.86E+03
1.58E+01	1.01E+05	-2.28E+03	2.30E+04	-2.25E+03
1.26E+01	1.01E+05	-2.69E+03	2.32E+04	-2.71E+03
9.98E+00	1.02E+05	-3.29E+03	2.35E+04	-3.25E+03
7.92E+00	1.02E+05	-3.94E+03	2.38E+04	-3.86E+03
6.29E+00	1.02E+05	-4.67E+03	2.42E+04	-4.59E+03
5.00E+00	1.03E+05	-5.61E+03	2.47E+04	-5.40E+03
3.97E+00	1.03E+05	-6.61E+03	2.52E+04	-6.32E+03
3.15E+00	1.04E+05	-7.82E+03	2.59E+04	-7.38E+03
2.51E+00	1.05E+05	-9.16E+03	2.66E+04	-8.59E+03
1.99E+00	1.06E+05	-1.07E+04	2.75E+04	-1.00E+04
1.58E+00	1.07E+05	-1.27E+04	2.84E+04	-1.16E+04
1.26E+00	1.08E+05	-1.47E+04	2.95E+04	-1.34E+04
9.98E-01	1.10E+05	-1.71E+04	3.08E+04	-1.57E+04
7.92E-01	1.12E+05	-1.98E+04	3.22E+04	-1.83E+04
6.29E-01	1.14E+05	-2.31E+04	3.40E+04	-2.13E+04
5.00E-01	1.16E+05	-2.63E+04	3.60E+04	-2.49E+04
3.97E-01	1.19E+05	-3.05E+04	3.84E+04	-2.91E+04
3.15E-01	1.23E+05	-3.52E+04	4.12E+04	-3.41E+04
2.51E-01	1.26E+05	-4.08E+04	4.46E+04	-3.99E+04
1.99E-01	1.31E+05	-4.68E+04	4.86E+04	-4.66E+04
1.58E-01	1.36E+05	-5.42E+04	5.33E+04	-5.45E+04
1.26E-01	1.42E+05	-6.18E+04	5.89E+04	-6.36E+04
1.00E-01	1.48E+05	-7.08E+04	6.55E+04	-7.44E+04

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.57E+03	-5.22E+03	3.16E+03	-3.51E+03
3.97E+06	3.55E+03	-5.65E+03	3.85E+03	-3.40E+03
3.15E+06	4.69E+03	-6.00E+03	4.52E+03	-3.18E+03
2.51E+06	5.89E+03	-6.10E+03	5.07E+03	-2.86E+03
1.99E+06	7.24E+03	-5.98E+03	5.56E+03	-2.46E+03
1.58E+06	8.47E+03	-5.67E+03	5.90E+03	-2.09E+03
1.26E+06	9.55E+03	-5.18E+03	6.14E+03	-1.73E+03
9.98E+05	1.05E+04	-4.25E+03	6.32E+03	-1.25E+03
7.92E+05	1.11E+04	-3.66E+03	6.43E+03	-1.02E+03
6.29E+05	1.16E+04	-3.07E+03	6.50E+03	-8.27E+02
5.00E+05	1.19E+04	-2.54E+03	6.55E+03	-6.68E+02
3.97E+05	1.22E+04	-2.07E+03	6.58E+03	-5.35E+02
3.15E+05	1.23E+04	-1.67E+03	6.60E+03	-4.26E+02
2.51E+05	1.24E+04	-1.35E+03	6.61E+03	-3.43E+02
1.99E+05	1.25E+04	-1.09E+03	6.62E+03	-2.79E+02
1.58E+05	1.25E+04	-8.74E+02	6.63E+03	-2.21E+02
1.26E+05	1.26E+04	-6.93E+02	6.63E+03	-1.74E+02
9.98E+04	1.26E+04	-5.47E+02	6.64E+03	-1.33E+02
7.92E+04	1.26E+04	-4.31E+02	6.64E+03	-1.03E+02
6.29E+04	1.26E+04	-3.54E+02	6.64E+03	-8.60E+01
5.00E+04	1.26E+04	-2.73E+02	6.65E+03	-6.34E+01
3.97E+04	1.26E+04	-2.04E+02	6.65E+03	-4.34E+01
3.15E+04	1.26E+04	-1.52E+02	6.65E+03	-2.95E+01
2.51E+04	1.26E+04	-9.70E+01	6.65E+03	-1.09E+01
1.99E+04	1.26E+04	-4.96E+01	6.64E+03	5.08E+00
1.58E+04	1.26E+04	-1.05E+01	6.64E+03	2.03E+01
1.26E+04	1.26E+04	2.87E+01	6.63E+03	3.63E+01
9.98E+03	1.26E+04	6.42E+01	6.62E+03	5.07E+01
7.92E+03	1.26E+04	1.02E+02	6.61E+03	6.42E+01
6.29E+03	1.25E+04	1.30E+02	6.59E+03	7.35E+01
5.00E+03	1.25E+04	1.46E+02	6.57E+03	8.24E+01
3.97E+03	1.25E+04	1.59E+02	6.55E+03	8.35E+01
3.15E+03	1.24E+04	1.52E+02	6.52E+03	7.89E+01
2.51E+03	1.24E+04	1.51E+02	6.50E+03	7.15E+01
1.99E+03	1.23E+04	1.25E+02	6.48E+03	5.28E+01
1.58E+03	1.23E+04	9.41E+01	6.47E+03	3.44E+01
1.26E+03	1.23E+04	6.72E+01	6.46E+03	1.62E+01
9.98E+02	1.23E+04	3.99E+01	6.46E+03	-5.54E+00
7.92E+02	1.23E+04	5.15E+00	6.46E+03	-2.51E+01
6.29E+02	1.23E+04	-1.81E+01	6.45E+03	-4.64E+01
5.00E+02	1.23E+04	-6.29E+01	6.46E+03	-7.31E+01
3.97E+02	1.23E+04	-9.44E+01	6.46E+03	-1.01E+02
3.15E+02	1.23E+04	-1.32E+02	6.46E+03	-1.34E+02
2.51E+02	1.23E+04	-1.92E+02	6.47E+03	-1.74E+02

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.23E+04	-2.41E+02	6.48E+03	-2.17E+02
1.58E+02	1.23E+04	-2.93E+02	6.49E+03	-2.69E+02
1.26E+02	1.23E+04	-3.58E+02	6.50E+03	-3.34E+02
9.98E+01	1.23E+04	-4.31E+02	6.51E+03	-4.10E+02
7.92E+01	1.24E+04	-5.44E+02	6.53E+03	-5.06E+02
6.29E+01	1.24E+04	-6.77E+02	6.56E+03	-6.22E+02
5.00E+01	1.24E+04	-8.24E+02	6.58E+03	-7.65E+02
3.97E+01	1.25E+04	-1.01E+03	6.63E+03	-9.33E+02
3.15E+01	1.25E+04	-1.23E+03	6.68E+03	-1.14E+03
2.51E+01	1.26E+04	-1.50E+03	6.76E+03	-1.39E+03
1.99E+01	1.27E+04	-1.82E+03	6.85E+03	-1.70E+03
1.58E+01	1.29E+04	-2.22E+03	6.97E+03	-2.07E+03
1.26E+01	1.30E+04	-2.68E+03	7.12E+03	-2.50E+03
9.98E+00	1.33E+04	-3.22E+03	7.32E+03	-3.02E+03
7.92E+00	1.36E+04	-3.86E+03	7.58E+03	-3.62E+03
6.29E+00	1.40E+04	-4.57E+03	7.89E+03	-4.32E+03
5.00E+00	1.44E+04	-5.38E+03	8.31E+03	-5.14E+03
3.97E+00	1.49E+04	-6.31E+03	8.77E+03	-6.08E+03
3.15E+00	1.55E+04	-7.39E+03	9.32E+03	-7.18E+03
2.51E+00	1.62E+04	-8.61E+03	9.96E+03	-8.46E+03
1.99E+00	1.70E+04	-1.01E+04	1.07E+04	-9.97E+03
1.58E+00	1.79E+04	-1.18E+04	1.17E+04	-1.18E+04
1.26E+00	1.90E+04	-1.38E+04	1.28E+04	-1.40E+04
9.98E-01	2.02E+04	-1.62E+04	1.42E+04	-1.64E+04
7.92E-01	2.17E+04	-1.90E+04	1.60E+04	-1.94E+04
6.29E-01	2.34E+04	-2.24E+04	1.83E+04	-2.29E+04
5.00E-01	2.56E+04	-2.63E+04	2.12E+04	-2.67E+04
3.97E-01	2.80E+04	-3.09E+04	2.49E+04	-3.12E+04
3.15E-01	3.12E+04	-3.62E+04	2.96E+04	-3.58E+04
2.51E-01	3.49E+04	-4.24E+04	3.55E+04	-4.06E+04
1.99E-01	3.93E+04	-4.95E+04	4.24E+04	-4.55E+04
1.58E-01	4.44E+04	-5.75E+04	5.08E+04	-4.99E+04
1.26E-01	5.07E+04	-6.69E+04	6.02E+04	-5.38E+04
1.00E-01	5.77E+04	-7.76E+04	7.07E+04	-5.69E+04

f / Hz	11		10	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	3.11E+03	-2.40E+03	2.82E+03	-1.67E+03
3.97E+06	3.52E+03	-2.16E+03	3.04E+03	-1.43E+03
3.15E+06	3.86E+03	-1.89E+03	3.22E+03	-1.21E+03
2.51E+06	4.10E+03	-1.61E+03	3.35E+03	-1.00E+03
1.99E+06	4.30E+03	-1.32E+03	3.44E+03	-8.01E+02
1.58E+06	4.44E+03	-1.08E+03	3.50E+03	-6.42E+02
1.26E+06	4.52E+03	-8.71E+02	3.53E+03	-5.12E+02
9.98E+05	4.58E+03	-5.78E+02	3.55E+03	-3.12E+02
7.92E+05	4.61E+03	-4.70E+02	3.56E+03	-2.53E+02
6.29E+05	4.63E+03	-3.77E+02	3.57E+03	-2.02E+02
5.00E+05	4.65E+03	-3.03E+02	3.58E+03	-1.63E+02
3.97E+05	4.66E+03	-2.42E+02	3.58E+03	-1.30E+02
3.15E+05	4.66E+03	-1.91E+02	3.58E+03	-1.02E+02
2.51E+05	4.67E+03	-1.54E+02	3.58E+03	-8.21E+01
1.99E+05	4.67E+03	-1.26E+02	3.58E+03	-6.71E+01
1.58E+05	4.67E+03	-9.86E+01	3.58E+03	-5.25E+01
1.26E+05	4.68E+03	-7.60E+01	3.59E+03	-4.05E+01
9.98E+04	4.68E+03	-5.80E+01	3.59E+03	-3.01E+01
7.92E+04	4.68E+03	-4.43E+01	3.59E+03	-2.29E+01
6.29E+04	4.68E+03	-3.77E+01	3.59E+03	-1.97E+01
5.00E+04	4.68E+03	-2.62E+01	3.59E+03	-1.29E+01
3.97E+04	4.68E+03	-1.61E+01	3.59E+03	-6.64E+00
3.15E+04	4.68E+03	-9.20E+00	3.59E+03	-2.85E+00
2.51E+04	4.68E+03	7.71E-01	3.59E+03	3.96E+00
1.99E+04	4.68E+03	1.03E+01	3.59E+03	1.00E+01
1.58E+04	4.67E+03	1.90E+01	3.58E+03	1.60E+01
1.26E+04	4.67E+03	2.82E+01	3.58E+03	2.13E+01
9.98E+03	4.66E+03	3.63E+01	3.58E+03	2.66E+01
7.92E+03	4.65E+03	4.44E+01	3.57E+03	3.15E+01
6.29E+03	4.64E+03	4.95E+01	3.56E+03	3.50E+01
5.00E+03	4.62E+03	5.32E+01	3.55E+03	3.64E+01
3.97E+03	4.61E+03	5.23E+01	3.54E+03	3.56E+01
3.15E+03	4.59E+03	4.72E+01	3.53E+03	2.89E+01
2.51E+03	4.58E+03	3.80E+01	3.51E+03	2.21E+01
1.99E+03	4.57E+03	2.53E+01	3.51E+03	1.27E+01
1.58E+03	4.56E+03	1.18E+01	3.50E+03	-1.54E-01
1.26E+03	4.55E+03	-3.78E+00	3.50E+03	-1.45E+01
9.98E+02	4.55E+03	-2.30E+01	3.50E+03	-2.89E+01
7.92E+02	4.55E+03	-4.29E+01	3.50E+03	-4.58E+01
6.29E+02	4.55E+03	-6.53E+01	3.50E+03	-6.57E+01
5.00E+02	4.55E+03	-8.57E+01	3.50E+03	-8.88E+01
3.97E+02	4.56E+03	-1.14E+02	3.50E+03	-1.14E+02
3.15E+02	4.56E+03	-1.42E+02	3.51E+03	-1.45E+02
2.51E+02	4.57E+03	-1.80E+02	3.52E+03	-1.83E+02

f / Hz	11		10	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	4.58E+03	-2.24E+02	3.53E+03	-2.26E+02
1.58E+02	4.59E+03	-2.78E+02	3.54E+03	-2.77E+02
1.26E+02	4.60E+03	-3.46E+02	3.55E+03	-3.40E+02
9.98E+01	4.62E+03	-4.23E+02	3.57E+03	-4.16E+02
7.92E+01	4.64E+03	-5.22E+02	3.59E+03	-5.12E+02
6.29E+01	4.66E+03	-6.40E+02	3.62E+03	-6.27E+02
5.00E+01	4.70E+03	-7.78E+02	3.65E+03	-7.66E+02
3.97E+01	4.74E+03	-9.59E+02	3.70E+03	-9.36E+02
3.15E+01	4.80E+03	-1.17E+03	3.76E+03	-1.14E+03
2.51E+01	4.88E+03	-1.42E+03	3.84E+03	-1.38E+03
1.99E+01	4.98E+03	-1.73E+03	3.94E+03	-1.68E+03
1.58E+01	5.11E+03	-2.09E+03	4.07E+03	-2.02E+03
1.26E+01	5.28E+03	-2.52E+03	4.24E+03	-2.42E+03
9.98E+00	5.48E+03	-3.02E+03	4.43E+03	-2.89E+03
7.92E+00	5.74E+03	-3.60E+03	4.68E+03	-3.44E+03
6.29E+00	6.04E+03	-4.28E+03	4.95E+03	-4.08E+03
5.00E+00	6.38E+03	-5.08E+03	5.27E+03	-4.84E+03
3.97E+00	6.82E+03	-6.02E+03	5.65E+03	-5.74E+03
3.15E+00	7.28E+03	-7.13E+03	6.09E+03	-6.81E+03
2.51E+00	7.83E+03	-8.45E+03	6.58E+03	-8.09E+03
1.99E+00	8.49E+03	-1.00E+04	7.18E+03	-9.67E+03
1.58E+00	9.25E+03	-1.20E+04	7.90E+03	-1.15E+04
1.26E+00	1.02E+04	-1.43E+04	8.79E+03	-1.38E+04
9.98E-01	1.14E+04	-1.71E+04	9.88E+03	-1.66E+04
7.92E-01	1.29E+04	-2.04E+04	1.13E+04	-1.99E+04
6.29E-01	1.49E+04	-2.44E+04	1.31E+04	-2.37E+04
5.00E-01	1.73E+04	-2.90E+04	1.54E+04	-2.84E+04
3.97E-01	2.06E+04	-3.44E+04	1.85E+04	-3.37E+04
3.15E-01	2.49E+04	-4.06E+04	2.24E+04	-3.99E+04
2.51E-01	3.04E+04	-4.75E+04	2.76E+04	-4.70E+04
1.99E-01	3.73E+04	-5.50E+04	3.42E+04	-5.46E+04
1.58E-01	4.62E+04	-6.26E+04	4.26E+04	-6.26E+04
1.26E-01	5.68E+04	-7.05E+04	5.30E+04	-7.08E+04
1.00E-01	6.91E+04	-7.80E+04	6.51E+04	-7.83E+04

f / Hz	09		08	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.57E+03	-1.29E+03	2.34E+03	-9.77E+02
3.97E+06	2.72E+03	-1.09E+03	2.43E+03	-8.11E+02
3.15E+06	2.83E+03	-9.00E+02	2.50E+03	-6.60E+02
2.51E+06	2.91E+03	-7.31E+02	2.54E+03	-5.30E+02
1.99E+06	2.96E+03	-5.77E+02	2.57E+03	-4.11E+02
1.58E+06	2.99E+03	-4.58E+02	2.58E+03	-3.21E+02
1.26E+06	3.01E+03	-3.59E+02	2.59E+03	-2.48E+02
9.98E+05	3.01E+03	-2.06E+02	2.59E+03	-1.27E+02
7.92E+05	3.02E+03	-1.67E+02	2.59E+03	-1.02E+02
6.29E+05	3.02E+03	-1.33E+02	2.59E+03	-8.11E+01
5.00E+05	3.03E+03	-1.07E+02	2.59E+03	-6.50E+01
3.97E+05	3.03E+03	-8.50E+01	2.59E+03	-5.12E+01
3.15E+05	3.03E+03	-6.65E+01	2.59E+03	-3.97E+01
2.51E+05	3.03E+03	-5.34E+01	2.59E+03	-3.23E+01
1.99E+05	3.03E+03	-4.39E+01	2.59E+03	-2.71E+01
1.58E+05	3.03E+03	-3.45E+01	2.59E+03	-2.10E+01
1.26E+05	3.03E+03	-2.59E+01	2.59E+03	-1.55E+01
9.98E+04	3.03E+03	-1.92E+01	2.59E+03	-1.06E+01
7.92E+04	3.04E+03	-1.41E+01	2.59E+03	-7.10E+00
6.29E+04	3.03E+03	-1.26E+01	2.59E+03	-7.11E+00
5.00E+04	3.03E+03	-7.60E+00	2.59E+03	-3.71E+00
3.97E+04	3.03E+03	-3.18E+00	2.59E+03	-3.30E-01
3.15E+04	3.03E+03	-5.30E-01	2.59E+03	1.46E+00
2.51E+04	3.03E+03	4.29E+00	2.59E+03	5.59E+00
1.99E+04	3.03E+03	9.14E+00	2.59E+03	9.27E+00
1.58E+04	3.03E+03	1.33E+01	2.59E+03	1.32E+01
1.26E+04	3.02E+03	1.80E+01	2.58E+03	1.70E+01
9.98E+03	3.02E+03	2.18E+01	2.58E+03	2.07E+01
7.92E+03	3.01E+03	2.63E+01	2.58E+03	2.48E+01
6.29E+03	3.01E+03	2.80E+01	2.57E+03	2.67E+01
5.00E+03	3.00E+03	3.00E+01	2.56E+03	2.88E+01
3.97E+03	2.99E+03	2.77E+01	2.55E+03	2.88E+01
3.15E+03	2.98E+03	2.20E+01	2.55E+03	2.52E+01
2.51E+03	2.97E+03	1.43E+01	2.54E+03	1.95E+01
1.99E+03	2.96E+03	4.52E+00	2.53E+03	1.41E+01
1.58E+03	2.96E+03	-5.89E+00	2.53E+03	7.58E+00
1.26E+03	2.96E+03	-1.98E+01	2.53E+03	-5.62E-01
9.98E+02	2.96E+03	-3.38E+01	2.53E+03	-9.31E+00
7.92E+02	2.96E+03	-5.03E+01	2.53E+03	-1.89E+01
6.29E+02	2.96E+03	-6.93E+01	2.53E+03	-2.67E+01
5.00E+02	2.96E+03	-8.90E+01	2.53E+03	-3.83E+01
3.97E+02	2.96E+03	-1.14E+02	2.53E+03	-5.04E+01
3.15E+02	2.97E+03	-1.43E+02	2.54E+03	-6.23E+01
2.51E+02	2.98E+03	-1.77E+02	2.54E+03	-7.83E+01

f / Hz	09		08	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	2.99E+03	-2.20E+02	2.54E+03	-9.66E+01
1.58E+02	3.00E+03	-2.73E+02	2.55E+03	-1.18E+02
1.26E+02	3.01E+03	-3.37E+02	2.56E+03	-1.44E+02
9.98E+01	3.03E+03	-4.13E+02	2.57E+03	-1.75E+02
7.92E+01	3.05E+03	-5.08E+02	2.58E+03	-2.10E+02
6.29E+01	3.07E+03	-6.22E+02	2.59E+03	-2.55E+02
5.00E+01	3.11E+03	-7.58E+02	2.61E+03	-3.06E+02
3.97E+01	3.16E+03	-9.29E+02	2.64E+03	-3.68E+02
3.15E+01	3.22E+03	-1.13E+03	2.66E+03	-4.40E+02
2.51E+01	3.30E+03	-1.37E+03	2.70E+03	-5.28E+02
1.99E+01	3.40E+03	-1.66E+03	2.74E+03	-6.31E+02
1.58E+01	3.52E+03	-2.00E+03	2.79E+03	-7.52E+02
1.26E+01	3.68E+03	-2.41E+03	2.85E+03	-8.99E+02
9.98E+00	3.88E+03	-2.88E+03	2.92E+03	-1.07E+03
7.92E+00	4.13E+03	-3.44E+03	3.01E+03	-1.27E+03
6.29E+00	4.42E+03	-4.08E+03	3.11E+03	-1.50E+03
5.00E+00	4.76E+03	-4.84E+03	3.23E+03	-1.78E+03
3.97E+00	5.17E+03	-5.73E+03	3.37E+03	-2.11E+03
3.15E+00	5.64E+03	-6.77E+03	3.54E+03	-2.51E+03
2.51E+00	6.19E+03	-8.00E+03	3.72E+03	-2.98E+03
1.99E+00	6.82E+03	-9.48E+03	3.95E+03	-3.55E+03
1.58E+00	7.57E+03	-1.13E+04	4.23E+03	-4.24E+03
1.26E+00	8.48E+03	-1.34E+04	4.57E+03	-5.07E+03
9.98E-01	9.58E+03	-1.59E+04	4.99E+03	-6.06E+03
7.92E-01	1.10E+04	-1.91E+04	5.55E+03	-7.25E+03
6.29E-01	1.27E+04	-2.26E+04	6.28E+03	-8.65E+03
5.00E-01	1.49E+04	-2.70E+04	7.20E+03	-1.03E+04
3.97E-01	1.78E+04	-3.21E+04	8.41E+03	-1.21E+04
3.15E-01	2.15E+04	-3.79E+04	9.98E+03	-1.42E+04
2.51E-01	2.64E+04	-4.46E+04	1.19E+04	-1.65E+04
1.99E-01	3.27E+04	-5.19E+04	1.44E+04	-1.89E+04
1.58E-01	4.06E+04	-5.97E+04	1.73E+04	-2.13E+04
1.26E-01	5.04E+04	-6.73E+04	2.06E+04	-2.38E+04
1.00E-01	6.23E+04	-7.48E+04	2.45E+04	-2.63E+04

	07		06	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.18E+03	-8.29E+02	2.03E+03	-6.99E+02
3.97E+06	2.25E+03	-6.82E+02	2.08E+03	-5.72E+02
3.15E+06	2.30E+03	-5.55E+02	2.11E+03	-4.60E+02
2.51E+06	2.33E+03	-4.44E+02	2.13E+03	-3.66E+02
1.99E+06	2.35E+03	-3.43E+02	2.15E+03	-2.82E+02
1.58E+06	2.36E+03	-2.66E+02	2.16E+03	-2.18E+02
1.26E+06	2.37E+03	-2.06E+02	2.16E+03	-1.67E+02
9.98E+05	2.36E+03	-9.95E+01	2.15E+03	-7.38E+01
7.92E+05	2.36E+03	-8.05E+01	2.15E+03	-5.97E+01
6.29E+05	2.36E+03	-6.41E+01	2.15E+03	-4.74E+01
5.00E+05	2.36E+03	-5.16E+01	2.15E+03	-3.83E+01
3.97E+05	2.36E+03	-4.07E+01	2.15E+03	-2.97E+01
3.15E+05	2.36E+03	-3.15E+01	2.15E+03	-2.30E+01
2.51E+05	2.36E+03	-2.60E+01	2.15E+03	-1.93E+01
1.99E+05	2.36E+03	-2.21E+01	2.15E+03	-1.65E+01
1.58E+05	2.36E+03	-1.69E+01	2.15E+03	-1.26E+01
1.26E+05	2.36E+03	-1.24E+01	2.15E+03	-9.06E+00
9.98E+04	2.36E+03	-7.97E+00	2.15E+03	-5.63E+00
7.92E+04	2.36E+03	-4.26E+00	2.15E+03	-2.54E+00
6.29E+04	2.37E+03	-5.67E+00	2.15E+03	-4.02E+00
5.00E+04	2.37E+03	-2.77E+00	2.15E+03	-1.71E+00
3.97E+04	2.37E+03	3.21E-01	2.15E+03	9.18E-01
3.15E+04	2.37E+03	1.68E+00	2.15E+03	1.96E+00
2.51E+04	2.37E+03	5.16E+00	2.15E+03	5.15E+00
1.99E+04	2.37E+03	8.16E+00	2.15E+03	8.33E+00
1.58E+04	2.36E+03	1.16E+01	2.15E+03	1.08E+01
1.26E+04	2.36E+03	1.56E+01	2.15E+03	1.34E+01
9.98E+03	2.36E+03	1.88E+01	2.15E+03	1.63E+01
7.92E+03	2.35E+03	2.24E+01	2.14E+03	1.96E+01
6.29E+03	2.35E+03	2.44E+01	2.14E+03	2.14E+01
5.00E+03	2.34E+03	2.58E+01	2.13E+03	2.24E+01
3.97E+03	2.33E+03	2.57E+01	2.13E+03	2.18E+01
3.15E+03	2.33E+03	2.23E+01	2.12E+03	1.96E+01
2.51E+03	2.32E+03	1.73E+01	2.11E+03	1.45E+01
1.99E+03	2.32E+03	1.39E+01	2.11E+03	1.06E+01
1.58E+03	2.31E+03	6.28E+00	2.11E+03	4.32E+00
1.26E+03	2.31E+03	-1.10E+00	2.11E+03	-2.50E+00
9.98E+02	2.31E+03	-7.90E+00	2.10E+03	-9.75E+00
7.92E+02	2.31E+03	-1.65E+01	2.10E+03	-1.70E+01
6.29E+02	2.31E+03	-2.59E+01	2.10E+03	-2.54E+01
5.00E+02	2.31E+03	-3.40E+01	2.11E+03	-3.47E+01
3.97E+02	2.31E+03	-4.41E+01	2.11E+03	-4.44E+01
3.15E+02	2.32E+03	-5.58E+01	2.11E+03	-5.58E+01
2.51E+02	2.32E+03	-7.46E+01	2.11E+03	-7.21E+01

f / Hz	07		06	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	2.32E+03	-9.08E+01	2.12E+03	-8.79E+01
1.58E+02	2.33E+03	-1.08E+02	2.12E+03	-1.07E+02
1.26E+02	2.34E+03	-1.31E+02	2.13E+03	-1.28E+02
9.98E+01	2.34E+03	-1.57E+02	2.14E+03	-1.56E+02
7.92E+01	2.36E+03	-1.90E+02	2.15E+03	-1.88E+02
6.29E+01	2.37E+03	-2.29E+02	2.16E+03	-2.29E+02
5.00E+01	2.38E+03	-2.80E+02	2.18E+03	-2.79E+02
3.97E+01	2.40E+03	-3.32E+02	2.20E+03	-3.31E+02
3.15E+01	2.43E+03	-3.99E+02	2.22E+03	-3.98E+02
2.51E+01	2.46E+03	-4.78E+02	2.25E+03	-4.79E+02
1.99E+01	2.50E+03	-5.73E+02	2.29E+03	-5.74E+02
1.58E+01	2.54E+03	-6.87E+02	2.33E+03	-6.88E+02
1.26E+01	2.60E+03	-8.19E+02	2.38E+03	-8.24E+02
9.98E+00	2.66E+03	-9.77E+02	2.44E+03	-9.85E+02
7.92E+00	2.74E+03	-1.16E+03	2.52E+03	-1.17E+03
6.29E+00	2.83E+03	-1.38E+03	2.61E+03	-1.40E+03
5.00E+00	2.94E+03	-1.64E+03	2.71E+03	-1.67E+03
3.97E+00	3.07E+03	-1.95E+03	2.83E+03	-1.99E+03
3.15E+00	3.20E+03	-2.32E+03	2.98E+03	-2.38E+03
2.51E+00	3.39E+03	-2.77E+03	3.14E+03	-2.84E+03
1.99E+00	3.57E+03	-3.31E+03	3.34E+03	-3.42E+03
1.58E+00	3.84E+03	-3.97E+03	3.60E+03	-4.10E+03
1.26E+00	4.14E+03	-4.75E+03	3.89E+03	-4.94E+03
9.98E-01	4.55E+03	-5.71E+03	4.31E+03	-5.92E+03
7.92E-01	5.07E+03	-6.85E+03	4.82E+03	-7.12E+03
6.29E-01	5.76E+03	-8.21E+03	5.54E+03	-8.57E+03
5.00E-01	6.63E+03	-9.74E+03	6.43E+03	-1.02E+04
3.97E-01	7.81E+03	-1.16E+04	7.62E+03	-1.22E+04
3.15E-01	9.29E+03	-1.36E+04	9.17E+03	-1.43E+04
2.51E-01	1.13E+04	-1.58E+04	1.12E+04	-1.67E+04
1.99E-01	1.37E+04	-1.82E+04	1.37E+04	-1.92E+04
1.58E-01	1.65E+04	-2.06E+04	1.67E+04	-2.17E+04
1.26E-01	1.99E+04	-2.29E+04	2.03E+04	-2.43E+04
1.00E-01	2.39E+04	-2.51E+04	2.45E+04	-2.67E+04

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.90E+03	-5.97E+02	1.81E+03	-5.28E+02
3.97E+06	1.93E+03	-4.86E+02	1.83E+03	-4.28E+02
3.15E+06	1.96E+03	-3.88E+02	1.85E+03	-3.42E+02
2.51E+06	1.97E+03	-3.07E+02	1.86E+03	-2.70E+02
1.99E+06	1.98E+03	-2.36E+02	1.87E+03	-2.06E+02
1.58E+06	1.99E+03	-1.81E+02	1.87E+03	-1.57E+02
1.26E+06	1.98E+03	-1.38E+02	1.87E+03	-1.19E+02
9.98E+05	1.98E+03	-5.62E+01	1.86E+03	-4.38E+01
7.92E+05	1.98E+03	-4.59E+01	1.86E+03	-3.56E+01
6.29E+05	1.98E+03	-3.65E+01	1.86E+03	-2.78E+01
5.00E+05	1.98E+03	-2.94E+01	1.86E+03	-2.22E+01
3.97E+05	1.98E+03	-2.31E+01	1.86E+03	-1.71E+01
3.15E+05	1.98E+03	-1.81E+01	1.86E+03	-1.32E+01
2.51E+05	1.98E+03	-1.54E+01	1.86E+03	-1.13E+01
1.99E+05	1.98E+03	-1.32E+01	1.86E+03	-9.94E+00
1.58E+05	1.98E+03	-1.02E+01	1.86E+03	-7.40E+00
1.26E+05	1.98E+03	-6.97E+00	1.86E+03	-5.01E+00
9.98E+04	1.98E+03	-4.30E+00	1.86E+03	-2.58E+00
7.92E+04	1.98E+03	-1.41E+00	1.86E+03	-4.99E-01
6.29E+04	1.98E+03	-2.87E+00	1.86E+03	-2.02E+00
5.00E+04	1.98E+03	-6.98E-01	1.86E+03	-3.05E-01
3.97E+04	1.98E+03	1.63E+00	1.86E+03	1.66E+00
3.15E+04	1.98E+03	2.50E+00	1.86E+03	2.26E+00
2.51E+04	1.98E+03	5.22E+00	1.86E+03	4.76E+00
1.99E+04	1.98E+03	7.81E+00	1.86E+03	6.82E+00
1.58E+04	1.98E+03	1.02E+01	1.86E+03	9.05E+00
1.26E+04	1.97E+03	1.27E+01	1.85E+03	1.14E+01
9.98E+03	1.97E+03	1.46E+01	1.85E+03	1.33E+01
7.92E+03	1.97E+03	1.68E+01	1.85E+03	1.55E+01
6.29E+03	1.96E+03	1.82E+01	1.84E+03	1.70E+01
5.00E+03	1.96E+03	1.87E+01	1.84E+03	1.73E+01
3.97E+03	1.95E+03	1.81E+01	1.83E+03	1.65E+01
3.15E+03	1.95E+03	1.57E+01	1.83E+03	1.39E+01
2.51E+03	1.95E+03	1.18E+01	1.82E+03	1.00E+01
1.99E+03	1.94E+03	7.21E+00	1.82E+03	6.46E+00
1.58E+03	1.94E+03	1.45E+00	1.82E+03	-2.26E-01
1.26E+03	1.94E+03	-5.02E+00	1.82E+03	-6.78E+00
9.98E+02	1.94E+03	-1.16E+01	1.82E+03	-1.25E+01
7.92E+02	1.94E+03	-1.79E+01	1.82E+03	-1.94E+01
6.29E+02	1.94E+03	-2.47E+01	1.82E+03	-2.78E+01
5.00E+02	1.94E+03	-3.48E+01	1.82E+03	-3.53E+01
3.97E+02	1.94E+03	-4.58E+01	1.82E+03	-4.58E+01
3.15E+02	1.94E+03	-5.51E+01	1.83E+03	-5.70E+01
2.51E+02	1.95E+03	-7.29E+01	1.83E+03	-7.07E+01

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.95E+03	-8.74E+01	1.83E+03	-8.74E+01
1.58E+02	1.96E+03	-1.05E+02	1.84E+03	-1.05E+02
1.26E+02	1.96E+03	-1.28E+02	1.85E+03	-1.27E+02
9.98E+01	1.97E+03	-1.54E+02	1.85E+03	-1.53E+02
7.92E+01	1.98E+03	-1.87E+02	1.86E+03	-1.85E+02
6.29E+01	1.99E+03	-2.25E+02	1.88E+03	-2.24E+02
5.00E+01	2.01E+03	-2.69E+02	1.89E+03	-2.72E+02
3.97E+01	2.03E+03	-3.26E+02	1.91E+03	-3.25E+02
3.15E+01	2.05E+03	-3.93E+02	1.93E+03	-3.90E+02
2.51E+01	2.08E+03	-4.73E+02	1.96E+03	-4.68E+02
1.99E+01	2.12E+03	-5.67E+02	2.00E+03	-5.64E+02
1.58E+01	2.16E+03	-6.80E+02	2.04E+03	-6.74E+02
1.26E+01	2.21E+03	-8.14E+02	2.09E+03	-8.07E+02
9.98E+00	2.27E+03	-9.74E+02	2.15E+03	-9.66E+02
7.92E+00	2.34E+03	-1.16E+03	2.22E+03	-1.15E+03
6.29E+00	2.43E+03	-1.39E+03	2.31E+03	-1.38E+03
5.00E+00	2.53E+03	-1.66E+03	2.40E+03	-1.65E+03
3.97E+00	2.65E+03	-1.98E+03	2.52E+03	-1.97E+03
3.15E+00	2.79E+03	-2.37E+03	2.64E+03	-2.36E+03
2.51E+00	2.96E+03	-2.84E+03	2.81E+03	-2.83E+03
1.99E+00	3.14E+03	-3.42E+03	3.00E+03	-3.41E+03
1.58E+00	3.40E+03	-4.11E+03	3.25E+03	-4.11E+03
1.26E+00	3.69E+03	-4.93E+03	3.56E+03	-4.96E+03
9.98E-01	4.11E+03	-5.94E+03	3.95E+03	-6.00E+03
7.92E-01	4.62E+03	-7.16E+03	4.48E+03	-7.22E+03
6.29E-01	5.32E+03	-8.61E+03	5.21E+03	-8.67E+03
5.00E-01	6.21E+03	-1.03E+04	6.10E+03	-1.03E+04
3.97E-01	7.40E+03	-1.23E+04	7.31E+03	-1.23E+04
3.15E-01	8.95E+03	-1.44E+04	8.86E+03	-1.45E+04
2.51E-01	1.10E+04	-1.68E+04	1.09E+04	-1.69E+04
1.99E-01	1.35E+04	-1.95E+04	1.35E+04	-1.95E+04
1.58E-01	1.65E+04	-2.21E+04	1.65E+04	-2.21E+04
1.26E-01	2.02E+04	-2.47E+04	2.02E+04	-2.46E+04
1.00E-01	2.45E+04	-2.72E+04	2.44E+04	-2.70E+04

f / Hz	03		02	
	Z´ / Ω	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	1.74E+03	-4.89E+02	1.68E+03	-4.44E+02
3.97E+06	1.76E+03	-3.95E+02	1.69E+03	-3.58E+02
3.15E+06	1.78E+03	-3.14E+02	1.71E+03	-2.84E+02
2.51E+06	1.79E+03	-2.47E+02	1.71E+03	-2.23E+02
1.99E+06	1.79E+03	-1.88E+02	1.71E+03	-1.69E+02
1.58E+06	1.79E+03	-1.42E+02	1.72E+03	-1.28E+02
1.26E+06	1.79E+03	-1.08E+02	1.71E+03	-9.73E+01
9.98E+05	1.78E+03	-3.71E+01	1.71E+03	-3.02E+01
7.92E+05	1.78E+03	-3.04E+01	1.70E+03	-2.47E+01
6.29E+05	1.78E+03	-2.37E+01	1.70E+03	-1.94E+01
5.00E+05	1.78E+03	-1.89E+01	1.70E+03	-1.54E+01
3.97E+05	1.78E+03	-1.46E+01	1.70E+03	-1.18E+01
3.15E+05	1.78E+03	-1.13E+01	1.70E+03	-9.05E+00
2.51E+05	1.78E+03	-9.68E+00	1.70E+03	-7.81E+00
1.99E+05	1.78E+03	-8.73E+00	1.70E+03	-7.36E+00
1.58E+05	1.78E+03	-6.46E+00	1.70E+03	-5.21E+00
1.26E+05	1.78E+03	-4.27E+00	1.70E+03	-3.42E+00
9.98E+04	1.78E+03	-2.03E+00	1.70E+03	-1.27E+00
7.92E+04	1.78E+03	-1.84E-01	1.70E+03	3.50E-01
6.29E+04	1.78E+03	-1.95E+00	1.70E+03	-1.43E+00
5.00E+04	1.78E+03	-3.22E-01	1.70E+03	-1.54E-03
3.97E+04	1.78E+03	1.31E+00	1.70E+03	1.44E+00
3.15E+04	1.78E+03	1.78E+00	1.70E+03	1.87E+00
2.51E+04	1.78E+03	4.00E+00	1.70E+03	4.13E+00
1.99E+04	1.78E+03	6.08E+00	1.70E+03	5.96E+00
1.58E+04	1.78E+03	7.78E+00	1.70E+03	7.52E+00
1.26E+04	1.78E+03	9.98E+00	1.70E+03	9.16E+00
9.98E+03	1.78E+03	1.20E+01	1.70E+03	1.11E+01
7.92E+03	1.78E+03	1.41E+01	1.69E+03	1.30E+01
6.29E+03	1.77E+03	1.62E+01	1.69E+03	1.42E+01
5.00E+03	1.77E+03	1.65E+01	1.69E+03	1.46E+01
3.97E+03	1.76E+03	1.61E+01	1.68E+03	1.39E+01
3.15E+03	1.76E+03	1.42E+01	1.68E+03	1.21E+01
2.51E+03	1.75E+03	1.06E+01	1.67E+03	9.59E+00
1.99E+03	1.75E+03	6.21E+00	1.67E+03	4.39E+00
1.58E+03	1.75E+03	5.64E-01	1.67E+03	-6.56E-01
1.26E+03	1.75E+03	-4.64E+00	1.67E+03	-6.77E+00
9.98E+02	1.74E+03	-1.18E+01	1.67E+03	-1.27E+01
7.92E+02	1.75E+03	-1.76E+01	1.67E+03	-1.95E+01
6.29E+02	1.75E+03	-2.77E+01	1.67E+03	-2.79E+01
5.00E+02	1.75E+03	-3.53E+01	1.67E+03	-3.65E+01
3.97E+02	1.75E+03	-4.46E+01	1.67E+03	-4.54E+01
3.15E+02	1.76E+03	-5.65E+01	1.68E+03	-5.70E+01
2.51E+02	1.76E+03	-7.16E+01	1.68E+03	-7.17E+01

f / Hz	03		02	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.76E+03	-8.58E+01	1.68E+03	-8.63E+01
1.58E+02	1.77E+03	-1.04E+02	1.69E+03	-1.04E+02
1.26E+02	1.78E+03	-1.24E+02	1.69E+03	-1.26E+02
9.98E+01	1.78E+03	-1.52E+02	1.70E+03	-1.52E+02
7.92E+01	1.79E+03	-1.83E+02	1.71E+03	-1.85E+02
6.29E+01	1.80E+03	-2.22E+02	1.73E+03	-2.23E+02
5.00E+01	1.82E+03	-2.69E+02	1.74E+03	-2.72E+02
3.97E+01	1.84E+03	-3.21E+02	1.76E+03	-3.26E+02
3.15E+01	1.86E+03	-3.85E+02	1.78E+03	-3.93E+02
2.51E+01	1.89E+03	-4.63E+02	1.81E+03	-4.71E+02
1.99E+01	1.92E+03	-5.56E+02	1.84E+03	-5.68E+02
1.58E+01	1.96E+03	-6.66E+02	1.88E+03	-6.82E+02
1.26E+01	2.01E+03	-7.98E+02	1.93E+03	-8.16E+02
9.98E+00	2.07E+03	-9.54E+02	1.99E+03	-9.78E+02
7.92E+00	2.14E+03	-1.14E+03	2.06E+03	-1.17E+03
6.29E+00	2.23E+03	-1.36E+03	2.15E+03	-1.40E+03
5.00E+00	2.32E+03	-1.63E+03	2.25E+03	-1.67E+03
3.97E+00	2.43E+03	-1.95E+03	2.37E+03	-2.00E+03
3.15E+00	2.56E+03	-2.34E+03	2.50E+03	-2.39E+03
2.51E+00	2.73E+03	-2.80E+03	2.67E+03	-2.87E+03
1.99E+00	2.91E+03	-3.38E+03	2.86E+03	-3.45E+03
1.58E+00	3.15E+03	-4.07E+03	3.11E+03	-4.16E+03
1.26E+00	3.45E+03	-4.93E+03	3.41E+03	-5.03E+03
9.98E-01	3.83E+03	-5.91E+03	3.80E+03	-6.04E+03
7.92E-01	4.35E+03	-7.13E+03	4.31E+03	-7.29E+03
6.29E-01	5.10E+03	-8.60E+03	5.03E+03	-8.77E+03
5.00E-01	5.99E+03	-1.02E+04	5.92E+03	-1.05E+04
3.97E-01	7.17E+03	-1.22E+04	7.12E+03	-1.25E+04
3.15E-01	8.71E+03	-1.44E+04	8.65E+03	-1.47E+04
2.51E-01	1.08E+04	-1.68E+04	1.07E+04	-1.72E+04
1.99E-01	1.33E+04	-1.94E+04	1.33E+04	-2.00E+04
1.58E-01	1.64E+04	-2.19E+04	1.64E+04	-2.27E+04
1.26E-01	2.00E+04	-2.44E+04	2.02E+04	-2.54E+04
1.00E-01	2.42E+04	-2.68E+04	2.45E+04	-2.78E+04

Tab. A. 4 Frequency dispersion of KCl solutions

	15		14	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	1.65E+02	-7.10E+03	1.97E+03	-6.11E+03
3.97E+06	6.23E+02	-8.63E+03	2.92E+03	-6.90E+03
3.15E+06	1.34E+03	-1.06E+04	4.21E+03	-7.75E+03
2.51E+06	2.14E+03	-1.28E+04	5.61E+03	-8.49E+03
1.99E+06	3.60E+03	-1.56E+04	7.49E+03	-9.00E+03
1.58E+06	5.32E+03	-1.87E+04	9.39E+03	-9.19E+03
1.26E+06	7.61E+03	-2.23E+04	1.14E+04	-9.02E+03
9.98E+05	1.16E+04	-2.60E+04	1.35E+04	-8.10E+03
7.92E+05	1.57E+04	-3.03E+04	1.50E+04	-7.35E+03
6.29E+05	2.12E+04	-3.48E+04	1.63E+04	-6.42E+03
5.00E+05	2.81E+04	-3.88E+04	1.72E+04	-5.47E+03
3.97E+05	3.64E+04	-4.16E+04	1.78E+04	-4.55E+03
3.15E+05	4.57E+04	-4.29E+04	1.83E+04	-3.72E+03
2.51E+05	5.53E+04	-4.24E+04	1.86E+04	-3.03E+03
1.99E+05	6.42E+04	-4.00E+04	1.88E+04	-2.46E+03
1.58E+05	7.18E+04	-3.61E+04	1.90E+04	-1.98E+03
1.26E+05	7.78E+04	-3.15E+04	1.91E+04	-1.58E+03
9.98E+04	8.23E+04	-2.67E+04	1.91E+04	-1.25E+03
7.92E+04	8.56E+04	-2.22E+04	1.92E+04	-9.93E+02
6.29E+04	8.78E+04	-1.83E+04	1.92E+04	-8.07E+02
5.00E+04	8.94E+04	-1.48E+04	1.93E+04	-6.30E+02
3.97E+04	9.04E+04	-1.19E+04	1.93E+04	-4.83E+02
3.15E+04	9.11E+04	-9.51E+03	1.93E+04	-3.73E+02
2.51E+04	9.15E+04	-7.47E+03	1.93E+04	-2.61E+02
1.99E+04	9.18E+04	-5.77E+03	1.93E+04	-1.70E+02
1.58E+04	9.19E+04	-4.38E+03	1.93E+04	-8.34E+01
1.26E+04	9.20E+04	-3.20E+03	1.93E+04	-8.72E+00
9.98E+03	9.19E+04	-2.19E+03	1.93E+04	6.47E+01
7.92E+03	9.18E+04	-1.36E+03	1.92E+04	1.30E+02
6.29E+03	9.16E+04	-6.97E+02	1.92E+04	1.79E+02
5.00E+03	9.14E+04	-1.32E+02	1.91E+04	2.30E+02
3.97E+03	9.10E+04	2.56E+02	1.90E+04	2.54E+02
3.15E+03	9.07E+04	4.99E+02	1.90E+04	2.56E+02
2.51E+03	9.03E+04	6.31E+02	1.89E+04	2.58E+02
1.99E+03	9.01E+04	6.42E+02	1.89E+04	2.19E+02
1.58E+03	8.98E+04	6.08E+02	1.88E+04	1.82E+02
1.26E+03	8.97E+04	5.05E+02	1.88E+04	1.44E+02
9.98E+02	8.96E+04	4.33E+02	1.88E+04	1.02E+02
7.92E+02	8.96E+04	3.23E+02	1.88E+04	6.20E+01
6.29E+02	8.94E+04	2.04E+02	1.87E+04	1.06E+01
5.00E+02	8.95E+04	1.06E+02	1.87E+04	-2.03E+01
3.97E+02	8.95E+04	5.12E+01	1.87E+04	-6.06E+01
3.15E+02	8.95E+04	3.30E+01	1.88E+04	-9.83E+01

f / Hz	15		14	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
2.51E+02	8.96E+04	-1.24E+02	1.88E+04	-1.53E+02
1.99E+02	8.95E+04	-1.93E+02	1.88E+04	-2.07E+02
1.58E+02	8.95E+04	-2.65E+02	1.88E+04	-2.58E+02
1.26E+02	8.95E+04	-3.64E+02	1.88E+04	-3.35E+02
9.98E+01	8.96E+04	-4.36E+02	1.88E+04	-4.03E+02
7.92E+01	8.96E+04	-5.45E+02	1.88E+04	-5.06E+02
6.29E+01	8.96E+04	-6.43E+02	1.89E+04	-6.17E+02
5.00E+01	8.92E+04	-1.45E+03	1.90E+04	-8.04E+02
3.97E+01	8.97E+04	-9.89E+02	1.90E+04	-9.17E+02
3.15E+01	8.98E+04	-1.21E+03	1.91E+04	-1.11E+03
2.51E+01	8.99E+04	-1.42E+03	1.91E+04	-1.34E+03
1.99E+01	9.00E+04	-1.74E+03	1.92E+04	-1.61E+03
1.58E+01	9.02E+04	-2.15E+03	1.94E+04	-1.93E+03
1.26E+01	9.04E+04	-2.52E+03	1.95E+04	-2.31E+03
9.98E+00	9.06E+04	-3.01E+03	1.97E+04	-2.77E+03
7.92E+00	9.09E+04	-3.63E+03	1.99E+04	-3.29E+03
6.29E+00	9.12E+04	-4.25E+03	2.02E+04	-3.93E+03
5.00E+00	9.15E+04	-5.04E+03	2.05E+04	-4.69E+03
3.97E+00	9.20E+04	-5.97E+03	2.09E+04	-5.57E+03
3.15E+00	9.25E+04	-7.02E+03	2.14E+04	-6.60E+03
2.51E+00	9.32E+04	-8.32E+03	2.20E+04	-7.83E+03
1.99E+00	9.40E+04	-9.77E+03	2.27E+04	-9.27E+03
1.58E+00	9.48E+04	-1.16E+04	2.35E+04	-1.10E+04
1.26E+00	9.61E+04	-1.37E+04	2.45E+04	-1.29E+04
9.98E-01	9.75E+04	-1.62E+04	2.58E+04	-1.52E+04
7.92E-01	9.91E+04	-1.88E+04	2.72E+04	-1.79E+04
6.29E-01	1.01E+05	-2.21E+04	2.88E+04	-2.11E+04
5.00E-01	1.04E+05	-2.58E+04	3.09E+04	-2.48E+04
3.97E-01	1.06E+05	-3.02E+04	3.33E+04	-2.91E+04
3.15E-01	1.10E+05	-3.53E+04	3.62E+04	-3.43E+04
2.51E-01	1.14E+05	-4.10E+04	3.99E+04	-4.03E+04
1.99E-01	1.19E+05	-4.80E+04	4.42E+04	-4.73E+04
1.58E-01	1.25E+05	-5.54E+04	5.00E+04	-5.54E+04
1.26E-01	1.33E+05	-6.44E+04	5.70E+04	-6.45E+04
1.00E-01	1.42E+05	-7.47E+04	6.57E+04	-7.44E+04

	13		12	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.77E+03	-4.88E+03	3.19E+03	-2.89E+03
3.97E+06	3.73E+03	-5.15E+03	3.72E+03	-2.68E+03
3.15E+06	4.86E+03	-5.26E+03	4.20E+03	-2.37E+03
2.51E+06	5.93E+03	-5.20E+03	4.57E+03	-2.07E+03
1.99E+06	7.04E+03	-4.84E+03	4.83E+03	-1.72E+03
1.58E+06	7.96E+03	-4.39E+03	5.05E+03	-1.42E+03
1.26E+06	8.68E+03	-3.82E+03	5.17E+03	-1.15E+03
9.98E+05	9.29E+03	-2.99E+03	5.26E+03	-7.87E+02
7.92E+05	9.67E+03	-2.51E+03	5.31E+03	-6.40E+02
6.29E+05	9.93E+03	-2.06E+03	5.35E+03	-5.14E+02
5.00E+05	1.01E+04	-1.68E+03	5.37E+03	-4.14E+02
3.97E+05	1.02E+04	-1.36E+03	5.39E+03	-3.30E+02
3.15E+05	1.03E+04	-1.09E+03	5.40E+03	-2.61E+02
2.51E+05	1.04E+04	-8.76E+02	5.40E+03	-2.10E+02
1.99E+05	1.04E+04	-7.08E+02	5.41E+03	-1.71E+02
1.58E+05	1.04E+04	-5.64E+02	5.42E+03	-1.36E+02
1.26E+05	1.04E+04	-4.46E+02	5.42E+03	-1.05E+02
9.98E+04	1.05E+04	-3.51E+02	5.43E+03	-8.02E+01
7.92E+04	1.05E+04	-2.75E+02	5.43E+03	-6.25E+01
6.29E+04	1.05E+04	-2.25E+02	5.43E+03	-5.25E+01
5.00E+04	1.05E+04	-1.72E+02	5.44E+03	-3.78E+01
3.97E+04	1.05E+04	-1.26E+02	5.44E+03	-2.47E+01
3.15E+04	1.05E+04	-9.22E+01	5.44E+03	-1.59E+01
2.51E+04	1.05E+04	-5.39E+01	5.44E+03	-3.21E+00
1.99E+04	1.05E+04	-2.13E+01	5.44E+03	7.93E+00
1.58E+04	1.05E+04	8.76E+00	5.44E+03	1.81E+01
1.26E+04	1.05E+04	3.46E+01	5.43E+03	2.97E+01
9.98E+03	1.05E+04	6.63E+01	5.43E+03	3.97E+01
7.92E+03	1.05E+04	9.73E+01	5.42E+03	5.35E+01
6.29E+03	1.04E+04	1.18E+02	5.41E+03	5.84E+01
5.00E+03	1.04E+04	1.36E+02	5.39E+03	7.17E+01
3.97E+03	1.04E+04	1.43E+02	5.38E+03	6.93E+01
3.15E+03	1.03E+04	1.37E+02	5.37E+03	6.17E+01
2.51E+03	1.03E+04	1.35E+02	5.33E+03	6.84E+01
1.99E+03	1.03E+04	1.15E+02	5.32E+03	4.43E+01
1.58E+03	1.02E+04	8.84E+01	5.31E+03	2.73E+01
1.26E+03	1.02E+04	6.47E+01	5.30E+03	1.07E+01
9.98E+02	1.02E+04	3.55E+01	5.30E+03	-4.51E+00
7.92E+02	1.02E+04	8.31E+00	5.30E+03	-2.42E+01
6.29E+02	1.02E+04	-2.08E+01	5.31E+03	-4.86E+01
5.00E+02	1.02E+04	-5.01E+01	5.31E+03	-6.95E+01
3.97E+02	1.02E+04	-8.05E+01	5.31E+03	-9.41E+01
3.15E+02	1.02E+04	-1.17E+02	5.32E+03	-1.23E+02
2.51E+02	1.03E+04	-1.62E+02	5.33E+03	-1.54E+02

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.03E+04	-2.05E+02	5.34E+03	-1.94E+02
1.58E+02	1.03E+04	-2.54E+02	5.35E+03	-2.38E+02
1.26E+02	1.03E+04	-3.19E+02	5.37E+03	-2.94E+02
9.98E+01	1.03E+04	-3.88E+02	5.39E+03	-3.55E+02
7.92E+01	1.03E+04	-4.78E+02	5.41E+03	-4.35E+02
6.29E+01	1.04E+04	-5.85E+02	5.45E+03	-5.26E+02
5.00E+01	1.03E+04	-7.48E+02	5.48E+03	-6.65E+02
3.97E+01	1.05E+04	-8.54E+02	5.53E+03	-7.61E+02
3.15E+01	1.05E+04	-1.03E+03	5.58E+03	-9.15E+02
2.51E+01	1.06E+04	-1.24E+03	5.65E+03	-1.10E+03
1.99E+01	1.07E+04	-1.49E+03	5.73E+03	-1.31E+03
1.58E+01	1.08E+04	-1.78E+03	5.84E+03	-1.57E+03
1.26E+01	1.09E+04	-2.13E+03	5.95E+03	-1.88E+03
9.98E+00	1.11E+04	-2.55E+03	6.09E+03	-2.24E+03
7.92E+00	1.13E+04	-3.04E+03	6.28E+03	-2.68E+03
6.29E+00	1.15E+04	-3.63E+03	6.48E+03	-3.19E+03
5.00E+00	1.18E+04	-4.33E+03	6.73E+03	-3.81E+03
3.97E+00	1.22E+04	-5.16E+03	7.04E+03	-4.52E+03
3.15E+00	1.26E+04	-6.12E+03	7.39E+03	-5.36E+03
2.51E+00	1.31E+04	-7.25E+03	7.84E+03	-6.38E+03
1.99E+00	1.38E+04	-8.59E+03	8.31E+03	-7.57E+03
1.58E+00	1.45E+04	-1.01E+04	8.85E+03	-8.98E+03
1.26E+00	1.54E+04	-1.20E+04	9.55E+03	-1.07E+04
9.98E-01	1.64E+04	-1.41E+04	1.03E+04	-1.27E+04
7.92E-01	1.76E+04	-1.68E+04	1.13E+04	-1.52E+04
6.29E-01	1.91E+04	-1.97E+04	1.24E+04	-1.82E+04
5.00E-01	2.08E+04	-2.34E+04	1.39E+04	-2.18E+04
3.97E-01	2.29E+04	-2.77E+04	1.57E+04	-2.60E+04
3.15E-01	2.55E+04	-3.28E+04	1.80E+04	-3.10E+04
2.51E-01	2.88E+04	-3.88E+04	2.10E+04	-3.71E+04
1.99E-01	3.28E+04	-4.58E+04	2.48E+04	-4.41E+04
1.58E-01	3.81E+04	-5.39E+04	2.97E+04	-5.22E+04
1.26E-01	4.47E+04	-6.33E+04	3.59E+04	-6.15E+04
1.00E-01	5.30E+04	-7.35E+04	4.37E+04	-7.17E+04

	11		10	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.88E+03	-1.74E+03	2.46E+03	-1.13E+03
3.97E+06	3.11E+03	-1.51E+03	2.57E+03	-9.37E+02
3.15E+06	3.31E+03	-1.26E+03	2.66E+03	-7.62E+02
2.51E+06	3.45E+03	-1.05E+03	2.72E+03	-6.22E+02
1.99E+06	3.54E+03	-8.39E+02	2.76E+03	-4.86E+02
1.58E+06	3.60E+03	-6.70E+02	2.78E+03	-3.81E+02
1.26E+06	3.64E+03	-5.33E+02	2.79E+03	-2.98E+02
9.98E+05	3.66E+03	-3.25E+02	2.80E+03	-1.61E+02
7.92E+05	3.67E+03	-2.63E+02	2.80E+03	-1.30E+02
6.29E+05	3.68E+03	-2.10E+02	2.80E+03	-1.03E+02
5.00E+05	3.69E+03	-1.69E+02	2.80E+03	-8.30E+01
3.97E+05	3.69E+03	-1.34E+02	2.81E+03	-6.56E+01
3.15E+05	3.69E+03	-1.06E+02	2.81E+03	-5.13E+01
2.51E+05	3.69E+03	-8.53E+01	2.81E+03	-4.13E+01
1.99E+05	3.70E+03	-6.99E+01	2.81E+03	-3.42E+01
1.58E+05	3.70E+03	-5.47E+01	2.81E+03	-2.67E+01
1.26E+05	3.70E+03	-4.26E+01	2.81E+03	-2.01E+01
9.98E+04	3.71E+03	-3.19E+01	2.81E+03	-1.48E+01
7.92E+04	3.71E+03	-2.49E+01	2.82E+03	-1.14E+01
6.29E+04	3.71E+03	-2.10E+01	2.82E+03	-9.89E+00
5.00E+04	3.71E+03	-1.41E+01	2.82E+03	-6.08E+00
3.97E+04	3.71E+03	-7.63E+00	2.82E+03	-2.22E+00
3.15E+04	3.71E+03	-3.77E+00	2.82E+03	-2.84E-01
2.51E+04	3.71E+03	2.88E+00	2.82E+03	3.84E+00
1.99E+04	3.71E+03	8.89E+00	2.82E+03	7.90E+00
1.58E+04	3.71E+03	1.49E+01	2.82E+03	1.17E+01
1.26E+04	3.70E+03	2.11E+01	2.81E+03	1.56E+01
9.98E+03	3.70E+03	2.74E+01	2.81E+03	1.93E+01
7.92E+03	3.69E+03	3.32E+01	2.81E+03	2.32E+01
6.29E+03	3.69E+03	3.73E+01	2.80E+03	2.66E+01
5.00E+03	3.68E+03	4.11E+01	2.79E+03	2.87E+01
3.97E+03	3.66E+03	4.12E+01	2.78E+03	2.74E+01
3.15E+03	3.65E+03	3.77E+01	2.78E+03	2.40E+01
2.51E+03	3.64E+03	3.23E+01	2.77E+03	1.66E+01
1.99E+03	3.63E+03	2.05E+01	2.76E+03	9.61E+00
1.58E+03	3.63E+03	8.28E+00	2.76E+03	-1.25E+00
1.26E+03	3.62E+03	-3.32E+00	2.76E+03	-1.32E+01
9.98E+02	3.62E+03	-1.88E+01	2.75E+03	-2.51E+01
7.92E+02	3.62E+03	-3.67E+01	2.76E+03	-3.86E+01
6.29E+02	3.62E+03	-5.56E+01	2.76E+03	-5.42E+01
5.00E+02	3.63E+03	-7.22E+01	2.76E+03	-7.39E+01
3.97E+02	3.63E+03	-9.44E+01	2.77E+03	-9.44E+01
3.15E+02	3.64E+03	-1.18E+02	2.77E+03	-1.16E+02
2.51E+02	3.65E+03	-1.48E+02	2.79E+03	-1.46E+02

f / Hz	11		10	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	3.66E+03	-1.85E+02	2.79E+03	-1.78E+02
1.58E+02	3.67E+03	-2.26E+02	2.81E+03	-2.18E+02
1.26E+02	3.69E+03	-2.77E+02	2.82E+03	-2.65E+02
9.98E+01	3.71E+03	-3.35E+02	2.84E+03	-3.21E+02
7.92E+01	3.73E+03	-4.06E+02	2.86E+03	-3.88E+02
6.29E+01	3.76E+03	-4.90E+02	2.89E+03	-4.66E+02
5.00E+01	3.82E+03	-5.92E+02	2.94E+03	-5.57E+02
3.97E+01	3.84E+03	-7.07E+02	2.97E+03	-6.71E+02
3.15E+01	3.89E+03	-8.48E+02	3.02E+03	-8.06E+02
2.51E+01	3.95E+03	-1.02E+03	3.08E+03	-9.63E+02
1.99E+01	4.03E+03	-1.22E+03	3.15E+03	-1.15E+03
1.58E+01	4.12E+03	-1.45E+03	3.23E+03	-1.37E+03
1.26E+01	4.23E+03	-1.74E+03	3.34E+03	-1.64E+03
9.98E+00	4.37E+03	-2.07E+03	3.47E+03	-1.96E+03
7.92E+00	4.53E+03	-2.47E+03	3.62E+03	-2.33E+03
6.29E+00	4.73E+03	-2.94E+03	3.79E+03	-2.77E+03
5.00E+00	4.95E+03	-3.49E+03	4.00E+03	-3.29E+03
3.97E+00	5.22E+03	-4.15E+03	4.23E+03	-3.92E+03
3.15E+00	5.52E+03	-4.93E+03	4.51E+03	-4.67E+03
2.51E+00	5.88E+03	-5.86E+03	4.82E+03	-5.58E+03
1.99E+00	6.28E+03	-6.99E+03	5.17E+03	-6.68E+03
1.58E+00	6.75E+03	-8.36E+03	5.60E+03	-8.02E+03
1.26E+00	7.33E+03	-1.00E+04	6.12E+03	-9.67E+03
9.98E-01	8.04E+03	-1.20E+04	6.78E+03	-1.16E+04
7.92E-01	8.87E+03	-1.44E+04	7.59E+03	-1.40E+04
6.29E-01	9.91E+03	-1.73E+04	8.63E+03	-1.69E+04
5.00E-01	1.13E+04	-2.08E+04	9.92E+03	-2.03E+04
3.97E-01	1.30E+04	-2.50E+04	1.16E+04	-2.45E+04
3.15E-01	1.52E+04	-3.00E+04	1.38E+04	-2.94E+04
2.51E-01	1.81E+04	-3.59E+04	1.66E+04	-3.52E+04
1.99E-01	2.18E+04	-4.28E+04	2.04E+04	-4.20E+04
1.58E-01	2.66E+04	-5.08E+04	2.52E+04	-4.97E+04
1.26E-01	3.29E+04	-5.99E+04	3.17E+04	-5.86E+04
1.00E-01	4.09E+04	-6.99E+04	3.97E+04	-6.82E+04

	09		08	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.18E+03	-8.34E+02	1.90E+03	-5.95E+02
3.97E+06	2.24E+03	-6.90E+02	1.94E+03	-4.87E+02
3.15E+06	2.30E+03	-5.53E+02	1.96E+03	-3.87E+02
2.51E+06	2.33E+03	-4.47E+02	1.98E+03	-3.10E+02
1.99E+06	2.35E+03	-3.46E+02	1.99E+03	-2.38E+02
1.58E+06	2.36E+03	-2.70E+02	2.00E+03	-1.83E+02
1.26E+06	2.37E+03	-2.08E+02	1.99E+03	-1.40E+02
9.98E+05	2.36E+03	-1.01E+02	1.99E+03	-5.62E+01
7.92E+05	2.37E+03	-8.14E+01	1.99E+03	-4.55E+01
6.29E+05	2.37E+03	-6.47E+01	1.99E+03	-3.59E+01
5.00E+05	2.37E+03	-5.20E+01	1.99E+03	-2.85E+01
3.97E+05	2.37E+03	-4.09E+01	1.99E+03	-2.20E+01
3.15E+05	2.37E+03	-3.15E+01	1.99E+03	-1.69E+01
2.51E+05	2.37E+03	-2.58E+01	1.99E+03	-1.41E+01
1.99E+05	2.37E+03	-2.20E+01	1.99E+03	-1.21E+01
1.58E+05	2.37E+03	-1.66E+01	1.99E+03	-9.18E+00
1.26E+05	2.37E+03	-1.25E+01	1.99E+03	-6.46E+00
9.98E+04	2.38E+03	-8.88E+00	1.99E+03	-4.62E+00
7.92E+04	2.38E+03	-7.01E+00	1.99E+03	-3.41E+00
6.29E+04	2.37E+03	-6.04E+00	1.99E+03	-3.12E+00
5.00E+04	2.38E+03	-3.18E+00	1.99E+03	-1.28E+00
3.97E+04	2.38E+03	-4.67E-01	1.99E+03	7.60E-01
3.15E+04	2.38E+03	7.16E-01	1.99E+03	1.37E+00
2.51E+04	2.38E+03	4.01E+00	1.99E+03	3.61E+00
1.99E+04	2.37E+03	6.64E+00	1.99E+03	5.43E+00
1.58E+04	2.37E+03	9.67E+00	1.99E+03	7.68E+00
1.26E+04	2.37E+03	1.23E+01	1.99E+03	9.48E+00
9.98E+03	2.37E+03	1.55E+01	1.99E+03	1.14E+01
7.92E+03	2.37E+03	1.87E+01	1.98E+03	1.32E+01
6.29E+03	2.36E+03	2.01E+01	1.98E+03	1.39E+01
5.00E+03	2.36E+03	2.10E+01	1.98E+03	1.40E+01
3.97E+03	2.35E+03	2.01E+01	1.97E+03	1.26E+01
3.15E+03	2.34E+03	1.58E+01	1.97E+03	9.04E+00
2.51E+03	2.33E+03	9.69E+00	1.96E+03	4.23E+00
1.99E+03	2.33E+03	3.71E+00	1.96E+03	-2.31E+00
1.58E+03	2.33E+03	-6.12E+00	1.96E+03	-1.06E+01
1.26E+03	2.33E+03	-1.67E+01	1.95E+03	-2.00E+01
9.98E+02	2.32E+03	-2.84E+01	1.95E+03	-3.12E+01
7.92E+02	2.33E+03	-4.20E+01	1.96E+03	-4.34E+01
6.29E+02	2.33E+03	-5.59E+01	1.96E+03	-5.81E+01
5.00E+02	2.33E+03	-7.40E+01	1.96E+03	-7.35E+01
3.97E+02	2.34E+03	-9.37E+01	1.97E+03	-9.06E+01
3.15E+02	2.34E+03	-1.18E+02	1.97E+03	-1.12E+02
2.51E+02	2.36E+03	-1.46E+02	1.98E+03	-1.41E+02

f / Hz	09		08	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	2.36E+03	-1.78E+02	1.99E+03	-1.71E+02
1.58E+02	2.37E+03	-2.16E+02	2.00E+03	-2.07E+02
1.26E+02	2.39E+03	-2.63E+02	2.02E+03	-2.50E+02
9.98E+01	2.41E+03	-3.18E+02	2.04E+03	-3.02E+02
7.92E+01	2.43E+03	-3.84E+02	2.06E+03	-3.64E+02
6.29E+01	2.46E+03	-4.64E+02	2.08E+03	-4.37E+02
5.00E+01	2.50E+03	-5.61E+02	2.12E+03	-5.12E+02
3.97E+01	2.53E+03	-6.70E+02	2.15E+03	-6.31E+02
3.15E+01	2.58E+03	-8.04E+02	2.20E+03	-7.57E+02
2.51E+01	2.65E+03	-9.61E+02	2.26E+03	-9.05E+02
1.99E+01	2.72E+03	-1.15E+03	2.32E+03	-1.08E+03
1.58E+01	2.80E+03	-1.37E+03	2.41E+03	-1.29E+03
1.26E+01	2.91E+03	-1.63E+03	2.50E+03	-1.54E+03
9.98E+00	3.04E+03	-1.94E+03	2.62E+03	-1.83E+03
7.92E+00	3.19E+03	-2.31E+03	2.75E+03	-2.18E+03
6.29E+00	3.36E+03	-2.74E+03	2.91E+03	-2.59E+03
5.00E+00	3.55E+03	-3.26E+03	3.08E+03	-3.09E+03
3.97E+00	3.78E+03	-3.88E+03	3.29E+03	-3.69E+03
3.15E+00	4.02E+03	-4.63E+03	3.52E+03	-4.41E+03
2.51E+00	4.34E+03	-5.53E+03	3.79E+03	-5.30E+03
1.99E+00	4.68E+03	-6.65E+03	4.11E+03	-6.38E+03
1.58E+00	5.11E+03	-8.00E+03	4.52E+03	-7.69E+03
1.26E+00	5.63E+03	-9.65E+03	5.00E+03	-9.29E+03
9.98E-01	6.26E+03	-1.17E+04	5.63E+03	-1.12E+04
7.92E-01	7.11E+03	-1.41E+04	6.42E+03	-1.36E+04
6.29E-01	8.18E+03	-1.70E+04	7.41E+03	-1.64E+04
5.00E-01	9.49E+03	-2.05E+04	8.73E+03	-1.98E+04
3.97E-01	1.12E+04	-2.46E+04	1.04E+04	-2.38E+04
3.15E-01	1.35E+04	-2.95E+04	1.26E+04	-2.86E+04
2.51E-01	1.65E+04	-3.53E+04	1.55E+04	-3.42E+04
1.99E-01	2.03E+04	-4.20E+04	1.93E+04	-4.08E+04
1.58E-01	2.53E+04	-4.96E+04	2.43E+04	-4.82E+04
1.26E-01	3.18E+04	-5.81E+04	3.07E+04	-5.65E+04
1.00E-01	4.00E+04	-6.74E+04	3.89E+04	-6.54E+04

f / Hz	07		06	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.77E+03	-5.01E+02	1.61E+03	-4.07E+02
3.97E+06	1.79E+03	-4.08E+02	1.62E+03	-3.30E+02
3.15E+06	1.81E+03	-3.22E+02	1.63E+03	-2.59E+02
2.51E+06	1.82E+03	-2.56E+02	1.64E+03	-2.05E+02
1.99E+06	1.82E+03	-1.95E+02	1.64E+03	-1.55E+02
1.58E+06	1.83E+03	-1.49E+02	1.64E+03	-1.17E+02
1.26E+06	1.82E+03	-1.13E+02	1.64E+03	-8.83E+01
9.98E+05	1.82E+03	-3.98E+01	1.63E+03	-2.53E+01
7.92E+05	1.82E+03	-3.25E+01	1.63E+03	-2.09E+01
6.29E+05	1.82E+03	-2.52E+01	1.63E+03	-1.63E+01
5.00E+05	1.82E+03	-2.01E+01	1.63E+03	-1.30E+01
3.97E+05	1.82E+03	-1.54E+01	1.63E+03	-9.75E+00
3.15E+05	1.81E+03	-1.18E+01	1.63E+03	-7.42E+00
2.51E+05	1.82E+03	-1.00E+01	1.63E+03	-6.32E+00
1.99E+05	1.82E+03	-8.94E+00	1.63E+03	-6.17E+00
1.58E+05	1.82E+03	-6.60E+00	1.63E+03	-4.37E+00
1.26E+05	1.82E+03	-4.51E+00	1.63E+03	-3.11E+00
9.98E+04	1.82E+03	-3.14E+00	1.64E+03	-1.67E+00
7.92E+04	1.82E+03	-2.70E+00	1.64E+03	-1.92E+00
6.29E+04	1.82E+03	-2.05E+00	1.63E+03	-1.35E+00
5.00E+04	1.82E+03	-6.40E-01	1.64E+03	-3.47E-03
3.97E+04	1.82E+03	9.37E-01	1.64E+03	1.20E+00
3.15E+04	1.82E+03	1.38E+00	1.64E+03	1.27E+00
2.51E+04	1.82E+03	3.29E+00	1.63E+03	3.14E+00
1.99E+04	1.82E+03	5.03E+00	1.63E+03	4.13E+00
1.58E+04	1.82E+03	6.84E+00	1.63E+03	5.47E+00
1.26E+04	1.81E+03	8.01E+00	1.63E+03	6.52E+00
9.98E+03	1.81E+03	9.76E+00	1.63E+03	8.06E+00
7.92E+03	1.81E+03	1.13E+01	1.63E+03	9.08E+00
6.29E+03	1.81E+03	1.18E+01	1.63E+03	9.16E+00
5.00E+03	1.80E+03	1.11E+01	1.62E+03	9.38E+00
3.97E+03	1.80E+03	9.79E+00	1.62E+03	7.11E+00
3.15E+03	1.79E+03	7.93E+00	1.61E+03	3.52E+00
2.51E+03	1.79E+03	1.82E+00	1.61E+03	7.64E-02
1.99E+03	1.79E+03	-4.02E+00	1.61E+03	-6.05E+00
1.58E+03	1.78E+03	-1.28E+01	1.61E+03	-1.41E+01
1.26E+03	1.78E+03	-2.18E+01	1.61E+03	-2.27E+01
9.98E+02	1.78E+03	-3.11E+01	1.61E+03	-3.18E+01
7.92E+02	1.78E+03	-4.25E+01	1.61E+03	-4.37E+01
6.29E+02	1.79E+03	-5.73E+01	1.61E+03	-5.73E+01
5.00E+02	1.79E+03	-7.23E+01	1.62E+03	-7.08E+01
3.97E+02	1.80E+03	-8.85E+01	1.62E+03	-8.90E+01
3.15E+02	1.80E+03	-1.10E+02	1.63E+03	-1.08E+02
2.51E+02	1.81E+03	-1.37E+02	1.64E+03	-1.36E+02

f / Hz	07		06	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.82E+03	-1.66E+02	1.64E+03	-1.64E+02
1.58E+02	1.83E+03	-2.00E+02	1.65E+03	-1.97E+02
1.26E+02	1.84E+03	-2.42E+02	1.67E+03	-2.37E+02
9.98E+01	1.86E+03	-2.91E+02	1.68E+03	-2.85E+02
7.92E+01	1.88E+03	-3.51E+02	1.70E+03	-3.45E+02
6.29E+01	1.91E+03	-4.23E+02	1.73E+03	-4.15E+02
5.00E+01	1.94E+03	-5.20E+02	1.77E+03	-4.92E+02
3.97E+01	1.98E+03	-6.08E+02	1.80E+03	-5.98E+02
3.15E+01	2.02E+03	-7.26E+02	1.84E+03	-7.15E+02
2.51E+01	2.08E+03	-8.69E+02	1.90E+03	-8.55E+02
1.99E+01	2.14E+03	-1.04E+03	1.96E+03	-1.02E+03
1.58E+01	2.22E+03	-1.24E+03	2.04E+03	-1.22E+03
1.26E+01	2.32E+03	-1.47E+03	2.13E+03	-1.45E+03
9.98E+00	2.43E+03	-1.75E+03	2.24E+03	-1.72E+03
7.92E+00	2.55E+03	-2.08E+03	2.36E+03	-2.05E+03
6.29E+00	2.70E+03	-2.48E+03	2.51E+03	-2.43E+03
5.00E+00	2.86E+03	-2.95E+03	2.65E+03	-2.90E+03
3.97E+00	3.05E+03	-3.53E+03	2.85E+03	-3.47E+03
3.15E+00	3.28E+03	-4.23E+03	3.04E+03	-4.18E+03
2.51E+00	3.55E+03	-5.08E+03	3.31E+03	-5.02E+03
1.99E+00	3.85E+03	-6.12E+03	3.60E+03	-6.06E+03
1.58E+00	4.24E+03	-7.40E+03	3.99E+03	-7.32E+03
1.26E+00	4.69E+03	-8.94E+03	4.45E+03	-8.89E+03
9.98E-01	5.34E+03	-1.08E+04	5.06E+03	-1.07E+04
7.92E-01	6.11E+03	-1.31E+04	5.83E+03	-1.30E+04
6.29E-01	7.11E+03	-1.58E+04	6.85E+03	-1.57E+04
5.00E-01	8.42E+03	-1.91E+04	8.19E+03	-1.90E+04
3.97E-01	1.01E+04	-2.29E+04	9.85E+03	-2.28E+04
3.15E-01	1.24E+04	-2.75E+04	1.22E+04	-2.73E+04
2.51E-01	1.53E+04	-3.27E+04	1.51E+04	-3.26E+04
1.99E-01	1.91E+04	-3.89E+04	1.90E+04	-3.86E+04
1.58E-01	2.41E+04	-4.58E+04	2.41E+04	-4.54E+04
1.26E-01	3.05E+04	-5.33E+04	3.05E+04	-5.27E+04
1.00E-01	3.86E+04	-6.12E+04	3.87E+04	-6.03E+04

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.47E+03	-3.28E+02	1.36E+03	-2.78E+02
3.97E+06	1.47E+03	-2.65E+02	1.37E+03	-2.25E+02
3.15E+06	1.48E+03	-2.08E+02	1.37E+03	-1.75E+02
2.51E+06	1.48E+03	-1.64E+02	1.37E+03	-1.37E+02
1.99E+06	1.48E+03	-1.23E+02	1.37E+03	-1.02E+02
1.58E+06	1.48E+03	-9.23E+01	1.37E+03	-7.56E+01
1.26E+06	1.48E+03	-6.91E+01	1.37E+03	-5.61E+01
9.98E+05	1.47E+03	-1.44E+01	1.36E+03	-6.77E+00
7.92E+05	1.47E+03	-1.21E+01	1.36E+03	-6.25E+00
6.29E+05	1.47E+03	-9.39E+00	1.36E+03	-4.70E+00
5.00E+05	1.47E+03	-7.63E+00	1.36E+03	-3.89E+00
3.97E+05	1.47E+03	-5.57E+00	1.36E+03	-2.64E+00
3.15E+05	1.47E+03	-3.94E+00	1.36E+03	-1.62E+00
2.51E+05	1.47E+03	-3.50E+00	1.36E+03	-1.74E+00
1.99E+05	1.47E+03	-3.75E+00	1.36E+03	-2.13E+00
1.58E+05	1.47E+03	-2.55E+00	1.36E+03	-1.42E+00
1.26E+05	1.47E+03	-1.48E+00	1.36E+03	-6.40E-01
9.98E+04	1.47E+03	-7.26E-01	1.36E+03	-2.25E-01
7.92E+04	1.48E+03	-1.12E+00	1.36E+03	-6.50E-01
6.29E+04	1.47E+03	-6.66E-01	1.36E+03	-2.96E-01
5.00E+04	1.47E+03	3.23E-01	1.36E+03	5.41E-01
3.97E+04	1.47E+03	1.31E+00	1.36E+03	1.34E+00
3.15E+04	1.47E+03	1.50E+00	1.36E+03	1.27E+00
2.51E+04	1.47E+03	2.61E+00	1.36E+03	2.20E+00
1.99E+04	1.47E+03	3.68E+00	1.36E+03	3.12E+00
1.58E+04	1.47E+03	4.88E+00	1.36E+03	3.70E+00
1.26E+04	1.47E+03	5.33E+00	1.36E+03	4.54E+00
9.98E+03	1.47E+03	6.15E+00	1.36E+03	5.46E+00
7.92E+03	1.47E+03	7.19E+00	1.35E+03	5.32E+00
6.29E+03	1.46E+03	7.17E+00	1.35E+03	5.23E+00
5.00E+03	1.46E+03	6.32E+00	1.35E+03	4.72E+00
3.97E+03	1.46E+03	4.94E+00	1.35E+03	2.47E+00
3.15E+03	1.46E+03	1.85E+00	1.34E+03	-3.75E-01
2.51E+03	1.45E+03	-1.98E+00	1.34E+03	-5.39E+00
1.99E+03	1.45E+03	-8.31E+00	1.34E+03	-9.67E+00
1.58E+03	1.45E+03	-1.58E+01	1.34E+03	-1.68E+01
1.26E+03	1.45E+03	-2.42E+01	1.34E+03	-2.40E+01
9.98E+02	1.45E+03	-3.34E+01	1.34E+03	-3.44E+01
7.92E+02	1.45E+03	-4.28E+01	1.34E+03	-4.38E+01
6.29E+02	1.46E+03	-5.52E+01	1.34E+03	-5.72E+01
5.00E+02	1.46E+03	-7.05E+01	1.35E+03	-7.11E+01
3.97E+02	1.46E+03	-8.72E+01	1.35E+03	-8.77E+01
3.15E+02	1.47E+03	-1.06E+02	1.36E+03	-1.08E+02
2.51E+02	1.48E+03	-1.32E+02	1.37E+03	-1.30E+02

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.49E+03	-1.59E+02	1.38E+03	-1.58E+02
1.58E+02	1.50E+03	-1.92E+02	1.39E+03	-1.90E+02
1.26E+02	1.51E+03	-2.31E+02	1.40E+03	-2.31E+02
9.98E+01	1.53E+03	-2.79E+02	1.42E+03	-2.79E+02
7.92E+01	1.55E+03	-3.34E+02	1.44E+03	-3.35E+02
6.29E+01	1.57E+03	-4.02E+02	1.46E+03	-4.03E+02
5.00E+01	1.59E+03	-4.77E+02	1.48E+03	-4.89E+02
3.97E+01	1.64E+03	-5.78E+02	1.53E+03	-5.77E+02
3.15E+01	1.68E+03	-6.92E+02	1.57E+03	-6.90E+02
2.51E+01	1.73E+03	-8.26E+02	1.62E+03	-8.23E+02
1.99E+01	1.80E+03	-9.85E+02	1.69E+03	-9.80E+02
1.58E+01	1.87E+03	-1.17E+03	1.76E+03	-1.16E+03
1.26E+01	1.96E+03	-1.39E+03	1.85E+03	-1.39E+03
9.98E+00	2.06E+03	-1.66E+03	1.95E+03	-1.65E+03
7.92E+00	2.18E+03	-1.97E+03	2.06E+03	-1.96E+03
6.29E+00	2.30E+03	-2.35E+03	2.19E+03	-2.33E+03
5.00E+00	2.46E+03	-2.81E+03	2.33E+03	-2.79E+03
3.97E+00	2.64E+03	-3.37E+03	2.51E+03	-3.35E+03
3.15E+00	2.82E+03	-4.05E+03	2.70E+03	-4.03E+03
2.51E+00	3.07E+03	-4.88E+03	2.95E+03	-4.85E+03
1.99E+00	3.35E+03	-5.90E+03	3.23E+03	-5.88E+03
1.58E+00	3.70E+03	-7.15E+03	3.59E+03	-7.12E+03
1.26E+00	4.15E+03	-8.68E+03	4.06E+03	-8.62E+03
9.98E-01	4.76E+03	-1.05E+04	4.64E+03	-1.04E+04
7.92E-01	5.50E+03	-1.27E+04	5.41E+03	-1.26E+04
6.29E-01	6.47E+03	-1.54E+04	6.45E+03	-1.53E+04
5.00E-01	7.74E+03	-1.86E+04	7.69E+03	-1.84E+04
3.97E-01	9.42E+03	-2.24E+04	9.42E+03	-2.22E+04
3.15E-01	1.16E+04	-2.69E+04	1.16E+04	-2.65E+04
2.51E-01	1.45E+04	-3.21E+04	1.46E+04	-3.16E+04
1.99E-01	1.83E+04	-3.81E+04	1.84E+04	-3.74E+04
1.58E-01	2.32E+04	-4.48E+04	2.33E+04	-4.38E+04
1.26E-01	2.94E+04	-5.21E+04	2.96E+04	-5.09E+04
1.00E-01	3.72E+04	-5.97E+04	3.74E+04	-5.80E+04

f / Hz	03		02	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.30E+03	-2.48E+02	1.23E+03	-2.19E+02
3.97E+06	1.30E+03	-2.00E+02	1.23E+03	-1.76E+02
3.15E+06	1.30E+03	-1.56E+02	1.23E+03	-1.37E+02
2.51E+06	1.30E+03	-1.23E+02	1.23E+03	-1.07E+02
1.99E+06	1.30E+03	-9.09E+01	1.23E+03	-7.84E+01
1.58E+06	1.30E+03	-6.69E+01	1.23E+03	-5.75E+01
1.26E+06	1.30E+03	-4.88E+01	1.22E+03	-4.19E+01
9.98E+05	1.29E+03	-3.12E+00	1.22E+03	6.62E-01
7.92E+05	1.29E+03	-3.20E+00	1.22E+03	-1.30E-01
6.29E+05	1.29E+03	-2.35E+00	1.22E+03	5.97E-02
5.00E+05	1.29E+03	-2.01E+00	1.22E+03	-8.84E-02
3.97E+05	1.29E+03	-1.14E+00	1.22E+03	4.96E-01
3.15E+05	1.29E+03	-2.87E-01	1.22E+03	9.43E-01
2.51E+05	1.29E+03	-7.68E-01	1.22E+03	2.70E-01
1.99E+05	1.29E+03	-1.32E+00	1.22E+03	-4.79E-01
1.58E+05	1.29E+03	-6.53E-01	1.22E+03	-6.86E-03
1.26E+05	1.29E+03	-6.93E-02	1.22E+03	4.40E-01
9.98E+04	1.37E+03	1.01E-01	1.22E+03	5.51E-01
7.92E+04	1.30E+03	-4.73E-01	1.22E+03	-1.58E-01
6.29E+04	1.29E+03	3.92E-02	1.22E+03	2.38E-01
5.00E+04	1.29E+03	8.29E-01	1.22E+03	8.60E-01
3.97E+04	1.29E+03	1.41E+00	1.22E+03	1.39E+00
3.15E+04	1.29E+03	1.40E+00	1.22E+03	1.28E+00
2.51E+04	1.29E+03	2.19E+00	1.22E+03	2.12E+00
1.99E+04	1.29E+03	3.29E+00	1.22E+03	2.25E+00
1.58E+04	1.29E+03	3.59E+00	1.22E+03	3.00E+00
1.26E+04	1.29E+03	4.04E+00	1.21E+03	3.58E+00
9.98E+03	1.29E+03	4.24E+00	1.21E+03	3.41E+00
7.92E+03	1.29E+03	5.14E+00	1.21E+03	4.48E+00
6.29E+03	1.29E+03	4.45E+00	1.21E+03	3.18E+00
5.00E+03	1.28E+03	3.65E+00	1.21E+03	2.55E+00
3.97E+03	1.28E+03	2.18E+00	1.21E+03	1.09E+00
3.15E+03	1.28E+03	-1.54E+00	1.20E+03	-1.81E+00
2.51E+03	1.28E+03	-4.19E+00	1.20E+03	-7.01E+00
1.99E+03	1.28E+03	-1.05E+01	1.20E+03	-1.12E+01
1.58E+03	1.27E+03	-1.69E+01	1.20E+03	-1.79E+01
1.26E+03	1.27E+03	-2.49E+01	1.20E+03	-2.58E+01
9.98E+02	1.28E+03	-3.39E+01	1.20E+03	-3.46E+01
7.92E+02	1.28E+03	-4.36E+01	1.20E+03	-4.37E+01
6.29E+02	1.28E+03	-5.48E+01	1.20E+03	-5.61E+01
5.00E+02	1.28E+03	-7.03E+01	1.21E+03	-6.84E+01
3.97E+02	1.29E+03	-8.55E+01	1.21E+03	-8.39E+01
3.15E+02	1.29E+03	-1.05E+02	1.22E+03	-1.04E+02
2.51E+02	1.30E+03	-1.28E+02	1.23E+03	-1.24E+02

f / Hz	03		02	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.31E+03	-1.55E+02	1.24E+03	-1.51E+02
1.58E+02	1.32E+03	-1.88E+02	1.25E+03	-1.82E+02
1.26E+02	1.34E+03	-2.26E+02	1.26E+03	-2.20E+02
9.98E+01	1.35E+03	-2.73E+02	1.28E+03	-2.64E+02
7.92E+01	1.37E+03	-3.28E+02	1.30E+03	-3.18E+02
6.29E+01	1.39E+03	-3.93E+02	1.32E+03	-3.81E+02
5.00E+01	1.42E+03	-4.65E+02	1.34E+03	-4.58E+02
3.97E+01	1.46E+03	-5.65E+02	1.38E+03	-5.46E+02
3.15E+01	1.50E+03	-6.77E+02	1.42E+03	-6.54E+02
2.51E+01	1.55E+03	-8.07E+02	1.47E+03	-7.78E+02
1.99E+01	1.61E+03	-9.61E+02	1.53E+03	-9.27E+02
1.58E+01	1.69E+03	-1.14E+03	1.60E+03	-1.10E+03
1.26E+01	1.77E+03	-1.36E+03	1.68E+03	-1.31E+03
9.98E+00	1.86E+03	-1.62E+03	1.78E+03	-1.56E+03
7.92E+00	1.98E+03	-1.93E+03	1.89E+03	-1.86E+03
6.29E+00	2.10E+03	-2.30E+03	2.00E+03	-2.22E+03
5.00E+00	2.24E+03	-2.76E+03	2.13E+03	-2.65E+03
3.97E+00	2.40E+03	-3.31E+03	2.29E+03	-3.19E+03
3.15E+00	2.60E+03	-3.99E+03	2.49E+03	-3.84E+03
2.51E+00	2.83E+03	-4.82E+03	2.71E+03	-4.64E+03
1.99E+00	3.11E+03	-5.83E+03	2.98E+03	-5.61E+03
1.58E+00	3.47E+03	-7.07E+03	3.33E+03	-6.81E+03
1.26E+00	3.91E+03	-8.57E+03	3.77E+03	-8.26E+03
9.98E-01	4.51E+03	-1.04E+04	4.32E+03	-9.98E+03
7.92E-01	5.26E+03	-1.26E+04	5.06E+03	-1.21E+04
6.29E-01	6.23E+03	-1.53E+04	6.02E+03	-1.47E+04
5.00E-01	7.53E+03	-1.84E+04	7.27E+03	-1.77E+04
3.97E-01	9.19E+03	-2.22E+04	8.91E+03	-2.13E+04
3.15E-01	1.14E+04	-2.65E+04	1.11E+04	-2.55E+04
2.51E-01	1.43E+04	-3.16E+04	1.39E+04	-3.04E+04
1.99E-01	1.82E+04	-3.73E+04	1.76E+04	-3.60E+04
1.58E-01	2.32E+04	-4.39E+04	2.25E+04	-4.22E+04
1.26E-01	2.94E+04	-5.07E+04	2.85E+04	-4.88E+04
1.00E-01	3.72E+04	-5.79E+04	3.61E+04	-5.56E+04

Tab. A.5 Frequency dispersion of $CaCl_2$ solutions

	15		14	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	4.74E+02	-6.94E+03	2.44E+03	-5.62E+03
3.97E+06	1.06E+03	-8.36E+03	3.41E+03	-6.18E+03
3.15E+06	1.93E+03	-1.01E+04	4.72E+03	-6.67E+03
2.51E+06	2.95E+03	-1.21E+04	6.03E+03	-7.00E+03
1.99E+06	4.62E+03	-1.44E+04	7.62E+03	-6.98E+03
1.58E+06	6.60E+03	-1.70E+04	9.06E+03	-6.69E+03
1.26E+06	9.23E+03	-1.98E+04	1.04E+04	-6.19E+03
9.98E+05	1.32E+04	-2.24E+04	1.16E+04	-5.16E+03
7.92E+05	1.75E+04	-2.51E+04	1.24E+04	-4.48E+03
6.29E+05	2.29E+04	-2.74E+04	1.30E+04	-3.77E+03
5.00E+05	2.89E+04	-2.88E+04	1.35E+04	-3.14E+03
3.97E+05	3.53E+04	-2.87E+04	1.38E+04	-2.56E+03
3.15E+05	4.14E+04	-2.73E+04	1.40E+04	-2.07E+03
2.51E+05	4.69E+04	-2.50E+04	1.41E+04	-1.67E+03
1.99E+05	5.12E+04	-2.20E+04	1.42E+04	-1.35E+03
1.58E+05	5.45E+04	-1.88E+04	1.42E+04	-1.08E+03
1.26E+05	5.70E+04	-1.57E+04	1.43E+04	-8.56E+02
9.98E+04	5.86E+04	-1.29E+04	1.43E+04	-6.76E+02
7.92E+04	5.98E+04	-1.05E+04	1.44E+04	-5.30E+02
6.29E+04	6.06E+04	-8.58E+03	1.44E+04	-4.36E+02
5.00E+04	6.11E+04	-6.86E+03	1.44E+04	-3.36E+02
3.97E+04	6.14E+04	-5.45E+03	1.44E+04	-2.52E+02
3.15E+04	6.17E+04	-4.33E+03	1.44E+04	-1.89E+02
2.51E+04	6.18E+04	-3.35E+03	1.44E+04	-1.24E+02
1.99E+04	6.19E+04	-2.55E+03	1.44E+04	-6.81E+01
1.58E+04	6.19E+04	-1.88E+03	1.44E+04	-1.62E+01
1.26E+04	6.19E+04	-1.29E+03	1.44E+04	2.59E+01
9.98E+03	6.19E+04	-8.00E+02	1.44E+04	7.20E+01
7.92E+03	6.18E+04	-3.76E+02	1.43E+04	1.17E+02
6.29E+03	6.16E+04	-3.64E+01	1.43E+04	1.51E+02
5.00E+03	6.15E+04	2.38E+02	1.43E+04	1.79E+02
3.97E+03	6.12E+04	4.27E+02	1.42E+04	1.93E+02
3.15E+03	6.10E+04	5.30E+02	1.42E+04	1.95E+02
2.51E+03	6.08E+04	5.42E+02	1.41E+04	1.87E+02
1.99E+03	6.06E+04	5.50E+02	1.41E+04	1.60E+02
1.58E+03	6.05E+04	4.94E+02	1.40E+04	1.25E+02
1.26E+03	6.04E+04	4.15E+02	1.40E+04	9.57E+01
9.98E+02	6.03E+04	3.19E+02	1.40E+04	5.99E+01
7.92E+02	6.03E+04	2.32E+02	1.40E+04	2.89E+01
6.29E+02	6.03E+04	1.69E+02	1.40E+04	-1.51E+01
5.00E+02	6.02E+04	8.85E+01	1.40E+04	-4.78E+01
3.97E+02	6.02E+04	-1.96E+00	1.40E+04	-8.55E+01
3.15E+02	6.02E+04	-5.59E+01	1.40E+04	-1.26E+02

	15		14	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
2.51E+02	6.03E+04	-1.62E+02	1.40E+04	-1.87E+02
1.99E+02	6.03E+04	-2.24E+02	1.40E+04	-2.32E+02
1.58E+02	6.03E+04	-3.05E+02	1.40E+04	-2.91E+02
1.26E+02	6.03E+04	-4.07E+02	1.40E+04	-3.73E+02
9.98E+01	6.03E+04	-4.92E+02	1.40E+04	-4.63E+02
7.92E+01	6.03E+04	-6.29E+02	1.41E+04	-5.70E+02
6.29E+01	6.04E+04	-7.94E+02	1.41E+04	-7.05E+02
5.00E+01	6.04E+04	-4.57E+02	1.41E+04	-9.57E+02
3.97E+01	6.05E+04	-1.20E+03	1.42E+04	-1.06E+03
3.15E+01	6.05E+04	-1.48E+03	1.43E+04	-1.29E+03
2.51E+01	6.06E+04	-1.78E+03	1.43E+04	-1.57E+03
1.99E+01	6.08E+04	-2.17E+03	1.44E+04	-1.90E+03
1.58E+01	6.09E+04	-2.66E+03	1.46E+04	-2.31E+03
1.26E+01	6.11E+04	-3.22E+03	1.47E+04	-2.79E+03
9.98E+00	6.14E+04	-3.89E+03	1.49E+04	-3.38E+03
7.92E+00	6.17E+04	-4.69E+03	1.52E+04	-4.07E+03
6.29E+00	6.21E+04	-5.60E+03	1.55E+04	-4.89E+03
5.00E+00	6.25E+04	-6.69E+03	1.59E+04	-5.88E+03
3.97E+00	6.31E+04	-8.00E+03	1.64E+04	-7.05E+03
3.15E+00	6.38E+04	-9.48E+03	1.69E+04	-8.42E+03
2.51E+00	6.47E+04	-1.13E+04	1.77E+04	-1.00E+04
1.99E+00	6.58E+04	-1.34E+04	1.86E+04	-1.19E+04
1.58E+00	6.70E+04	-1.58E+04	1.97E+04	-1.41E+04
1.26E+00	6.86E+04	-1.88E+04	2.10E+04	-1.67E+04
9.98E-01	7.05E+04	-2.21E+04	2.26E+04	-1.96E+04
7.92E-01	7.29E+04	-2.60E+04	2.45E+04	-2.31E+04
6.29E-01	7.58E+04	-3.05E+04	2.67E+04	-2.72E+04
5.00E-01	7.93E+04	-3.54E+04	2.94E+04	-3.20E+04
3.97E-01	8.35E+04	-4.11E+04	3.26E+04	-3.75E+04
3.15E-01	8.87E+04	-4.76E+04	3.66E+04	-4.41E+04
2.51E-01	9.48E+04	-5.48E+04	4.15E+04	-5.18E+04
1.99E-01	1.02E+05	-6.31E+04	4.76E+04	-6.04E+04
1.58E-01	1.11E+05	-7.25E+04	5.58E+04	-7.04E+04
1.26E-01	1.22E+05	-8.27E+04	6.54E+04	-8.15E+04
1.00E-01	1.35E+05	-9.38E+04	7.75E+04	-9.32E+04

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	3.14E+03	-4.13E+03	3.06E+03	-2.22E+03
3.97E+06	3.95E+03	-4.14E+03	3.41E+03	-1.98E+03
3.15E+06	4.83E+03	-3.99E+03	3.72E+03	-1.70E+03
2.51E+06	5.58E+03	-3.75E+03	3.94E+03	-1.44E+03
1.99E+06	6.28E+03	-3.31E+03	4.09E+03	-1.17E+03
1.58E+06	6.81E+03	-2.87E+03	4.20E+03	-9.47E+02
1.26E+06	7.21E+03	-2.42E+03	4.26E+03	-7.56E+02
9.98E+05	7.51E+03	-1.79E+03	4.31E+03	-4.88E+02
7.92E+05	7.69E+03	-1.48E+03	4.33E+03	-3.95E+02
6.29E+05	7.81E+03	-1.20E+03	4.35E+03	-3.16E+02
5.00E+05	7.89E+03	-9.74E+02	4.36E+03	-2.53E+02
3.97E+05	7.94E+03	-7.82E+02	4.36E+03	-2.01E+02
3.15E+05	7.98E+03	-6.24E+02	4.37E+03	-1.59E+02
2.51E+05	8.00E+03	-5.00E+02	4.37E+03	-1.28E+02
1.99E+05	8.02E+03	-4.05E+02	4.37E+03	-1.04E+02
1.58E+05	8.03E+03	-3.22E+02	4.37E+03	-8.15E+01
1.26E+05	8.04E+03	-2.53E+02	4.38E+03	-6.28E+01
9.98E+04	8.05E+03	-1.98E+02	4.38E+03	-4.81E+01
7.92E+04	8.06E+03	-1.52E+02	4.38E+03	-3.70E+01
6.29E+04	8.06E+03	-1.28E+02	4.38E+03	-3.14E+01
5.00E+04	8.07E+03	-9.54E+01	4.38E+03	-2.18E+01
3.97E+04	8.07E+03	-6.81E+01	4.38E+03	-1.32E+01
3.15E+04	8.07E+03	-4.83E+01	4.38E+03	-7.76E+00
2.51E+04	8.07E+03	-2.42E+01	4.38E+03	9.95E-01
1.99E+04	8.07E+03	-2.95E+00	4.38E+03	8.37E+00
1.58E+04	8.06E+03	1.71E+01	4.38E+03	1.63E+01
1.26E+04	8.06E+03	3.59E+01	4.37E+03	2.40E+01
9.98E+03	8.05E+03	5.56E+01	4.37E+03	3.19E+01
7.92E+03	8.04E+03	7.44E+01	4.36E+03	4.06E+01
6.29E+03	8.01E+03	9.40E+01	4.35E+03	4.81E+01
5.00E+03	7.99E+03	1.04E+02	4.34E+03	5.16E+01
3.97E+03	7.97E+03	1.07E+02	4.33E+03	5.38E+01
3.15E+03	7.93E+03	1.10E+02	4.32E+03	4.20E+01
2.51E+03	7.90E+03	9.85E+01	4.30E+03	4.28E+01
1.99E+03	7.89E+03	8.08E+01	4.28E+03	3.30E+01
1.58E+03	7.87E+03	5.64E+01	4.27E+03	1.75E+01
1.26E+03	7.86E+03	3.60E+01	4.27E+03	3.26E-02
9.98E+02	7.84E+03	1.43E+01	4.26E+03	-1.70E+01
7.92E+02	7.84E+03	-1.20E+01	4.26E+03	-3.49E+01
6.29E+02	7.84E+03	-4.50E+01	4.26E+03	-5.45E+01
5.00E+02	7.85E+03	-7.08E+01	4.27E+03	-8.31E+01
3.97E+02	7.85E+03	-1.01E+02	4.26E+03	-1.06E+02
3.15E+02	7.85E+03	-1.36E+02	4.27E+03	-1.41E+02
2.51E+02	7.87E+03	-1.87E+02	4.28E+03	-1.71E+02

	13		12	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	7.88E+03	-2.32E+02	4.29E+03	-2.21E+02
1.58E+02	7.89E+03	-2.88E+02	4.30E+03	-2.75E+02
1.26E+02	7.90E+03	-3.59E+02	4.31E+03	-3.43E+02
9.98E+01	7.93E+03	-4.36E+02	4.33E+03	-4.30E+02
7.92E+01	7.95E+03	-5.41E+02	4.36E+03	-5.07E+02
6.29E+01	7.97E+03	-6.59E+02	4.39E+03	-6.21E+02
5.00E+01	8.02E+03	-7.57E+02	4.40E+03	-7.37E+02
3.97E+01	8.06E+03	-9.86E+02	4.48E+03	-9.10E+02
3.15E+01	8.12E+03	-1.20E+03	4.54E+03	-1.11E+03
2.51E+01	8.20E+03	-1.46E+03	4.61E+03	-1.33E+03
1.99E+01	8.30E+03	-1.77E+03	4.70E+03	-1.60E+03
1.58E+01	8.42E+03	-2.13E+03	4.81E+03	-1.95E+03
1.26E+01	8.57E+03	-2.58E+03	4.96E+03	-2.33E+03
9.98E+00	8.75E+03	-3.11E+03	5.15E+03	-2.79E+03
7.92E+00	8.99E+03	-3.73E+03	5.36E+03	-3.33E+03
6.29E+00	9.26E+03	-4.48E+03	5.62E+03	-3.98E+03
5.00E+00	9.64E+03	-5.37E+03	5.92E+03	-4.74E+03
3.97E+00	1.01E+04	-6.43E+03	6.30E+03	-5.65E+03
3.15E+00	1.06E+04	-7.65E+03	6.70E+03	-6.72E+03
2.51E+00	1.12E+04	-9.09E+03	7.19E+03	-8.01E+03
1.99E+00	1.19E+04	-1.08E+04	7.71E+03	-9.54E+03
1.58E+00	1.28E+04	-1.28E+04	8.35E+03	-1.14E+04
1.26E+00	1.39E+04	-1.52E+04	9.12E+03	-1.37E+04
9.98E-01	1.51E+04	-1.81E+04	1.00E+04	-1.64E+04
7.92E-01	1.66E+04	-2.15E+04	1.12E+04	-1.97E+04
6.29E-01	1.84E+04	-2.55E+04	1.25E+04	-2.37E+04
5.00E-01	2.07E+04	-3.04E+04	1.44E+04	-2.86E+04
3.97E-01	2.35E+04	-3.61E+04	1.66E+04	-3.43E+04
3.15E-01	2.70E+04	-4.29E+04	1.95E+04	-4.14E+04
2.51E-01	3.14E+04	-5.07E+04	2.33E+04	-4.96E+04
1.99E-01	3.71E+04	-5.99E+04	2.82E+04	-5.92E+04
1.58E-01	4.43E+04	-7.04E+04	3.47E+04	-7.06E+04
1.26E-01	5.37E+04	-8.20E+04	4.32E+04	-8.34E+04
1.00E-01	6.51E+04	-9.46E+04	5.37E+04	-9.76E+04

	11		10	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.62E+03	-1.30E+03	2.24E+03	-8.81E+02
3.97E+06	2.75E+03	-1.10E+03	2.31E+03	-7.27E+02
3.15E+06	2.87E+03	-9.06E+02	2.36E+03	-5.88E+02
2.51E+06	2.95E+03	-7.36E+02	2.40E+03	-4.71E+02
1.99E+06	3.00E+03	-5.82E+02	2.42E+03	-3.66E+02
1.58E+06	3.03E+03	-4.59E+02	2.43E+03	-2.84E+02
1.26E+06	3.05E+03	-3.59E+02	2.44E+03	-2.20E+02
9.98E+05	3.05E+03	-2.03E+02	2.43E+03	-1.08E+02
7.92E+05	3.06E+03	-1.64E+02	2.44E+03	-8.74E+01
6.29E+05	3.06E+03	-1.30E+02	2.44E+03	-6.94E+01
5.00E+05	3.07E+03	-1.04E+02	2.44E+03	-5.56E+01
3.97E+05	3.07E+03	-8.25E+01	2.44E+03	-4.35E+01
3.15E+05	3.07E+03	-6.44E+01	2.44E+03	-3.35E+01
2.51E+05	3.07E+03	-5.17E+01	2.44E+03	-2.73E+01
1.99E+05	3.07E+03	-4.25E+01	2.44E+03	-2.30E+01
1.58E+05	3.07E+03	-3.34E+01	2.44E+03	-1.75E+01
1.26E+05	3.07E+03	-2.53E+01	2.44E+03	-1.31E+01
9.98E+04	3.08E+03	-1.89E+01	2.44E+03	-9.60E+00
7.92E+04	3.08E+03	-1.45E+01	2.44E+03	-8.02E+00
6.29E+04	3.08E+03	-1.27E+01	2.44E+03	-6.63E+00
5.00E+04	3.08E+03	-7.84E+00	2.44E+03	-3.66E+00
3.97E+04	3.08E+03	-3.41E+00	2.44E+03	-9.19E-01
3.15E+04	3.08E+03	-1.14E+00	2.44E+03	3.55E-01
2.51E+04	3.08E+03	4.06E+00	2.44E+03	3.59E+00
1.99E+04	3.08E+03	8.30E+00	2.44E+03	6.31E+00
1.58E+04	3.07E+03	1.26E+01	2.44E+03	9.41E+00
1.26E+04	3.07E+03	1.73E+01	2.44E+03	1.24E+01
9.98E+03	3.07E+03	2.22E+01	2.44E+03	1.51E+01
7.92E+03	3.07E+03	2.76E+01	2.44E+03	1.92E+01
6.29E+03	3.06E+03	3.32E+01	2.43E+03	1.91E+01
5.00E+03	3.05E+03	3.33E+01	2.42E+03	2.39E+01
3.97E+03	3.04E+03	3.67E+01	2.42E+03	2.48E+01
3.15E+03	3.04E+03	2.99E+01	2.41E+03	2.07E+01
2.51E+03	3.03E+03	2.47E+01	2.41E+03	1.25E+01
1.99E+03	3.01E+03	2.08E+01	2.39E+03	1.09E+01
1.58E+03	3.01E+03	9.47E+00	2.39E+03	-1.53E+00
1.26E+03	3.00E+03	-1.86E+00	2.39E+03	-1.11E+01
9.98E+02	3.01E+03	-1.63E+01	2.39E+03	-2.44E+01
7.92E+02	3.00E+03	-3.05E+01	2.38E+03	-3.88E+01
6.29E+02	3.01E+03	-4.35E+01	2.39E+03	-5.12E+01
5.00E+02	3.01E+03	-6.31E+01	2.38E+03	-6.99E+01
3.97E+02	3.01E+03	-8.15E+01	2.39E+03	-9.25E+01
3.15E+02	3.01E+03	-1.07E+02	2.40E+03	-1.18E+02
2.51E+02	3.02E+03	-1.27E+02	2.41E+03	-1.51E+02

f / Hz	11		10	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	3.03E+03	-1.64E+02	2.42E+03	-1.85E+02
1.58E+02	3.04E+03	-2.02E+02	2.43E+03	-2.25E+02
1.26E+02	3.05E+03	-2.46E+02	2.44E+03	-2.74E+02
9.98E+01	3.07E+03	-2.94E+02	2.46E+03	-3.32E+02
7.92E+01	3.09E+03	-3.68E+02	2.48E+03	-4.03E+02
6.29E+01	3.12E+03	-4.48E+02	2.51E+03	-4.89E+02
5.00E+01	3.14E+03	-5.59E+02	2.54E+03	-5.73E+02
3.97E+01	3.19E+03	-6.52E+02	2.58E+03	-7.12E+02
3.15E+01	3.24E+03	-7.87E+02	2.64E+03	-8.57E+02
2.51E+01	3.30E+03	-9.46E+02	2.70E+03	-1.03E+03
1.99E+01	3.38E+03	-1.12E+03	2.77E+03	-1.23E+03
1.58E+01	3.46E+03	-1.35E+03	2.86E+03	-1.48E+03
1.26E+01	3.58E+03	-1.60E+03	2.96E+03	-1.76E+03
9.98E+00	3.70E+03	-1.90E+03	3.08E+03	-2.11E+03
7.92E+00	3.84E+03	-2.24E+03	3.22E+03	-2.52E+03
6.29E+00	4.01E+03	-2.69E+03	3.38E+03	-3.02E+03
5.00E+00	4.19E+03	-3.20E+03	3.59E+03	-3.63E+03
3.97E+00	4.42E+03	-3.83E+03	3.80E+03	-4.35E+03
3.15E+00	4.66E+03	-4.58E+03	4.08E+03	-5.25E+03
2.51E+00	4.95E+03	-5.50E+03	4.39E+03	-6.32E+03
1.99E+00	5.32E+03	-6.60E+03	4.77E+03	-7.61E+03
1.58E+00	5.74E+03	-7.95E+03	5.22E+03	-9.17E+03
1.26E+00	6.30E+03	-9.59E+03	5.80E+03	-1.11E+04
9.98E-01	6.94E+03	-1.15E+04	6.49E+03	-1.34E+04
7.92E-01	7.72E+03	-1.39E+04	7.35E+03	-1.62E+04
6.29E-01	8.63E+03	-1.68E+04	8.36E+03	-1.97E+04
5.00E-01	9.80E+03	-2.03E+04	9.70E+03	-2.38E+04
3.97E-01	1.12E+04	-2.46E+04	1.14E+04	-2.88E+04
3.15E-01	1.30E+04	-2.98E+04	1.35E+04	-3.49E+04
2.51E-01	1.52E+04	-3.62E+04	1.63E+04	-4.22E+04
1.99E-01	1.83E+04	-4.40E+04	2.01E+04	-5.10E+04
1.58E-01	2.21E+04	-5.34E+04	2.49E+04	-6.12E+04
1.26E-01	2.73E+04	-6.45E+04	3.13E+04	-7.35E+04
1.00E-01	3.38E+04	-7.77E+04	3.99E+04	-8.73E+04

f / Hz	09		08	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.05E+03	-7.01E+02	1.81E+03	-5.24E+02
3.97E+06	2.09E+03	-5.75E+02	1.83E+03	-4.28E+02
3.15E+06	2.12E+03	-4.64E+02	1.85E+03	-3.43E+02
2.51E+06	2.15E+03	-3.69E+02	1.86E+03	-2.70E+02
1.99E+06	2.16E+03	-2.84E+02	1.87E+03	-2.06E+02
1.58E+06	2.17E+03	-2.20E+02	1.87E+03	-1.58E+02
1.26E+06	2.17E+03	-1.68E+02	1.87E+03	-1.19E+02
9.98E+05	2.16E+03	-7.42E+01	1.86E+03	-4.38E+01
7.92E+05	2.16E+03	-5.99E+01	1.86E+03	-3.56E+01
6.29E+05	2.16E+03	-4.72E+01	1.86E+03	-2.75E+01
5.00E+05	2.16E+03	-3.78E+01	1.86E+03	-2.19E+01
3.97E+05	2.16E+03	-2.90E+01	1.86E+03	-1.66E+01
3.15E+05	2.16E+03	-2.21E+01	1.86E+03	-1.26E+01
2.51E+05	2.16E+03	-1.83E+01	1.86E+03	-1.06E+01
1.99E+05	2.16E+03	-1.53E+01	1.86E+03	-9.24E+00
1.58E+05	2.16E+03	-1.15E+01	1.86E+03	-6.79E+00
1.26E+05	2.17E+03	-8.35E+00	1.87E+03	-4.54E+00
9.98E+04	2.17E+03	-6.07E+00	1.87E+03	-3.31E+00
7.92E+04	2.17E+03	-5.28E+00	1.87E+03	-3.26E+00
6.29E+04	2.17E+03	-4.33E+00	1.87E+03	-2.55E+00
5.00E+04	2.17E+03	-2.09E+00	1.87E+03	-9.05E-01
3.97E+04	2.17E+03	2.58E-01	1.87E+03	7.89E-01
3.15E+04	2.17E+03	1.10E+00	1.87E+03	1.14E+00
2.51E+04	2.17E+03	3.92E+00	1.87E+03	3.42E+00
1.99E+04	2.16E+03	6.52E+00	1.87E+03	5.49E+00
1.58E+04	2.16E+03	8.50E+00	1.86E+03	6.70E+00
1.26E+04	2.17E+03	1.23E+01	1.87E+03	6.73E+00
9.98E+03	2.16E+03	1.16E+01	1.87E+03	1.00E+01
7.92E+03	2.16E+03	1.80E+01	1.86E+03	1.44E+01
6.29E+03	2.16E+03	1.91E+01	1.86E+03	1.03E+01
5.00E+03	2.15E+03	2.03E+01	1.85E+03	1.50E+01
3.97E+03	2.14E+03	2.29E+01	1.85E+03	1.82E+01
3.15E+03	2.15E+03	1.36E+01	1.85E+03	1.34E+01
2.51E+03	2.13E+03	1.41E+01	1.83E+03	1.31E+01
1.99E+03	2.12E+03	1.05E+01	1.83E+03	5.59E+00
1.58E+03	2.12E+03	9.85E-01	1.83E+03	-2.34E+00
1.26E+03	2.12E+03	-7.29E+00	1.83E+03	-1.26E+01
9.98E+02	2.11E+03	-1.88E+01	1.83E+03	-2.34E+01
7.92E+02	2.12E+03	-3.29E+01	1.82E+03	-3.64E+01
6.29E+02	2.12E+03	-4.24E+01	1.83E+03	-4.71E+01
5.00E+02	2.12E+03	-5.85E+01	1.83E+03	-6.35E+01
3.97E+02	2.12E+03	-7.52E+01	1.84E+03	-8.22E+01
3.15E+02	2.13E+03	-9.94E+01	1.84E+03	-1.03E+02
2.51E+02	2.13E+03	-1.15E+02	1.85E+03	-1.24E+02

	09		08	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
1.99E+02	2.14E+03	-1.43E+02	1.85E+03	-1.55E+02
1.58E+02	2.15E+03	-1.79E+02	1.86E+03	-1.87E+02
1.26E+02	2.16E+03	-2.23E+02	1.88E+03	-2.29E+02
9.98E+01	2.18E+03	-2.77E+02	1.88E+03	-2.71E+02
7.92E+01	2.19E+03	-3.26E+02	1.91E+03	-3.43E+02
6.29E+01	2.22E+03	-3.98E+02	1.93E+03	-4.09E+02
5.00E+01	2.25E+03	-4.95E+02	1.96E+03	-5.23E+02
3.97E+01	2.28E+03	-5.92E+02	2.00E+03	-6.11E+02
3.15E+01	2.32E+03	-7.11E+02	2.04E+03	-7.39E+02
2.51E+01	2.37E+03	-8.60E+02	2.09E+03	-8.92E+02
1.99E+01	2.43E+03	-1.03E+03	2.15E+03	-1.08E+03
1.58E+01	2.51E+03	-1.23E+03	2.21E+03	-1.29E+03
1.26E+01	2.59E+03	-1.48E+03	2.31E+03	-1.55E+03
9.98E+00	2.70E+03	-1.77E+03	2.42E+03	-1.85E+03
7.92E+00	2.82E+03	-2.13E+03	2.53E+03	-2.24E+03
6.29E+00	2.96E+03	-2.53E+03	2.68E+03	-2.67E+03
5.00E+00	3.12E+03	-3.03E+03	2.83E+03	-3.21E+03
3.97E+00	3.31E+03	-3.63E+03	3.04E+03	-3.85E+03
3.15E+00	3.55E+03	-4.36E+03	3.26E+03	-4.66E+03
2.51E+00	3.81E+03	-5.25E+03	3.53E+03	-5.62E+03
1.99E+00	4.12E+03	-6.34E+03	3.86E+03	-6.80E+03
1.58E+00	4.49E+03	-7.64E+03	4.25E+03	-8.22E+03
1.26E+00	4.95E+03	-9.23E+03	4.75E+03	-9.95E+03
9.98E-01	5.51E+03	-1.12E+04	5.34E+03	-1.21E+04
7.92E-01	6.18E+03	-1.35E+04	6.06E+03	-1.46E+04
6.29E-01	7.00E+03	-1.63E+04	6.92E+03	-1.76E+04
5.00E-01	8.09E+03	-1.99E+04	8.04E+03	-2.15E+04
3.97E-01	9.34E+03	-2.40E+04	9.38E+03	-2.60E+04
3.15E-01	1.09E+04	-2.92E+04	1.11E+04	-3.15E+04
2.51E-01	1.30E+04	-3.53E+04	1.33E+04	-3.82E+04
1.99E-01	1.55E+04	-4.29E+04	1.60E+04	-4.64E+04
1.58E-01	1.87E+04	-5.20E+04	1.97E+04	-5.63E+04
1.26E-01	2.30E+04	-6.31E+04	2.47E+04	-6.81E+04
1.00E-01	2.85E+04	-7.61E+04	3.09E+04	-8.20E+04

	07		06	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	1.70E+03	-4.49E+02	1.60E+03	-3.94E+02
3.97E+06	1.71E+03	-3.67E+02	1.61E+03	-3.20E+02
3.15E+06	1.73E+03	-2.94E+02	1.62E+03	-2.55E+02
2.51E+06	1.74E+03	-2.30E+02	1.63E+03	-1.99E+02
1.99E+06	1.74E+03	-1.76E+02	1.63E+03	-1.51E+02
1.58E+06	1.74E+03	-1.33E+02	1.63E+03	-1.13E+02
1.26E+06	1.74E+03	-9.97E+01	1.63E+03	-8.48E+01
9.98E+05	1.73E+03	-3.21E+01	1.62E+03	-2.32E+01
7.92E+05	1.73E+03	-2.61E+01	1.62E+03	-1.90E+01
6.29E+05	1.73E+03	-2.02E+01	1.62E+03	-1.47E+01
5.00E+05	1.73E+03	-1.60E+01	1.62E+03	-1.15E+01
3.97E+05	1.73E+03	-1.20E+01	1.62E+03	-8.47E+00
3.15E+05	1.73E+03	-9.02E+00	1.62E+03	-6.26E+00
2.51E+05	1.73E+03	-7.62E+00	1.62E+03	-5.28E+00
1.99E+05	1.73E+03	-6.97E+00	1.62E+03	-5.23E+00
1.58E+05	1.73E+03	-5.05E+00	1.62E+03	-3.56E+00
1.26E+05	1.73E+03	-3.50E+00	1.62E+03	-2.39E+00
9.98E+04	1.74E+03	-2.26E+00	1.62E+03	-1.39E+00
7.92E+04	1.74E+03	-2.68E+00	1.62E+03	-2.10E+00
6.29E+04	1.73E+03	-1.93E+00	1.62E+03	-1.31E+00
5.00E+04	1.73E+03	-5.31E-01	1.62E+03	-2.58E-01
3.97E+04	1.73E+03	1.02E+00	1.62E+03	1.05E+00
3.15E+04	1.73E+03	1.18E+00	1.62E+03	1.16E+00
2.51E+04	1.73E+03	2.96E+00	1.62E+03	2.95E+00
1.99E+04	1.73E+03	4.60E+00	1.62E+03	4.18E+00
1.58E+04	1.73E+03	6.20E+00	1.62E+03	5.21E+00
1.26E+04	1.73E+03	7.41E+00	1.62E+03	6.36E+00
9.98E+03	1.73E+03	1.12E+01	1.62E+03	1.07E+01
7.92E+03	1.73E+03	1.10E+01	1.62E+03	1.14E+01
6.29E+03	1.73E+03	8.57E+00	1.61E+03	1.48E+01
5.00E+03	1.72E+03	1.30E+01	1.61E+03	9.49E+00
3.97E+03	1.72E+03	1.37E+01	1.61E+03	1.16E+01
3.15E+03	1.71E+03	1.30E+01	1.60E+03	8.21E+00
2.51E+03	1.72E+03	4.96E+00	1.59E+03	1.12E+01
1.99E+03	1.71E+03	1.90E+00	1.59E+03	6.31E-02
1.58E+03	1.70E+03	-4.11E+00	1.59E+03	-9.00E+00
1.26E+03	1.70E+03	-1.54E+01	1.59E+03	-1.76E+01
9.98E+02	1.69E+03	-2.61E+01	1.59E+03	-2.92E+01
7.92E+02	1.70E+03	-3.97E+01	1.58E+03	-4.03E+01
6.29E+02	1.70E+03	-5.00E+01	1.59E+03	-5.26E+01
5.00E+02	1.70E+03	-6.64E+01	1.58E+03	-6.98E+01
3.97E+02	1.71E+03	-8.73E+01	1.60E+03	-9.10E+01
3.15E+02	1.71E+03	-1.10E+02	1.60E+03	-1.16E+02
2.51E+02	1.72E+03	-1.32E+02	1.61E+03	-1.41E+02

f / Hz	07		06	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.73E+03	-1.65E+02	1.62E+03	-1.61E+02
1.58E+02	1.74E+03	-2.04E+02	1.63E+03	-2.08E+02
1.26E+02	1.75E+03	-2.44E+02	1.64E+03	-2.49E+02
9.98E+01	1.76E+03	-2.95E+02	1.65E+03	-2.97E+02
7.92E+01	1.79E+03	-3.61E+02	1.68E+03	-3.69E+02
6.29E+01	1.81E+03	-4.47E+02	1.70E+03	-4.58E+02
5.00E+01	1.85E+03	-5.44E+02	1.74E+03	-5.47E+02
3.97E+01	1.88E+03	-6.51E+02	1.77E+03	-6.63E+02
3.15E+01	1.92E+03	-7.84E+02	1.82E+03	-7.97E+02
2.51E+01	1.97E+03	-9.42E+02	1.87E+03	-9.60E+02
1.99E+01	2.03E+03	-1.12E+03	1.93E+03	-1.15E+03
1.58E+01	2.11E+03	-1.37E+03	2.01E+03	-1.39E+03
1.26E+01	2.20E+03	-1.63E+03	2.10E+03	-1.66E+03
9.98E+00	2.30E+03	-1.95E+03	2.20E+03	-1.99E+03
7.92E+00	2.43E+03	-2.37E+03	2.32E+03	-2.41E+03
6.29E+00	2.57E+03	-2.83E+03	2.46E+03	-2.89E+03
5.00E+00	2.74E+03	-3.41E+03	2.65E+03	-3.48E+03
3.97E+00	2.94E+03	-4.12E+03	2.85E+03	-4.20E+03
3.15E+00	3.19E+03	-4.96E+03	3.06E+03	-5.08E+03
2.51E+00	3.48E+03	-6.00E+03	3.36E+03	-6.14E+03
1.99E+00	3.81E+03	-7.26E+03	3.69E+03	-7.43E+03
1.58E+00	4.23E+03	-8.77E+03	4.09E+03	-9.00E+03
1.26E+00	4.73E+03	-1.07E+04	4.62E+03	-1.09E+04
9.98E-01	5.36E+03	-1.29E+04	5.19E+03	-1.33E+04
7.92E-01	6.09E+03	-1.57E+04	5.95E+03	-1.61E+04
6.29E-01	7.01E+03	-1.90E+04	6.87E+03	-1.96E+04
5.00E-01	8.17E+03	-2.31E+04	8.03E+03	-2.38E+04
3.97E-01	9.61E+03	-2.81E+04	9.53E+03	-2.90E+04
3.15E-01	1.15E+04	-3.41E+04	1.15E+04	-3.52E+04
2.51E-01	1.41E+04	-4.15E+04	1.40E+04	-4.28E+04
1.99E-01	1.73E+04	-5.03E+04	1.72E+04	-5.19E+04
1.58E-01	2.16E+04	-6.08E+04	2.16E+04	-6.29E+04
1.26E-01	2.73E+04	-7.34E+04	2.72E+04	-7.60E+04
1.00E-01	3.47E+04	-8.79E+04	3.45E+04	-9.13E+04

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.53E+03	-3.51E+02	1.42E+03	-2.99E+02
3.97E+06	1.53E+03	-2.84E+02	1.42E+03	-2.43E+02
3.15E+06	1.54E+03	-2.25E+02	1.43E+03	-1.93E+02
2.51E+06	1.54E+03	-1.76E+02	1.43E+03	-1.50E+02
1.99E+06	1.54E+03	-1.33E+02	1.43E+03	-1.12E+02
1.58E+06	1.54E+03	-9.89E+01	1.43E+03	-8.39E+01
1.26E+06	1.54E+03	-7.35E+01	1.43E+03	-6.19E+01
9.98E+05	1.53E+03	-1.66E+01	1.42E+03	-1.01E+01
7.92E+05	1.53E+03	-1.37E+01	1.42E+03	-8.62E+00
6.29E+05	1.53E+03	-1.05E+01	1.42E+03	-6.49E+00
5.00E+05	1.53E+03	-8.33E+00	1.42E+03	-5.26E+00
3.97E+05	1.53E+03	-6.00E+00	1.42E+03	-3.63E+00
3.15E+05	1.53E+03	-4.25E+00	1.42E+03	-2.28E+00
2.51E+05	1.53E+03	-3.71E+00	1.42E+03	-2.21E+00
1.99E+05	1.53E+03	-3.94E+00	1.42E+03	-2.53E+00
1.58E+05	1.53E+03	-2.59E+00	1.42E+03	-1.74E+00
1.26E+05	1.53E+03	-1.76E+00	1.42E+03	-8.95E-01
9.98E+04	1.53E+03	-1.05E+00	1.42E+03	-6.13E-01
7.92E+04	1.53E+03	-2.00E+00	1.42E+03	-1.67E+00
6.29E+04	1.53E+03	-1.00E+00	1.42E+03	-6.84E-01
5.00E+04	1.53E+03	-9.60E-03	1.42E+03	1.99E-01
3.97E+04	1.53E+03	1.11E+00	1.42E+03	1.05E+00
3.15E+04	1.53E+03	1.05E+00	1.42E+03	1.01E+00
2.51E+04	1.53E+03	2.56E+00	1.42E+03	2.23E+00
1.99E+04	1.53E+03	3.38E+00	1.42E+03	3.18E+00
1.58E+04	1.53E+03	4.52E+00	1.42E+03	4.23E+00
1.26E+04	1.53E+03	2.50E+00	1.42E+03	6.27E+00
9.98E+03	1.53E+03	9.30E+00	1.42E+03	5.56E+00
7.92E+03	1.52E+03	8.58E+00	1.42E+03	6.93E+00
6.29E+03	1.52E+03	1.14E+01	1.42E+03	1.05E+01
5.00E+03	1.51E+03	9.40E+00	1.41E+03	6.85E+00
3.97E+03	1.51E+03	1.08E+01	1.41E+03	8.14E+00
3.15E+03	1.52E+03	1.70E+00	1.40E+03	9.67E+00
2.51E+03	1.50E+03	4.05E+00	1.40E+03	4.12E-02
1.99E+03	1.50E+03	-2.66E+00	1.40E+03	-3.55E+00
1.58E+03	1.50E+03	-1.20E+01	1.40E+03	-1.09E+01
1.26E+03	1.50E+03	-1.90E+01	1.40E+03	-2.04E+01
9.98E+02	1.50E+03	-3.45E+01	1.40E+03	-3.41E+01
7.92E+02	1.49E+03	-4.42E+01	1.40E+03	-4.64E+01
6.29E+02	1.50E+03	-5.77E+01	1.40E+03	-5.48E+01
5.00E+02	1.50E+03	-7.53E+01	1.40E+03	-7.20E+01
3.97E+02	1.50E+03	-9.34E+01	1.41E+03	-9.47E+01
3.15E+02	1.51E+03	-1.21E+02	1.41E+03	-1.19E+02
2.51E+02	1.52E+03	-1.43E+02	1.42E+03	-1.41E+02

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.53E+03	-1.73E+02	1.43E+03	-1.76E+02
1.58E+02	1.54E+03	-2.19E+02	1.44E+03	-2.14E+02
1.26E+02	1.55E+03	-2.59E+02	1.46E+03	-2.59E+02
9.98E+01	1.58E+03	-3.11E+02	1.47E+03	-3.26E+02
7.92E+01	1.59E+03	-3.84E+02	1.49E+03	-3.85E+02
6.29E+01	1.62E+03	-4.70E+02	1.52E+03	-4.59E+02
5.00E+01	1.66E+03	-5.75E+02	1.56E+03	-5.60E+02
3.97E+01	1.69E+03	-6.85E+02	1.59E+03	-6.79E+02
3.15E+01	1.73E+03	-8.23E+02	1.64E+03	-8.21E+02
2.51E+01	1.79E+03	-9.88E+02	1.69E+03	-9.89E+02
1.99E+01	1.86E+03	-1.19E+03	1.76E+03	-1.18E+03
1.58E+01	1.93E+03	-1.44E+03	1.84E+03	-1.41E+03
1.26E+01	2.02E+03	-1.71E+03	1.93E+03	-1.70E+03
9.98E+00	2.13E+03	-2.04E+03	2.03E+03	-2.04E+03
7.92E+00	2.25E+03	-2.45E+03	2.16E+03	-2.44E+03
6.29E+00	2.40E+03	-2.96E+03	2.30E+03	-2.95E+03
5.00E+00	2.57E+03	-3.56E+03	2.48E+03	-3.55E+03
3.97E+00	2.77E+03	-4.29E+03	2.68E+03	-4.28E+03
3.15E+00	2.98E+03	-5.20E+03	2.92E+03	-5.18E+03
2.51E+00	3.25E+03	-6.29E+03	3.18E+03	-6.26E+03
1.99E+00	3.58E+03	-7.63E+03	3.52E+03	-7.59E+03
1.58E+00	3.96E+03	-9.26E+03	3.90E+03	-9.20E+03
1.26E+00	4.44E+03	-1.13E+04	4.40E+03	-1.12E+04
9.98E-01	4.97E+03	-1.37E+04	4.95E+03	-1.36E+04
7.92E-01	5.71E+03	-1.67E+04	5.67E+03	-1.66E+04
6.29E-01	6.57E+03	-2.04E+04	6.56E+03	-2.02E+04
5.00E-01	7.74E+03	-2.49E+04	7.79E+03	-2.47E+04
3.97E-01	9.20E+03	-3.04E+04	9.25E+03	-3.01E+04
3.15E-01	1.11E+04	-3.70E+04	1.12E+04	-3.66E+04
2.51E-01	1.36E+04	-4.51E+04	1.38E+04	-4.45E+04
1.99E-01	1.69E+04	-5.48E+04	1.70E+04	-5.41E+04
1.58E-01	2.13E+04	-6.63E+04	2.14E+04	-6.55E+04
1.26E-01	2.72E+04	-8.01E+04	2.72E+04	-7.91E+04
1.00E-01	3.48E+04	-9.61E+04	3.47E+04	-9.50E+04

f / Hz	03		02	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.38E+03	-2.80E+02	1.38E+03	-2.77E+02
3.97E+06	1.38E+03	-2.27E+02	1.37E+03	-2.24E+02
3.15E+06	1.39E+03	-1.79E+02	1.38E+03	-1.77E+02
2.51E+06	1.39E+03	-1.40E+02	1.38E+03	-1.37E+02
1.99E+06	1.39E+03	-1.04E+02	1.38E+03	-1.02E+02
1.58E+06	1.39E+03	-7.73E+01	1.38E+03	-7.59E+01
1.26E+06	1.39E+03	-5.71E+01	1.37E+03	-5.56E+01
9.98E+05	1.38E+03	-7.22E+00	1.37E+03	-6.23E+00
7.92E+05	1.38E+03	-6.54E+00	1.36E+03	-5.68E+00
6.29E+05	1.38E+03	-4.90E+00	1.36E+03	-4.13E+00
5.00E+05	1.38E+03	-3.97E+00	1.36E+03	-3.36E+00
3.97E+05	1.38E+03	-2.63E+00	1.36E+03	-2.12E+00
3.15E+05	1.38E+03	-1.52E+00	1.36E+03	-1.12E+00
2.51E+05	1.38E+03	-1.64E+00	1.36E+03	-1.27E+00
1.99E+05	1.38E+03	-2.04E+00	1.36E+03	-1.66E+00
1.58E+05	1.38E+03	-1.39E+00	1.36E+03	-1.05E+00
1.26E+05	1.38E+03	-6.03E-01	1.36E+03	-4.29E-01
9.98E+04	1.38E+03	-4.90E-01	1.37E+03	-3.54E-01
7.92E+04	1.38E+03	-1.50E+00	1.37E+03	-1.43E+00
6.29E+04	1.38E+03	-4.76E-01	1.36E+03	-3.46E-01
5.00E+04	1.38E+03	3.51E-01	1.36E+03	4.34E-01
3.97E+04	1.38E+03	1.19E+00	1.36E+03	1.17E+00
3.15E+04	1.38E+03	8.92E-01	1.36E+03	1.13E+00
2.51E+04	1.38E+03	2.30E+00	1.36E+03	2.48E+00
1.99E+04	1.38E+03	3.21E+00	1.36E+03	3.16E+00
1.58E+04	1.38E+03	4.01E+00	1.36E+03	3.70E+00
1.26E+04	1.38E+03	4.80E+00	1.36E+03	3.14E+00
9.98E+03	1.38E+03	5.04E+00	1.36E+03	5.83E+00
7.92E+03	1.38E+03	7.87E+00	1.36E+03	8.69E+00
6.29E+03	1.38E+03	4.50E+00	1.36E+03	7.48E+00
5.00E+03	1.37E+03	7.56E+00	1.35E+03	4.62E+00
3.97E+03	1.37E+03	7.78E+00	1.35E+03	5.74E+00
3.15E+03	1.38E+03	-1.71E-01	1.34E+03	4.76E+00
2.51E+03	1.36E+03	5.99E+00	1.35E+03	-6.55E+00
1.99E+03	1.36E+03	-5.54E+00	1.34E+03	-6.62E+00
1.58E+03	1.36E+03	-1.47E+01	1.34E+03	-1.57E+01
1.26E+03	1.36E+03	-2.27E+01	1.34E+03	-2.49E+01
9.98E+02	1.36E+03	-3.36E+01	1.34E+03	-3.81E+01
7.92E+02	1.36E+03	-4.81E+01	1.34E+03	-4.75E+01
6.29E+02	1.36E+03	-5.73E+01	1.34E+03	-5.99E+01
5.00E+02	1.36E+03	-7.72E+01	1.34E+03	-7.87E+01
3.97E+02	1.37E+03	-9.68E+01	1.35E+03	-9.95E+01
3.15E+02	1.38E+03	-1.22E+02	1.35E+03	-1.26E+02
2.51E+02	1.39E+03	-1.45E+02	1.36E+03	-1.44E+02

f / Hz	03		02	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	1.39E+03	-1.75E+02	1.37E+03	-1.83E+02
1.58E+02	1.40E+03	-2.23E+02	1.38E+03	-2.23E+02
1.26E+02	1.42E+03	-2.66E+02	1.40E+03	-2.71E+02
9.98E+01	1.43E+03	-3.23E+02	1.42E+03	-3.39E+02
7.92E+01	1.46E+03	-3.94E+02	1.44E+03	-4.03E+02
6.29E+01	1.49E+03	-4.79E+02	1.47E+03	-4.90E+02
5.00E+01	1.52E+03	-5.92E+02	1.49E+03	-5.90E+02
3.97E+01	1.56E+03	-6.99E+02	1.54E+03	-7.09E+02
3.15E+01	1.61E+03	-8.39E+02	1.60E+03	-8.52E+02
2.51E+01	1.67E+03	-1.01E+03	1.66E+03	-1.02E+03
1.99E+01	1.74E+03	-1.20E+03	1.73E+03	-1.21E+03
1.58E+01	1.81E+03	-1.45E+03	1.81E+03	-1.47E+03
1.26E+01	1.92E+03	-1.73E+03	1.91E+03	-1.74E+03
9.98E+00	2.03E+03	-2.08E+03	2.02E+03	-2.08E+03
7.92E+00	2.16E+03	-2.48E+03	2.15E+03	-2.51E+03
6.29E+00	2.30E+03	-2.98E+03	2.29E+03	-2.99E+03
5.00E+00	2.46E+03	-3.59E+03	2.44E+03	-3.59E+03
3.97E+00	2.68E+03	-4.33E+03	2.64E+03	-4.33E+03
3.15E+00	2.89E+03	-5.23E+03	2.83E+03	-5.25E+03
2.51E+00	3.18E+03	-6.33E+03	3.07E+03	-6.37E+03
1.99E+00	3.49E+03	-7.69E+03	3.37E+03	-7.75E+03
1.58E+00	3.88E+03	-9.32E+03	3.71E+03	-9.45E+03
1.26E+00	4.39E+03	-1.13E+04	4.15E+03	-1.15E+04
9.98E-01	4.94E+03	-1.38E+04	4.68E+03	-1.41E+04
7.92E-01	5.67E+03	-1.68E+04	5.37E+03	-1.73E+04
6.29E-01	6.60E+03	-2.05E+04	6.20E+03	-2.11E+04
5.00E-01	7.78E+03	-2.50E+04	7.39E+03	-2.59E+04
3.97E-01	9.31E+03	-3.06E+04	8.83E+03	-3.17E+04
3.15E-01	1.13E+04	-3.73E+04	1.08E+04	-3.87E+04
2.51E-01	1.39E+04	-4.54E+04	1.33E+04	-4.71E+04
1.99E-01	1.72E+04	-5.51E+04	1.67E+04	-5.73E+04
1.58E-01	2.16E+04	-6.68E+04	2.11E+04	-6.95E+04
1.26E-01	2.74E+04	-8.08E+04	2.70E+04	-8.41E+04
1.00E-01	3.53E+04	-9.70E+04	3.48E+04	-1.01E+05

Tab. A. 6 Frequency dispersion of $MgCl_2$ solutions

	14		13	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	1.74E+03	-5.48E+03	3.24E+03	-4.60E+03
3.97E+06	2.66E+03	-6.21E+03	4.13E+03	-4.62E+03
3.15E+06	3.83E+03	-6.93E+03	5.06E+03	-4.57E+03
2.51E+06	5.17E+03	-7.46E+03	5.92E+03	-4.33E+03
1.99E+06	6.78E+03	-7.81E+03	6.76E+03	-3.96E+03
1.58E+06	8.44E+03	-7.93E+03	7.44E+03	-3.52E+03
1.26E+06	1.00E+04	-7.73E+03	7.97E+03	-3.05E+03
9.98E+05	1.17E+04	-7.27E+03	8.39E+03	-2.56E+03
7.92E+05	1.30E+04	-6.52E+03	8.64E+03	-2.10E+03
6.29E+05	1.40E+04	-5.67E+03	8.89E+03	-1.61E+03
5.00E+05	1.50E+04	-4.74E+03	9.02E+03	-1.32E+03
3.97E+05	1.56E+04	-3.97E+03	9.10E+03	-1.06E+03
3.15E+05	1.60E+04	-3.24E+03	9.16E+03	-8.48E+02
2.51E+05	1.63E+04	-2.65E+03	9.20E+03	-6.81E+02
1.99E+05	1.65E+04	-2.15E+03	9.23E+03	-5.51E+02
1.58E+05	1.66E+04	-1.72E+03	9.25E+03	-4.37E+02
1.26E+05	1.67E+04	-1.37E+03	9.27E+03	-3.43E+02
9.98E+04	1.68E+04	-1.08E+03	9.28E+03	-2.67E+02
7.92E+04	1.69E+04	-8.57E+02	9.29E+03	-2.08E+02
6.29E+04	1.68E+04	-7.04E+02	9.28E+03	-1.75E+02
5.00E+04	1.69E+04	-5.52E+02	9.29E+03	-1.32E+02
3.97E+04	1.69E+04	-4.20E+02	9.29E+03	-9.66E+01
3.15E+04	1.69E+04	-3.20E+02	9.29E+03	-6.99E+01
2.51E+04	1.69E+04	-2.16E+02	9.29E+03	-3.96E+01
1.99E+04	1.69E+04	-7.69E+01	9.29E+03	-1.16E+01
1.58E+04	1.69E+04	-6.31E+01	9.28E+03	1.26E+01
1.26E+04	1.69E+04	1.81E+01	9.27E+03	3.88E+01
9.98E+03	1.69E+04	1.25E+02	9.26E+03	5.73E+01
7.92E+03	1.68E+04	1.66E+02	9.25E+03	8.43E+01
6.29E+03	1.67E+04	2.52E+02	9.23E+03	9.90E+01
5.00E+03	1.67E+04	2.65E+02	9.19E+03	1.14E+02
3.97E+03	1.67E+04	2.99E+02	9.16E+03	1.23E+02
3.15E+03	1.67E+04	2.42E+02	9.13E+03	1.20E+02
2.51E+03	1.66E+04	2.57E+02	9.08E+03	1.17E+02
1.99E+03	1.64E+04	2.95E+02	9.06E+03	9.68E+01
1.58E+03	1.64E+04	2.62E+02	9.04E+03	7.40E+01
1.26E+03	1.63E+04	2.17E+02	9.03E+03	5.06E+01
9.98E+02	1.63E+04	1.32E+02	9.02E+03	2.53E+01
7.92E+02	1.63E+04	1.01E+02	9.01E+03	1.17E+00
6.29E+02	1.62E+04	6.77E+01	9.01E+03	-3.02E+01
5.00E+02	1.61E+04	5.60E+01	9.01E+03	-5.35E+01
3.97E+02	1.62E+04	-2.06E+01	9.01E+03	-8.37E+01
3.15E+02	1.62E+04	-8.06E+01	9.01E+03	-1.17E+02

f / Hz	14		13	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
2.51E+02	1.62E+04	-4.45E+01	9.02E+03	-1.69E+02
1.99E+02	1.62E+04	-1.37E+02	9.03E+03	-2.09E+02
1.58E+02	1.62E+04	-2.95E+02	9.04E+03	-2.47E+02
1.26E+02	1.62E+04	-2.90E+02	9.05E+03	-3.08E+02
9.98E+01	1.63E+04	-3.57E+02	9.08E+03	-3.74E+02
7.92E+01	1.63E+04	-4.63E+02	9.10E+03	-4.65E+02
6.29E+01	1.64E+04	-5.41E+02	9.14E+03	-5.83E+02
5.00E+01	1.69E+04	-8.13E+02	8.95E+03	-8.10E+02
3.97E+01	1.64E+04	-9.25E+02	9.21E+03	-8.44E+02
3.15E+01	1.65E+04	-1.16E+03	9.27E+03	-1.02E+03
2.51E+01	1.66E+04	-1.34E+03	9.35E+03	-1.23E+03
1.99E+01	1.67E+04	-1.58E+03	9.43E+03	-1.48E+03
1.58E+01	1.69E+04	-1.88E+03	9.54E+03	-1.76E+03
1.26E+01	1.70E+04	-2.37E+03	9.68E+03	-2.12E+03
9.98E+00	1.72E+04	-2.85E+03	9.84E+03	-2.53E+03
7.92E+00	1.74E+04	-3.19E+03	1.00E+04	-3.05E+03
6.29E+00	1.77E+04	-3.94E+03	1.03E+04	-3.63E+03
5.00E+00	1.80E+04	-4.68E+03	1.06E+04	-4.32E+03
3.97E+00	1.83E+04	-5.52E+03	1.09E+04	-5.14E+03
3.15E+00	1.88E+04	-6.62E+03	1.13E+04	-6.13E+03
2.51E+00	1.93E+04	-7.86E+03	1.18E+04	-7.29E+03
1.99E+00	2.00E+04	-9.34E+03	1.24E+04	-8.67E+03
1.58E+00	2.07E+04	-1.10E+04	1.31E+04	-1.03E+04
1.26E+00	2.16E+04	-1.30E+04	1.39E+04	-1.22E+04
9.98E-01	2.27E+04	-1.55E+04	1.49E+04	-1.45E+04
7.92E-01	2.40E+04	-1.84E+04	1.61E+04	-1.72E+04
6.29E-01	2.55E+04	-2.18E+04	1.75E+04	-2.04E+04
5.00E-01	2.72E+04	-2.56E+04	1.91E+04	-2.43E+04
3.97E-01	2.93E+04	-3.06E+04	2.12E+04	-2.88E+04
3.15E-01	3.23E+04	-3.62E+04	2.36E+04	-3.41E+04
2.51E-01	3.56E+04	-4.30E+04	2.65E+04	-4.04E+04
1.99E-01	3.96E+04	-5.08E+04	3.02E+04	-4.79E+04
1.58E-01	4.47E+04	-5.92E+04	3.46E+04	-5.65E+04
1.26E-01	4.97E+04	-6.91E+04	4.00E+04	-6.64E+04
1.00E-01	5.75E+04	-8.14E+04	4.65E+04	-7.77E+04

f / Hz	12		11	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	3.28E+03	-2.86E+03	2.92E+03	-1.85E+03
3.97E+06	3.76E+03	-2.64E+03	3.18E+03	-1.61E+03
3.15E+06	4.22E+03	-2.38E+03	3.40E+03	-1.37E+03
2.51E+06	4.58E+03	-2.06E+03	3.55E+03	-1.13E+03
1.99E+06	4.87E+03	-1.73E+03	3.66E+03	-9.11E+02
1.58E+06	5.07E+03	-1.44E+03	3.73E+03	-7.33E+02
1.26E+06	5.21E+03	-1.18E+03	3.77E+03	-5.81E+02
9.98E+05	5.30E+03	-9.38E+02	3.80E+03	-3.61E+02
7.92E+05	5.34E+03	-7.33E+02	3.81E+03	-2.92E+02
6.29E+05	5.40E+03	-5.30E+02	3.82E+03	-2.33E+02
5.00E+05	5.43E+03	-4.26E+02	3.83E+03	-1.87E+02
3.97E+05	5.44E+03	-3.41E+02	3.83E+03	-1.48E+02
3.15E+05	5.45E+03	-2.69E+02	3.84E+03	-1.16E+02
2.51E+05	5.46E+03	-2.16E+02	3.84E+03	-9.30E+01
1.99E+05	5.47E+03	-1.75E+02	3.84E+03	-7.55E+01
1.58E+05	5.47E+03	-1.38E+02	3.84E+03	-5.84E+01
1.26E+05	5.48E+03	-1.05E+02	3.85E+03	-4.49E+01
9.98E+04	5.49E+03	-7.96E+01	3.85E+03	-3.30E+01
7.92E+04	5.50E+03	-6.20E+01	3.86E+03	-2.61E+01
6.29E+04	5.48E+03	-5.52E+01	3.85E+03	-2.37E+01
5.00E+04	5.49E+03	-3.99E+01	3.85E+03	-1.61E+01
3.97E+04	5.49E+03	-2.67E+01	3.85E+03	-9.32E+00
3.15E+04	5.49E+03	-1.76E+01	3.85E+03	-5.10E+00
2.51E+04	5.49E+03	-4.63E+00	3.85E+03	1.93E+00
1.99E+04	5.48E+03	6.51E+00	3.85E+03	8.40E+00
1.58E+04	5.48E+03	1.73E+01	3.85E+03	1.47E+01
1.26E+04	5.48E+03	2.90E+01	3.84E+03	1.94E+01
9.98E+03	5.47E+03	3.84E+01	3.84E+03	2.82E+01
7.92E+03	5.47E+03	5.07E+01	3.83E+03	3.63E+01
6.29E+03	5.45E+03	6.27E+01	3.82E+03	4.19E+01
5.00E+03	5.43E+03	6.49E+01	3.81E+03	4.23E+01
3.97E+03	5.41E+03	7.03E+01	3.80E+03	4.48E+01
3.15E+03	5.41E+03	6.13E+01	3.78E+03	5.08E+01
2.51E+03	5.37E+03	6.17E+01	3.77E+03	3.42E+01
1.99E+03	5.36E+03	4.70E+01	3.76E+03	2.59E+01
1.58E+03	5.35E+03	3.36E+01	3.75E+03	1.47E+01
1.26E+03	5.34E+03	1.37E+01	3.75E+03	3.35E-01
9.98E+02	5.33E+03	-3.78E+00	3.74E+03	-1.41E+01
7.92E+02	5.33E+03	-2.66E+01	3.74E+03	-3.57E+01
6.29E+02	5.33E+03	-4.38E+01	3.74E+03	-5.58E+01
5.00E+02	5.32E+03	-6.82E+01	3.75E+03	-7.45E+01
3.97E+02	5.33E+03	-9.87E+01	3.75E+03	-9.87E+01
3.15E+02	5.34E+03	-1.32E+02	3.75E+03	-1.28E+02
2.51E+02	5.35E+03	-1.60E+02	3.76E+03	-1.61E+02

f / Hz	12		11	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	5.36E+03	-2.16E+02	3.77E+03	-2.03E+02
1.58E+02	5.37E+03	-2.56E+02	3.78E+03	-2.56E+02
1.26E+02	5.39E+03	-3.18E+02	3.80E+03	-2.95E+02
9.98E+01	5.41E+03	-3.90E+02	3.83E+03	-3.56E+02
7.92E+01	5.43E+03	-4.73E+02	3.84E+03	-4.42E+02
6.29E+01	5.48E+03	-5.84E+02	3.88E+03	-5.42E+02
5.00E+01	5.36E+03	-7.47E+02	3.88E+03	-7.68E+02
3.97E+01	5.55E+03	-8.46E+02	3.95E+03	-7.93E+02
3.15E+01	5.61E+03	-1.02E+03	4.01E+03	-9.54E+02
2.51E+01	5.68E+03	-1.23E+03	4.08E+03	-1.15E+03
1.99E+01	5.78E+03	-1.47E+03	4.16E+03	-1.39E+03
1.58E+01	5.88E+03	-1.76E+03	4.27E+03	-1.65E+03
1.26E+01	6.02E+03	-2.12E+03	4.39E+03	-1.99E+03
9.98E+00	6.19E+03	-2.55E+03	4.54E+03	-2.39E+03
7.92E+00	6.38E+03	-3.04E+03	4.73E+03	-2.86E+03
6.29E+00	6.63E+03	-3.63E+03	4.96E+03	-3.40E+03
5.00E+00	6.93E+03	-4.31E+03	5.23E+03	-4.05E+03
3.97E+00	7.30E+03	-5.13E+03	5.57E+03	-4.81E+03
3.15E+00	7.73E+03	-6.08E+03	5.95E+03	-5.71E+03
2.51E+00	8.25E+03	-7.20E+03	6.46E+03	-6.78E+03
1.99E+00	8.85E+03	-8.52E+03	7.01E+03	-8.03E+03
1.58E+00	9.58E+03	-1.01E+04	7.69E+03	-9.52E+03
1.26E+00	1.04E+04	-1.19E+04	8.46E+03	-1.12E+04
9.98E-01	1.15E+04	-1.41E+04	9.44E+03	-1.33E+04
7.92E-01	1.27E+04	-1.66E+04	1.05E+04	-1.57E+04
6.29E-01	1.41E+04	-1.96E+04	1.19E+04	-1.86E+04
5.00E-01	1.57E+04	-2.31E+04	1.34E+04	-2.20E+04
3.97E-01	1.77E+04	-2.73E+04	1.52E+04	-2.59E+04
3.15E-01	2.01E+04	-3.22E+04	1.74E+04	-3.07E+04
2.51E-01	2.28E+04	-3.79E+04	2.00E+04	-3.63E+04
1.99E-01	2.61E+04	-4.48E+04	2.31E+04	-4.29E+04
1.58E-01	3.00E+04	-5.28E+04	2.67E+04	-5.08E+04
1.26E-01	3.47E+04	-6.23E+04	3.13E+04	-6.01E+04
1.00E-01	4.03E+04	-7.33E+04	3.68E+04	-7.08E+04

	10		09	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.59E+03	-1.33E+03	2.39E+03	-1.04E+03
3.97E+06	2.75E+03	-1.12E+03	2.49E+03	-8.66E+02
3.15E+06	2.88E+03	-9.24E+02	2.57E+03	-7.07E+02
2.51E+06	2.95E+03	-7.57E+02	2.61E+03	-5.69E+02
1.99E+06	3.00E+03	-5.96E+02	2.65E+03	-4.44E+02
1.58E+06	3.04E+03	-4.71E+02	2.67E+03	-3.46E+02
1.26E+06	3.05E+03	-3.69E+02	2.67E+03	-2.70E+02
9.98E+05	3.06E+03	-2.10E+02	2.67E+03	-1.41E+02
7.92E+05	3.07E+03	-1.69E+02	2.68E+03	-1.14E+02
6.29E+05	3.07E+03	-1.35E+02	2.68E+03	-9.04E+01
5.00E+05	3.07E+03	-1.08E+02	2.68E+03	-7.21E+01
3.97E+05	3.08E+03	-8.49E+01	2.68E+03	-5.67E+01
3.15E+05	3.08E+03	-6.59E+01	2.68E+03	-4.36E+01
2.51E+05	3.08E+03	-5.26E+01	2.68E+03	-3.51E+01
1.99E+05	3.08E+03	-4.28E+01	2.68E+03	-2.88E+01
1.58E+05	3.08E+03	-3.31E+01	2.68E+03	-2.20E+01
1.26E+05	3.09E+03	-2.46E+01	2.68E+03	-1.64E+01
9.98E+04	3.09E+03	-1.83E+01	2.69E+03	-1.17E+01
7.92E+04	3.10E+03	-1.49E+01	2.69E+03	-9.89E+00
6.29E+04	3.08E+03	-1.34E+01	2.68E+03	-8.31E+00
5.00E+04	3.09E+03	-8.14E+00	2.68E+03	-4.72E+00
3.97E+04	3.09E+03	-3.71E+00	2.68E+03	-1.23E+00
3.15E+04	3.08E+03	-3.09E-01	2.68E+03	4.56E-01
2.51E+04	3.08E+03	4.13E+00	2.68E+03	4.34E+00
1.99E+04	3.08E+03	8.56E+00	2.68E+03	8.23E+00
1.58E+04	3.08E+03	1.21E+01	2.68E+03	1.17E+01
1.26E+04	3.08E+03	1.55E+01	2.68E+03	1.54E+01
9.98E+03	3.08E+03	1.91E+01	2.68E+03	1.73E+01
7.92E+03	3.07E+03	2.60E+01	2.67E+03	2.43E+01
6.29E+03	3.07E+03	2.75E+01	2.67E+03	3.08E+01
5.00E+03	3.06E+03	2.99E+01	2.66E+03	2.75E+01
3.97E+03	3.05E+03	3.07E+01	2.65E+03	3.03E+01
3.15E+03	3.03E+03	3.10E+01	2.64E+03	3.56E+01
2.51E+03	3.03E+03	2.10E+01	2.63E+03	3.00E+01
1.99E+03	3.02E+03	1.38E+01	2.63E+03	1.98E+01
1.58E+03	3.01E+03	5.35E+00	2.62E+03	1.05E+01
1.26E+03	3.01E+03	-7.61E+00	2.61E+03	1.97E+00
9.98E+02	3.01E+03	-2.48E+01	2.61E+03	-1.07E+01
7.92E+02	3.01E+03	-3.85E+01	2.61E+03	-2.06E+01
6.29E+02	3.01E+03	-5.55E+01	2.62E+03	-2.96E+01
5.00E+02	3.01E+03	-7.37E+01	2.62E+03	-4.79E+01
3.97E+02	3.02E+03	-9.54E+01	2.62E+03	-6.37E+01
3.15E+02	3.02E+03	-1.20E+02	2.62E+03	-8.27E+01
2.51E+02	3.03E+03	-1.49E+02	2.63E+03	-1.04E+02

f / Hz	10		09	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	3.04E+03	-1.89E+02	2.63E+03	-1.28E+02
1.58E+02	3.04E+03	-2.39E+02	2.64E+03	-1.49E+02
1.26E+02	3.06E+03	-2.90E+02	2.65E+03	-1.86E+02
9.98E+01	3.08E+03	-3.46E+02	2.65E+03	-2.25E+02
7.92E+01	3.10E+03	-4.27E+02	2.68E+03	-2.78E+02
6.29E+01	3.13E+03	-5.23E+02	2.69E+03	-3.42E+02
5.00E+01	3.17E+03	-6.45E+02	2.79E+03	-4.39E+02
3.97E+01	3.22E+03	-7.69E+02	2.74E+03	-5.04E+02
3.15E+01	3.28E+03	-9.27E+02	2.78E+03	-6.07E+02
2.51E+01	3.36E+03	-1.11E+03	2.82E+03	-7.36E+02
1.99E+01	3.46E+03	-1.33E+03	2.87E+03	-8.90E+02
1.58E+01	3.59E+03	-1.57E+03	2.93E+03	-1.07E+03
1.26E+01	3.74E+03	-1.85E+03	3.01E+03	-1.28E+03
9.98E+00	3.92E+03	-2.17E+03	3.10E+03	-1.53E+03
7.92E+00	4.11E+03	-2.54E+03	3.22E+03	-1.85E+03
6.29E+00	4.34E+03	-2.96E+03	3.35E+03	-2.19E+03
5.00E+00	4.57E+03	-3.47E+03	3.50E+03	-2.61E+03
3.97E+00	4.84E+03	-4.07E+03	3.69E+03	-3.12E+03
3.15E+00	5.14E+03	-4.79E+03	3.90E+03	-3.73E+03
2.51E+00	5.48E+03	-5.66E+03	4.16E+03	-4.46E+03
1.99E+00	5.85E+03	-6.72E+03	4.44E+03	-5.35E+03
1.58E+00	6.31E+03	-8.00E+03	4.78E+03	-6.40E+03
1.26E+00	6.81E+03	-9.58E+03	5.18E+03	-7.72E+03
9.98E-01	7.46E+03	-1.15E+04	5.68E+03	-9.27E+03
7.92E-01	8.22E+03	-1.39E+04	6.26E+03	-1.12E+04
6.29E-01	9.18E+03	-1.66E+04	7.02E+03	-1.35E+04
5.00E-01	1.03E+04	-2.00E+04	7.89E+03	-1.62E+04
3.97E-01	1.18E+04	-2.41E+04	9.01E+03	-1.96E+04
3.15E-01	1.37E+04	-2.90E+04	1.04E+04	-2.36E+04
2.51E-01	1.61E+04	-3.47E+04	1.22E+04	-2.84E+04
1.99E-01	1.90E+04	-4.15E+04	1.43E+04	-3.42E+04
1.58E-01	2.26E+04	-4.95E+04	1.70E+04	-4.09E+04
1.26E-01	2.72E+04	-5.89E+04	2.03E+04	-4.89E+04
1.00E-01	3.26E+04	-6.94E+04	2.45E+04	-5.83E+04

	08		07	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.17E+03	-8.19E+02	2.12E+03	-7.40E+02
3.97E+06	2.23E+03	-6.77E+02	2.16E+03	-6.08E+02
3.15E+06	2.28E+03	-5.50E+02	2.21E+03	-4.91E+02
2.51E+06	2.31E+03	-4.37E+02	2.23E+03	-3.89E+02
1.99E+06	2.33E+03	-3.39E+02	2.24E+03	-3.01E+02
1.58E+06	2.34E+03	-2.64E+02	2.25E+03	-2.32E+02
1.26E+06	2.34E+03	-2.03E+02	2.25E+03	-1.79E+02
9.98E+05	2.34E+03	-9.76E+01	2.24E+03	-8.00E+01
7.92E+05	2.34E+03	-7.89E+01	2.25E+03	-6.47E+01
6.29E+05	2.34E+03	-6.25E+01	2.25E+03	-5.12E+01
5.00E+05	2.34E+03	-5.00E+01	2.24E+03	-4.10E+01
3.97E+05	2.34E+03	-3.90E+01	2.24E+03	-3.16E+01
3.15E+05	2.34E+03	-2.98E+01	2.24E+03	-2.41E+01
2.51E+05	2.34E+03	-2.41E+01	2.24E+03	-1.97E+01
1.99E+05	2.34E+03	-2.00E+01	2.25E+03	-1.64E+01
1.58E+05	2.34E+03	-1.48E+01	2.25E+03	-1.21E+01
1.26E+05	2.34E+03	-1.07E+01	2.25E+03	-8.76E+00
9.98E+04	2.35E+03	-7.45E+00	2.25E+03	-6.30E+00
7.92E+04	2.35E+03	-6.47E+00	2.26E+03	-6.07E+00
6.29E+04	2.34E+03	-5.68E+00	2.25E+03	-4.62E+00
5.00E+04	2.34E+03	-3.07E+00	2.25E+03	-2.33E+00
3.97E+04	2.34E+03	-3.58E-01	2.25E+03	7.68E-02
3.15E+04	2.34E+03	8.17E-01	2.25E+03	9.76E-01
2.51E+04	2.34E+03	4.03E+00	2.25E+03	3.92E+00
1.99E+04	2.34E+03	6.40E+00	2.24E+03	6.87E+00
1.58E+04	2.34E+03	9.56E+00	2.24E+03	9.19E+00
1.26E+04	2.34E+03	1.08E+01	2.24E+03	1.15E+01
9.98E+03	2.34E+03	1.75E+01	2.24E+03	1.37E+01
7.92E+03	2.34E+03	1.89E+01	2.24E+03	1.92E+01
6.29E+03	2.33E+03	1.80E+01	2.23E+03	2.32E+01
5.00E+03	2.32E+03	2.10E+01	2.23E+03	2.07E+01
3.97E+03	2.32E+03	2.48E+01	2.22E+03	2.19E+01
3.15E+03	2.30E+03	2.90E+01	2.21E+03	2.72E+01
2.51E+03	2.30E+03	2.15E+01	2.21E+03	1.36E+01
1.99E+03	2.30E+03	1.27E+01	2.20E+03	1.08E+01
1.58E+03	2.29E+03	5.82E+00	2.20E+03	3.27E+00
1.26E+03	2.29E+03	-4.86E+00	2.19E+03	-6.90E+00
9.98E+02	2.29E+03	-1.78E+01	2.20E+03	-2.08E+01
7.92E+02	2.29E+03	-2.92E+01	2.19E+03	-2.92E+01
6.29E+02	2.29E+03	-3.95E+01	2.19E+03	-4.11E+01
5.00E+02	2.29E+03	-5.44E+01	2.19E+03	-5.40E+01
3.97E+02	2.29E+03	-7.11E+01	2.20E+03	-7.42E+01
3.15E+02	2.30E+03	-9.28E+01	2.20E+03	-9.50E+01
2.51E+02	2.30E+03	-1.04E+02	2.21E+03	-1.08E+02

	08		07	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	2.31E+03	-1.37E+02	2.21E+03	-1.42E+02
1.58E+02	2.31E+03	-1.71E+02	2.22E+03	-1.69E+02
1.26E+02	2.32E+03	-2.05E+02	2.24E+03	-2.12E+02
9.98E+01	2.33E+03	-2.58E+02	2.25E+03	-2.57E+02
7.92E+01	2.35E+03	-3.05E+02	2.26E+03	-3.17E+02
6.29E+01	2.38E+03	-3.78E+02	2.28E+03	-3.83E+02
5.00E+01	2.34E+03	-4.82E+02	2.33E+03	-5.24E+02
3.97E+01	2.43E+03	-5.53E+02	2.34E+03	-5.71E+02
3.15E+01	2.47E+03	-6.66E+02	2.38E+03	-6.87E+02
2.51E+01	2.51E+03	-8.06E+02	2.42E+03	-8.27E+02
1.99E+01	2.57E+03	-9.79E+02	2.48E+03	-1.01E+03
1.58E+01	2.65E+03	-1.17E+03	2.56E+03	-1.20E+03
1.26E+01	2.72E+03	-1.40E+03	2.64E+03	-1.44E+03
9.98E+00	2.83E+03	-1.67E+03	2.75E+03	-1.73E+03
7.92E+00	2.95E+03	-1.99E+03	2.87E+03	-2.05E+03
6.29E+00	3.09E+03	-2.39E+03	3.02E+03	-2.47E+03
5.00E+00	3.25E+03	-2.85E+03	3.19E+03	-2.95E+03
3.97E+00	3.45E+03	-3.39E+03	3.39E+03	-3.53E+03
3.15E+00	3.67E+03	-4.08E+03	3.61E+03	-4.22E+03
2.51E+00	3.93E+03	-4.89E+03	3.89E+03	-5.06E+03
1.99E+00	4.25E+03	-5.88E+03	4.21E+03	-6.09E+03
1.58E+00	4.63E+03	-7.07E+03	4.60E+03	-7.30E+03
1.26E+00	5.09E+03	-8.50E+03	5.10E+03	-8.80E+03
9.98E-01	5.65E+03	-1.02E+04	5.68E+03	-1.06E+04
7.92E-01	6.37E+03	-1.23E+04	6.41E+03	-1.28E+04
6.29E-01	7.20E+03	-1.49E+04	7.31E+03	-1.53E+04
5.00E-01	8.29E+03	-1.79E+04	8.43E+03	-1.85E+04
3.97E-01	9.60E+03	-2.15E+04	9.81E+03	-2.22E+04
3.15E-01	1.13E+04	-2.58E+04	1.16E+04	-2.66E+04
2.51E-01	1.33E+04	-3.08E+04	1.36E+04	-3.17E+04
1.99E-01	1.58E+04	-3.68E+04	1.62E+04	-3.79E+04
1.58E-01	1.90E+04	-4.40E+04	1.95E+04	-4.52E+04
1.26E-01	2.27E+04	-5.23E+04	2.35E+04	-5.37E+04
1.00E-01	2.73E+04	-6.19E+04	2.84E+04	-6.33E+04

	06		05	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.00E+03	-6.74E+02	1.92E+03	-6.08E+02
3.97E+06	2.04E+03	-5.51E+02	1.95E+03	-4.95E+02
3.15E+06	2.08E+03	-4.42E+02	1.98E+03	-3.95E+02
2.51E+06	2.10E+03	-3.53E+02	1.99E+03	-3.14E+02
1.99E+06	2.11E+03	-2.72E+02	2.00E+03	-2.40E+02
1.58E+06	2.12E+03	-2.10E+02	2.01E+03	-1.85E+02
1.26E+06	2.12E+03	-1.61E+02	2.00E+03	-1.41E+02
9.98E+05	2.11E+03	-6.97E+01	2.00E+03	-5.70E+01
7.92E+05	2.11E+03	-5.62E+01	2.00E+03	-4.62E+01
6.29E+05	2.11E+03	-4.42E+01	2.00E+03	-3.62E+01
5.00E+05	2.11E+03	-3.54E+01	2.00E+03	-2.85E+01
3.97E+05	2.11E+03	-2.70E+01	2.00E+03	-2.18E+01
3.15E+05	2.11E+03	-2.04E+01	2.00E+03	-1.64E+01
2.51E+05	2.11E+03	-1.67E+01	2.00E+03	-1.35E+01
1.99E+05	2.11E+03	-1.38E+01	2.00E+03	-1.13E+01
1.58E+05	2.11E+03	-1.02E+01	2.00E+03	-8.25E+00
1.26E+05	2.12E+03	-7.00E+00	2.00E+03	-5.47E+00
9.98E+04	2.12E+03	-5.19E+00	2.01E+03	-4.06E+00
7.92E+04	2.13E+03	-5.83E+00	2.01E+03	-5.15E+00
6.29E+04	2.11E+03	-4.49E+00	2.00E+03	-3.78E+00
5.00E+04	2.12E+03	-1.64E+00	2.00E+03	-1.08E+00
3.97E+04	2.12E+03	3.95E-01	2.00E+03	3.93E-01
3.15E+04	2.11E+03	1.77E+00	2.00E+03	1.71E+00
2.51E+04	2.11E+03	4.15E+00	2.00E+03	4.25E+00
1.99E+04	2.11E+03	6.44E+00	2.00E+03	5.96E+00
1.58E+04	2.11E+03	9.04E+00	2.00E+03	7.98E+00
1.26E+04	2.11E+03	1.17E+01	2.00E+03	8.36E+00
9.98E+03	2.11E+03	1.37E+01	2.00E+03	1.24E+01
7.92E+03	2.11E+03	1.64E+01	1.99E+03	1.55E+01
6.29E+03	2.11E+03	1.39E+01	1.99E+03	1.29E+01
5.00E+03	2.10E+03	1.94E+01	1.99E+03	1.62E+01
3.97E+03	2.09E+03	1.81E+01	1.98E+03	1.65E+01
3.15E+03	2.08E+03	1.88E+01	1.97E+03	1.47E+01
2.51E+03	2.08E+03	9.54E+00	1.97E+03	4.44E+00
1.99E+03	2.07E+03	4.85E+00	1.96E+03	3.89E+00
1.58E+03	2.07E+03	-1.03E+00	1.96E+03	-5.32E+00
1.26E+03	2.07E+03	-1.14E+01	1.96E+03	-1.55E+01
9.98E+02	2.06E+03	-2.14E+01	1.96E+03	-2.61E+01
7.92E+02	2.06E+03	-3.44E+01	1.96E+03	-3.89E+01
6.29E+02	2.07E+03	-4.84E+01	1.96E+03	-5.43E+01
5.00E+02	2.07E+03	-6.15E+01	1.97E+03	-6.76E+01
3.97E+02	2.07E+03	-7.98E+01	1.96E+03	-8.62E+01
3.15E+02	2.08E+03	-1.00E+02	1.97E+03	-1.10E+02
2.51E+02	2.09E+03	-1.20E+02	1.98E+03	-1.34E+02

	06		05	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
1.99E+02	2.09E+03	-1.50E+02	1.98E+03	-1.72E+02
1.58E+02	2.10E+03	-1.85E+02	1.99E+03	-2.10E+02
1.26E+02	2.11E+03	-2.28E+02	2.00E+03	-2.61E+02
9.98E+01	2.13E+03	-2.64E+02	2.01E+03	-3.10E+02
7.92E+01	2.14E+03	-3.31E+02	2.04E+03	-3.79E+02
6.29E+01	2.17E+03	-4.09E+02	2.07E+03	-4.68E+02
5.00E+01	2.19E+03	-4.29E+02	2.05E+03	-5.38E+02
3.97E+01	2.23E+03	-5.89E+02	2.15E+03	-6.79E+02
3.15E+01	2.27E+03	-7.08E+02	2.21E+03	-8.18E+02
2.51E+01	2.33E+03	-8.50E+02	2.28E+03	-9.73E+02
1.99E+01	2.39E+03	-1.02E+03	2.36E+03	-1.15E+03
1.58E+01	2.48E+03	-1.22E+03	2.45E+03	-1.37E+03
1.26E+01	2.56E+03	-1.45E+03	2.57E+03	-1.61E+03
9.98E+00	2.66E+03	-1.73E+03	2.70E+03	-1.90E+03
7.92E+00	2.78E+03	-2.05E+03	2.84E+03	-2.25E+03
6.29E+00	2.91E+03	-2.45E+03	3.00E+03	-2.66E+03
5.00E+00	3.06E+03	-2.93E+03	3.18E+03	-3.15E+03
3.97E+00	3.22E+03	-3.51E+03	3.37E+03	-3.76E+03
3.15E+00	3.44E+03	-4.23E+03	3.61E+03	-4.49E+03
2.51E+00	3.68E+03	-5.12E+03	3.90E+03	-5.39E+03
1.99E+00	3.95E+03	-6.20E+03	4.22E+03	-6.48E+03
1.58E+00	4.30E+03	-7.50E+03	4.62E+03	-7.79E+03
1.26E+00	4.75E+03	-9.11E+03	5.09E+03	-9.43E+03
9.98E-01	5.28E+03	-1.11E+04	5.66E+03	-1.14E+04
7.92E-01	5.98E+03	-1.34E+04	6.41E+03	-1.37E+04
6.29E-01	6.92E+03	-1.62E+04	7.29E+03	-1.65E+04
5.00E-01	8.01E+03	-1.96E+04	8.44E+03	-2.01E+04
3.97E-01	9.40E+03	-2.37E+04	9.87E+03	-2.42E+04
3.15E-01	1.12E+04	-2.85E+04	1.17E+04	-2.91E+04
2.51E-01	1.35E+04	-3.43E+04	1.39E+04	-3.49E+04
1.99E-01	1.62E+04	-4.10E+04	1.67E+04	-4.18E+04
1.58E-01	1.97E+04	-4.92E+04	2.02E+04	-5.00E+04
1.26E-01	2.39E+04	-5.83E+04	2.46E+04	-5.96E+04
1.00E-01	2.90E+04	-6.89E+04	3.00E+04	-7.04E+04

f / Hz	04		03	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.83E+03	-5.53E+02	1.78E+03	-5.14E+02
3.97E+06	1.86E+03	-4.49E+02	1.80E+03	-4.17E+02
3.15E+06	1.88E+03	-3.58E+02	1.83E+03	-3.32E+02
2.51E+06	1.90E+03	-2.84E+02	1.83E+03	-2.64E+02
1.99E+06	1.90E+03	-2.17E+02	1.84E+03	-2.01E+02
1.58E+06	1.91E+03	-1.66E+02	1.84E+03	-1.53E+02
1.26E+06	1.90E+03	-1.27E+02	1.84E+03	-1.15E+02
9.98E+05	1.90E+03	-4.85E+01	1.84E+03	-4.22E+01
7.92E+05	1.90E+03	-3.92E+01	1.83E+03	-3.41E+01
6.29E+05	1.90E+03	-3.05E+01	1.83E+03	-2.64E+01
5.00E+05	1.90E+03	-2.41E+01	1.83E+03	-2.07E+01
3.97E+05	1.90E+03	-1.82E+01	1.83E+03	-1.57E+01
3.15E+05	1.90E+03	-1.37E+01	1.83E+03	-1.16E+01
2.51E+05	1.90E+03	-1.12E+01	1.83E+03	-9.63E+00
1.99E+05	1.90E+03	-9.49E+00	1.84E+03	-8.24E+00
1.58E+05	1.90E+03	-6.78E+00	1.84E+03	-5.79E+00
1.26E+05	1.90E+03	-4.48E+00	1.84E+03	-3.84E+00
9.98E+04	1.91E+03	-3.35E+00	1.84E+03	-2.90E+00
7.92E+04	1.91E+03	-4.18E+00	1.85E+03	-4.22E+00
6.29E+04	1.90E+03	-3.15E+00	1.84E+03	-2.94E+00
5.00E+04	1.90E+03	-5.44E-01	1.84E+03	-6.80E-01
3.97E+04	1.90E+03	9.81E-01	1.84E+03	5.64E-01
3.15E+04	1.90E+03	1.75E+00	1.84E+03	1.67E+00
2.51E+04	1.90E+03	3.61E+00	1.84E+03	3.70E+00
1.99E+04	1.90E+03	5.18E+00	1.84E+03	5.35E+00
1.58E+04	1.90E+03	7.41E+00	1.83E+03	6.82E+00
1.26E+04	1.90E+03	7.80E+00	1.84E+03	8.56E+00
9.98E+03	1.90E+03	9.07E+00	1.83E+03	1.22E+01
7.92E+03	1.90E+03	1.30E+01	1.83E+03	1.27E+01
6.29E+03	1.89E+03	1.47E+01	1.83E+03	1.15E+01
5.00E+03	1.89E+03	1.40E+01	1.82E+03	1.37E+01
3.97E+03	1.88E+03	1.37E+01	1.82E+03	1.16E+01
3.15E+03	1.87E+03	1.49E+01	1.81E+03	1.86E+01
2.51E+03	1.88E+03	4.12E+00	1.81E+03	4.77E+00
1.99E+03	1.87E+03	1.91E+00	1.80E+03	1.10E+00
1.58E+03	1.86E+03	-6.33E+00	1.80E+03	-7.60E+00
1.26E+03	1.86E+03	-1.52E+01	1.80E+03	-1.70E+01
9.98E+02	1.86E+03	-2.63E+01	1.80E+03	-2.76E+01
7.92E+02	1.86E+03	-3.97E+01	1.80E+03	-4.02E+01
6.29E+02	1.86E+03	-5.31E+01	1.80E+03	-5.50E+01
5.00E+02	1.87E+03	-6.84E+01	1.80E+03	-6.93E+01
3.97E+02	1.87E+03	-8.95E+01	1.81E+03	-8.99E+01
3.15E+02	1.88E+03	-1.13E+02	1.81E+03	-1.13E+02
2.51E+02	1.88E+03	-1.39E+02	1.82E+03	-1.33E+02

	04		03	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
1.99E+02	1.89E+03	-1.70E+02	1.82E+03	-1.70E+02
1.58E+02	1.90E+03	-2.14E+02	1.83E+03	-2.13E+02
1.26E+02	1.91E+03	-2.64E+02	1.85E+03	-2.61E+02
9.98E+01	1.92E+03	-3.09E+02	1.86E+03	-3.04E+02
7.92E+01	1.94E+03	-3.87E+02	1.89E+03	-3.87E+02
6.29E+01	1.98E+03	-4.73E+02	1.91E+03	-4.73E+02
5.00E+01	2.02E+03	-6.29E+02	2.01E+03	-5.59E+02
3.97E+01	2.06E+03	-6.86E+02	2.00E+03	-6.85E+02
3.15E+01	2.11E+03	-8.23E+02	2.06E+03	-8.22E+02
2.51E+01	2.18E+03	-9.80E+02	2.13E+03	-9.79E+02
1.99E+01	2.27E+03	-1.17E+03	2.21E+03	-1.16E+03
1.58E+01	2.36E+03	-1.38E+03	2.32E+03	-1.38E+03
1.26E+01	2.48E+03	-1.63E+03	2.43E+03	-1.62E+03
9.98E+00	2.61E+03	-1.92E+03	2.56E+03	-1.91E+03
7.92E+00	2.75E+03	-2.26E+03	2.70E+03	-2.26E+03
6.29E+00	2.91E+03	-2.68E+03	2.86E+03	-2.67E+03
5.00E+00	3.09E+03	-3.18E+03	3.03E+03	-3.16E+03
3.97E+00	3.28E+03	-3.79E+03	3.24E+03	-3.77E+03
3.15E+00	3.54E+03	-4.53E+03	3.46E+03	-4.51E+03
2.51E+00	3.81E+03	-5.44E+03	3.75E+03	-5.41E+03
1.99E+00	4.15E+03	-6.53E+03	4.06E+03	-6.51E+03
1.58E+00	4.53E+03	-7.87E+03	4.43E+03	-7.85E+03
1.26E+00	5.02E+03	-9.49E+03	4.92E+03	-9.49E+03
9.98E-01	5.61E+03	-1.15E+04	5.48E+03	-1.15E+04
7.92E-01	6.35E+03	-1.39E+04	6.22E+03	-1.39E+04
6.29E-01	7.24E+03	-1.67E+04	7.10E+03	-1.68E+04
5.00E-01	8.40E+03	-2.03E+04	8.25E+03	-2.03E+04
3.97E-01	9.83E+03	-2.44E+04	9.71E+03	-2.45E+04
3.15E-01	1.17E+04	-2.95E+04	1.16E+04	-2.95E+04
2.51E-01	1.40E+04	-3.53E+04	1.39E+04	-3.55E+04
1.99E-01	1.69E+04	-4.23E+04	1.68E+04	-4.25E+04
1.58E-01	2.04E+04	-5.07E+04	2.04E+04	-5.08E+04
1.26E-01	2.48E+04	-6.02E+04	2.50E+04	-6.06E+04
1.00E-01	3.03E+04	-7.14E+04	3.04E+04	-7.16E+04

Tab. A.7 Frequency dispersion of Na_2SO_4 solutions

	15		14	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	3.19E+02	-6.96E+03	2.11E+03	-5.88E+03
3.97E+06	8.81E+02	-8.45E+03	3.11E+03	-6.61E+03
3.15E+06	1.64E+03	-1.03E+04	4.32E+03	-7.33E+03
2.51E+06	2.72E+03	-1.23E+04	5.79E+03	-7.83E+03
1.99E+06	4.27E+03	-1.48E+04	7.55E+03	-8.15E+03
1.58E+06	6.27E+03	-1.75E+04	9.33E+03	-8.14E+03
1.26E+06	8.78E+03	-2.07E+04	1.10E+04	-7.79E+03
9.98E+05	1.27E+04	-2.34E+04	1.27E+04	-6.76E+03
7.92E+05	1.70E+04	-2.66E+04	1.39E+04	-6.00E+03
6.29E+05	2.24E+04	-2.95E+04	1.48E+04	-5.15E+03
5.00E+05	2.87E+04	-3.17E+04	1.55E+04	-4.34E+03
3.97E+05	3.57E+04	-3.24E+04	1.60E+04	-3.58E+03
3.15E+05	4.28E+04	-3.17E+04	1.63E+04	-2.90E+03
2.51E+05	4.95E+04	-2.97E+04	1.65E+04	-2.36E+03
1.99E+05	5.50E+04	-2.68E+04	1.67E+04	-1.91E+03
1.58E+05	5.94E+04	-2.33E+04	1.67E+04	-1.53E+03
1.26E+05	6.27E+04	-1.97E+04	1.68E+04	-1.22E+03
9.98E+04	6.50E+04	-1.64E+04	1.69E+04	-9.72E+02
7.92E+04	6.67E+04	-1.34E+04	1.69E+04	-7.70E+02
6.29E+04	6.78E+04	-1.10E+04	1.69E+04	-6.22E+02
5.00E+04	6.85E+04	-8.80E+03	1.69E+04	-4.84E+02
3.97E+04	6.90E+04	-7.01E+03	1.70E+04	-3.67E+02
3.15E+04	6.93E+04	-5.59E+03	1.70E+04	-2.80E+02
2.51E+04	6.95E+04	-4.35E+03	1.70E+04	-1.91E+02
1.99E+04	6.96E+04	-3.33E+03	1.70E+04	-1.14E+02
1.58E+04	6.97E+04	-2.48E+03	1.70E+04	-4.78E+01
1.26E+04	6.97E+04	-1.75E+03	1.69E+04	1.53E+01
9.98E+03	6.97E+04	-1.14E+03	1.69E+04	7.44E+01
7.92E+03	6.95E+04	-6.12E+02	1.69E+04	1.30E+02
6.29E+03	6.94E+04	-1.74E+02	1.69E+04	1.76E+02
5.00E+03	6.92E+04	1.62E+02	1.68E+04	2.11E+02
3.97E+03	6.89E+04	3.97E+02	1.67E+04	2.31E+02
3.15E+03	6.86E+04	5.48E+02	1.67E+04	2.32E+02
2.51E+03	6.84E+04	5.42E+02	1.66E+04	2.20E+02
1.99E+03	6.82E+04	5.79E+02	1.66E+04	1.94E+02
1.58E+03	6.80E+04	4.97E+02	1.65E+04	1.60E+02
1.26E+03	6.79E+04	4.41E+02	1.65E+04	1.22E+02
9.98E+02	6.78E+04	3.34E+02	1.65E+04	8.60E+01
7.92E+02	6.78E+04	2.59E+02	1.65E+04	5.34E+01
6.29E+02	6.78E+04	2.28E+02	1.65E+04	2.46E+01
5.00E+02	6.77E+04	1.15E+02	1.65E+04	-1.40E+01
3.97E+02	6.77E+04	3.18E+01	1.65E+04	-4.60E+01
3.15E+02	6.77E+04	9.44E+00	1.65E+04	-8.22E+01

	15		14	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
2.51E+02	6.78E+04	-1.01E+02	1.65E+04	-1.30E+02
1.99E+02	6.78E+04	-1.59E+02	1.65E+04	-1.61E+02
1.58E+02	6.78E+04	-2.03E+02	1.65E+04	-2.06E+02
1.26E+02	6.78E+04	-2.70E+02	1.65E+04	-2.47E+02
9.98E+01	6.78E+04	-2.95E+02	1.65E+04	-3.03E+02
7.92E+01	6.78E+04	-3.91E+02	1.66E+04	-3.73E+02
6.29E+01	6.78E+04	-5.00E+02	1.66E+04	-4.53E+02
5.00E+01	6.80E+04	-7.15E+02	1.66E+04	-5.61E+02
3.97E+01	6.79E+04	-7.01E+02	1.67E+04	-6.57E+02
3.15E+01	6.79E+04	-8.42E+02	1.67E+04	-7.92E+02
2.51E+01	6.80E+04	-1.02E+03	1.68E+04	-9.50E+02
1.99E+01	6.81E+04	-1.21E+03	1.68E+04	-1.14E+03
1.58E+01	6.82E+04	-1.45E+03	1.69E+04	-1.37E+03
1.26E+01	6.83E+04	-1.75E+03	1.70E+04	-1.64E+03
9.98E+00	6.84E+04	-2.13E+03	1.72E+04	-1.97E+03
7.92E+00	6.86E+04	-2.55E+03	1.73E+04	-2.35E+03
6.29E+00	6.88E+04	-3.02E+03	1.75E+04	-2.81E+03
5.00E+00	6.91E+04	-3.60E+03	1.78E+04	-3.35E+03
3.97E+00	6.94E+04	-4.30E+03	1.81E+04	-3.98E+03
3.15E+00	6.98E+04	-5.12E+03	1.85E+04	-4.71E+03
2.51E+00	7.04E+04	-6.04E+03	1.89E+04	-5.57E+03
1.99E+00	7.10E+04	-7.09E+03	1.95E+04	-6.55E+03
1.58E+00	7.18E+04	-8.33E+03	2.02E+04	-7.69E+03
1.26E+00	7.27E+04	-9.70E+03	2.10E+04	-8.99E+03
9.98E-01	7.38E+04	-1.13E+04	2.19E+04	-1.05E+04
7.92E-01	7.52E+04	-1.30E+04	2.31E+04	-1.22E+04
6.29E-01	7.68E+04	-1.49E+04	2.46E+04	-1.42E+04
5.00E-01	7.87E+04	-1.72E+04	2.62E+04	-1.63E+04
3.97E-01	8.08E+04	-1.98E+04	2.83E+04	-1.89E+04
3.15E-01	8.35E+04	-2.24E+04	3.07E+04	-2.18E+04
2.51E-01	8.66E+04	-2.53E+04	3.38E+04	-2.50E+04
1.99E-01	9.03E+04	-2.87E+04	3.76E+04	-2.85E+04
1.58E-01	9.47E+04	-3.23E+04	4.20E+04	-3.23E+04
1.26E-01	9.99E+04	-3.61E+04	4.74E+04	-3.60E+04
1.00E-01	1.06E+05	-4.00E+04	5.37E+04	-3.96E+04

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.91E+03	-4.69E+03	3.20E+03	-2.96E+03
3.97E+06	3.84E+03	-4.85E+03	3.74E+03	-2.75E+03
3.15E+06	4.84E+03	-4.92E+03	4.23E+03	-2.48E+03
2.51E+06	5.87E+03	-4.73E+03	4.62E+03	-2.14E+03
1.99E+06	6.84E+03	-4.40E+03	4.92E+03	-1.79E+03
1.58E+06	7.64E+03	-3.94E+03	5.13E+03	-1.49E+03
1.26E+06	8.28E+03	-3.41E+03	5.27E+03	-1.20E+03
9.98E+05	8.79E+03	-2.65E+03	5.37E+03	-8.27E+02
7.92E+05	9.11E+03	-2.21E+03	5.42E+03	-6.72E+02
6.29E+05	9.33E+03	-1.82E+03	5.46E+03	-5.40E+02
5.00E+05	9.48E+03	-1.48E+03	5.49E+03	-4.34E+02
3.97E+05	9.58E+03	-1.20E+03	5.50E+03	-3.47E+02
3.15E+05	9.64E+03	-9.56E+02	5.51E+03	-2.75E+02
2.51E+05	9.69E+03	-7.69E+02	5.52E+03	-2.21E+02
1.99E+05	9.72E+03	-6.23E+02	5.52E+03	-1.81E+02
1.58E+05	9.74E+03	-4.97E+02	5.53E+03	-1.43E+02
1.26E+05	9.76E+03	-3.93E+02	5.53E+03	-1.11E+02
9.98E+04	9.77E+03	-3.09E+02	5.53E+03	-8.50E+01
7.92E+04	9.78E+03	-2.42E+02	5.54E+03	-6.57E+01
6.29E+04	9.79E+03	-1.97E+02	5.54E+03	-5.52E+01
5.00E+04	9.80E+03	-1.50E+02	5.54E+03	-3.99E+01
3.97E+04	9.80E+03	-1.09E+02	5.55E+03	-2.63E+01
3.15E+04	9.80E+03	-7.96E+01	5.55E+03	-1.72E+01
2.51E+04	9.80E+03	-4.53E+01	5.55E+03	-4.00E+00
1.99E+04	9.80E+03	-1.59E+01	5.54E+03	7.80E+00
1.58E+04	9.79E+03	1.15E+01	5.54E+03	1.91E+01
1.26E+04	9.78E+03	3.98E+01	5.54E+03	3.05E+01
9.98E+03	9.77E+03	6.62E+01	5.53E+03	4.18E+01
7.92E+03	9.75E+03	9.10E+01	5.52E+03	5.36E+01
6.29E+03	9.73E+03	1.11E+02	5.51E+03	6.12E+01
5.00E+03	9.70E+03	1.29E+02	5.49E+03	6.91E+01
3.97E+03	9.66E+03	1.34E+02	5.47E+03	7.09E+01
3.15E+03	9.63E+03	1.34E+02	5.45E+03	6.81E+01
2.51E+03	9.60E+03	1.21E+02	5.44E+03	5.81E+01
1.99E+03	9.56E+03	1.04E+02	5.42E+03	4.89E+01
1.58E+03	9.54E+03	8.14E+01	5.41E+03	3.38E+01
1.26E+03	9.53E+03	5.89E+01	5.40E+03	1.64E+01
9.98E+02	9.52E+03	3.20E+01	5.40E+03	4.49E-01
7.92E+02	9.52E+03	6.93E+00	5.40E+03	-1.63E+01
6.29E+02	9.52E+03	-9.47E+00	5.39E+03	-3.69E+01
5.00E+02	9.52E+03	-4.26E+01	5.40E+03	-5.43E+01
3.97E+02	9.52E+03	-6.70E+01	5.40E+03	-7.60E+01
3.15E+02	9.53E+03	-9.28E+01	5.41E+03	-9.73E+01

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
2.51E+02	9.53E+03	-1.32E+02	5.41E+03	-1.30E+02
1.99E+02	9.54E+03	-1.65E+02	5.42E+03	-1.61E+02
1.58E+02	9.55E+03	-2.04E+02	5.43E+03	-1.98E+02
1.26E+02	9.56E+03	-2.50E+02	5.45E+03	-2.41E+02
9.98E+01	9.58E+03	-3.02E+02	5.46E+03	-2.94E+02
7.92E+01	9.60E+03	-3.67E+02	5.48E+03	-3.54E+02
6.29E+01	9.63E+03	-4.45E+02	5.51E+03	-4.27E+02
5.00E+01	9.65E+03	-5.58E+02	5.54E+03	-5.24E+02
3.97E+01	9.70E+03	-6.45E+02	5.57E+03	-6.19E+02
3.15E+01	9.75E+03	-7.75E+02	5.62E+03	-7.44E+02
2.51E+01	9.80E+03	-9.33E+02	5.67E+03	-8.91E+02
1.99E+01	9.87E+03	-1.12E+03	5.74E+03	-1.07E+03
1.58E+01	9.95E+03	-1.34E+03	5.82E+03	-1.28E+03
1.26E+01	1.01E+04	-1.61E+03	5.92E+03	-1.53E+03
9.98E+00	1.02E+04	-1.92E+03	6.05E+03	-1.82E+03
7.92E+00	1.03E+04	-2.30E+03	6.20E+03	-2.18E+03
6.29E+00	1.05E+04	-2.74E+03	6.38E+03	-2.59E+03
5.00E+00	1.08E+04	-3.26E+03	6.61E+03	-3.07E+03
3.97E+00	1.11E+04	-3.87E+03	6.88E+03	-3.64E+03
3.15E+00	1.14E+04	-4.58E+03	7.18E+03	-4.31E+03
2.51E+00	1.19E+04	-5.41E+03	7.58E+03	-5.10E+03
1.99E+00	1.24E+04	-6.36E+03	8.00E+03	-6.02E+03
1.58E+00	1.30E+04	-7.48E+03	8.54E+03	-7.12E+03
1.26E+00	1.38E+04	-8.79E+03	9.19E+03	-8.41E+03
9.98E-01	1.46E+04	-1.03E+04	9.99E+03	-9.93E+03
7.92E-01	1.57E+04	-1.21E+04	1.10E+04	-1.18E+04
6.29E-01	1.70E+04	-1.41E+04	1.22E+04	-1.39E+04
5.00E-01	1.86E+04	-1.65E+04	1.38E+04	-1.63E+04
3.97E-01	2.06E+04	-1.93E+04	1.57E+04	-1.92E+04
3.15E-01	2.31E+04	-2.23E+04	1.82E+04	-2.23E+04
2.51E-01	2.63E+04	-2.57E+04	2.15E+04	-2.57E+04
1.99E-01	3.02E+04	-2.94E+04	2.54E+04	-2.95E+04
1.58E-01	3.47E+04	-3.34E+04	3.02E+04	-3.33E+04
1.26E-01	4.04E+04	-3.72E+04	3.59E+04	-3.69E+04
1.00E-01	4.69E+04	-4.08E+04	4.25E+04	-4.02E+04

f / Hz	11		10	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	3.00E+03	-2.05E+03	2.71E+03	-1.49E+03
3.97E+06	3.31E+03	-1.80E+03	2.89E+03	-1.27E+03
3.15E+06	3.56E+03	-1.54E+03	3.04E+03	-1.06E+03
2.51E+06	3.76E+03	-1.28E+03	3.15E+03	-8.69E+02
1.99E+06	3.89E+03	-1.04E+03	3.22E+03	-6.90E+02
1.58E+06	3.97E+03	-8.37E+02	3.26E+03	-5.48E+02
1.26E+06	4.03E+03	-6.65E+02	3.28E+03	-4.32E+02
9.98E+05	4.06E+03	-4.22E+02	3.30E+03	-2.55E+02
7.92E+05	4.08E+03	-3.41E+02	3.31E+03	-2.06E+02
6.29E+05	4.09E+03	-2.72E+02	3.31E+03	-1.65E+02
5.00E+05	4.10E+03	-2.18E+02	3.32E+03	-1.32E+02
3.97E+05	4.10E+03	-1.73E+02	3.32E+03	-1.05E+02
3.15E+05	4.11E+03	-1.37E+02	3.32E+03	-8.27E+01
2.51E+05	4.11E+03	-1.11E+02	3.32E+03	-6.71E+01
1.99E+05	4.11E+03	-9.07E+01	3.32E+03	-5.50E+01
1.58E+05	4.11E+03	-7.10E+01	3.32E+03	-4.35E+01
1.26E+05	4.12E+03	-5.49E+01	3.33E+03	-3.36E+01
9.98E+04	4.12E+03	-4.16E+01	3.33E+03	-2.47E+01
7.92E+04	4.12E+03	-3.12E+01	3.33E+03	-1.77E+01
6.29E+04	4.13E+03	-2.74E+01	3.33E+03	-1.65E+01
5.00E+04	4.13E+03	-1.86E+01	3.33E+03	-1.08E+01
3.97E+04	4.13E+03	-1.10E+01	3.34E+03	-5.68E+00
3.15E+04	4.13E+03	-5.96E+00	3.34E+03	-2.48E+00
2.51E+04	4.13E+03	1.95E+00	3.34E+03	3.24E+00
1.99E+04	4.13E+03	9.34E+00	3.33E+03	8.65E+00
1.58E+04	4.13E+03	1.66E+01	3.33E+03	1.36E+01
1.26E+04	4.12E+03	2.45E+01	3.33E+03	1.89E+01
9.98E+03	4.12E+03	3.19E+01	3.33E+03	2.41E+01
7.92E+03	4.11E+03	3.88E+01	3.32E+03	2.98E+01
6.29E+03	4.10E+03	4.43E+01	3.31E+03	3.36E+01
5.00E+03	4.09E+03	4.88E+01	3.31E+03	3.66E+01
3.97E+03	4.08E+03	4.92E+01	3.30E+03	3.63E+01
3.15E+03	4.07E+03	4.76E+01	3.28E+03	3.33E+01
2.51E+03	4.05E+03	4.14E+01	3.27E+03	2.78E+01
1.99E+03	4.04E+03	3.00E+01	3.27E+03	1.93E+01
1.58E+03	4.04E+03	1.86E+01	3.26E+03	7.82E+00
1.26E+03	4.03E+03	4.74E+00	3.26E+03	-4.04E+00
9.98E+02	4.03E+03	-1.05E+01	3.26E+03	-1.69E+01
7.92E+02	4.03E+03	-2.35E+01	3.26E+03	-3.12E+01
6.29E+02	4.03E+03	-4.24E+01	3.26E+03	-4.79E+01
5.00E+02	4.03E+03	-5.83E+01	3.27E+03	-6.16E+01
3.97E+02	4.04E+03	-7.83E+01	3.27E+03	-8.19E+01
3.15E+02	4.04E+03	-9.83E+01	3.27E+03	-1.02E+02
2.51E+02	4.05E+03	-1.26E+02	3.28E+03	-1.32E+02

f / Hz	11		10	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	4.06E+03	-1.57E+02	3.29E+03	-1.60E+02
1.58E+02	4.07E+03	-1.92E+02	3.30E+03	-1.96E+02
1.26E+02	4.08E+03	-2.34E+02	3.31E+03	-2.36E+02
9.98E+01	4.10E+03	-2.83E+02	3.33E+03	-2.86E+02
7.92E+01	4.12E+03	-3.41E+02	3.35E+03	-3.46E+02
6.29E+01	4.15E+03	-4.12E+02	3.37E+03	-4.16E+02
5.00E+01	4.16E+03	-5.06E+02	3.40E+03	-4.91E+02
3.97E+01	4.21E+03	-5.95E+02	3.44E+03	-6.02E+02
3.15E+01	4.26E+03	-7.13E+02	3.49E+03	-7.22E+02
2.51E+01	4.31E+03	-8.55E+02	3.54E+03	-8.64E+02
1.99E+01	4.38E+03	-1.02E+03	3.61E+03	-1.03E+03
1.58E+01	4.46E+03	-1.22E+03	3.69E+03	-1.24E+03
1.26E+01	4.56E+03	-1.46E+03	3.79E+03	-1.47E+03
9.98E+00	4.69E+03	-1.73E+03	3.91E+03	-1.76E+03
7.92E+00	4.83E+03	-2.06E+03	4.05E+03	-2.09E+03
6.29E+00	5.01E+03	-2.44E+03	4.22E+03	-2.48E+03
5.00E+00	5.21E+03	-2.89E+03	4.42E+03	-2.94E+03
3.97E+00	5.46E+03	-3.41E+03	4.64E+03	-3.49E+03
3.15E+00	5.74E+03	-4.04E+03	4.93E+03	-4.14E+03
2.51E+00	6.06E+03	-4.78E+03	5.25E+03	-4.93E+03
1.99E+00	6.46E+03	-5.68E+03	5.61E+03	-5.89E+03
1.58E+00	6.92E+03	-6.74E+03	6.09E+03	-7.02E+03
1.26E+00	7.51E+03	-8.04E+03	6.67E+03	-8.41E+03
9.98E-01	8.20E+03	-9.57E+03	7.39E+03	-1.00E+04
7.92E-01	9.10E+03	-1.14E+04	8.33E+03	-1.20E+04
6.29E-01	1.03E+04	-1.35E+04	9.61E+03	-1.43E+04
5.00E-01	1.18E+04	-1.60E+04	1.12E+04	-1.70E+04
3.97E-01	1.37E+04	-1.90E+04	1.33E+04	-2.01E+04
3.15E-01	1.61E+04	-2.21E+04	1.59E+04	-2.35E+04
2.51E-01	1.93E+04	-2.58E+04	1.95E+04	-2.72E+04
1.99E-01	2.33E+04	-2.99E+04	2.38E+04	-3.13E+04
1.58E-01	2.80E+04	-3.40E+04	2.89E+04	-3.53E+04
1.26E-01	3.40E+04	-3.80E+04	3.54E+04	-3.91E+04
1.00E-01	4.11E+04	-4.19E+04	4.28E+04	-4.25E+04

	09		08	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.58E+03	-1.26E+03	2.36E+03	-1.00E+03
3.97E+06	2.71E+03	-1.06E+03	2.45E+03	-8.35E+02
3.15E+06	2.82E+03	-8.76E+02	2.52E+03	-6.82E+02
2.51E+06	2.89E+03	-7.12E+02	2.57E+03	-5.48E+02
1.99E+06	2.94E+03	-5.59E+02	2.60E+03	-4.29E+02
1.58E+06	2.97E+03	-4.42E+02	2.62E+03	-3.38E+02
1.26E+06	2.99E+03	-3.44E+02	2.63E+03	-2.62E+02
9.98E+05	2.99E+03	-1.93E+02	2.63E+03	-1.37E+02
7.92E+05	2.99E+03	-1.56E+02	2.63E+03	-1.11E+02
6.29E+05	3.00E+03	-1.24E+02	2.63E+03	-8.85E+01
5.00E+05	3.00E+03	-9.97E+01	2.63E+03	-7.10E+01
3.97E+05	3.00E+03	-7.91E+01	2.63E+03	-5.63E+01
3.15E+05	3.00E+03	-6.19E+01	2.63E+03	-4.41E+01
2.51E+05	3.00E+03	-4.99E+01	2.63E+03	-3.60E+01
1.99E+05	3.00E+03	-4.14E+01	2.63E+03	-3.04E+01
1.58E+05	3.00E+03	-3.27E+01	2.64E+03	-2.37E+01
1.26E+05	3.00E+03	-2.47E+01	2.64E+03	-1.80E+01
9.98E+04	3.00E+03	-1.80E+01	2.64E+03	-1.28E+01
7.92E+04	3.00E+03	-1.26E+01	2.64E+03	-9.04E+00
6.29E+04	3.01E+03	-1.22E+01	2.64E+03	-8.92E+00
5.00E+04	3.01E+03	-7.79E+00	2.64E+03	-5.43E+00
3.97E+04	3.01E+03	-3.41E+00	2.64E+03	-2.06E+00
3.15E+04	3.01E+03	-9.00E-01	2.64E+03	-3.34E-01
2.51E+04	3.01E+03	3.92E+00	2.64E+03	3.69E+00
1.99E+04	3.00E+03	8.34E+00	2.64E+03	7.23E+00
1.58E+04	3.00E+03	1.26E+01	2.64E+03	1.05E+01
1.26E+04	3.00E+03	1.69E+01	2.64E+03	1.45E+01
9.98E+03	3.00E+03	2.18E+01	2.64E+03	1.80E+01
7.92E+03	2.99E+03	2.58E+01	2.63E+03	2.15E+01
6.29E+03	2.98E+03	2.90E+01	2.63E+03	2.37E+01
5.00E+03	2.98E+03	3.15E+01	2.62E+03	2.59E+01
3.97E+03	2.97E+03	3.08E+01	2.61E+03	2.50E+01
3.15E+03	2.96E+03	2.84E+01	2.61E+03	2.10E+01
2.51E+03	2.95E+03	2.29E+01	2.60E+03	1.77E+01
1.99E+03	2.94E+03	1.41E+01	2.59E+03	8.19E+00
1.58E+03	2.93E+03	3.16E+00	2.59E+03	-6.92E-01
1.26E+03	2.93E+03	-7.66E+00	2.59E+03	-1.15E+01
9.98E+02	2.93E+03	-1.91E+01	2.59E+03	-2.33E+01
7.92E+02	2.93E+03	-3.25E+01	2.59E+03	-3.64E+01
6.29E+02	2.93E+03	-4.87E+01	2.59E+03	-5.00E+01
5.00E+02	2.94E+03	-6.38E+01	2.59E+03	-6.58E+01
3.97E+02	2.94E+03	-8.10E+01	2.60E+03	-8.60E+01
3.15E+02	2.94E+03	-1.02E+02	2.61E+03	-1.07E+02
2.51E+02	2.95E+03	-1.29E+02	2.61E+03	-1.31E+02

	09		08	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
1.99E+02	2.96E+03	-1.58E+02	2.62E+03	-1.61E+02
1.58E+02	2.97E+03	-1.92E+02	2.63E+03	-1.96E+02
1.26E+02	2.98E+03	-2.33E+02	2.65E+03	-2.37E+02
9.98E+01	3.00E+03	-2.83E+02	2.67E+03	-2.87E+02
7.92E+01	3.02E+03	-3.42E+02	2.69E+03	-3.43E+02
6.29E+01	3.04E+03	-4.12E+02	2.72E+03	-4.11E+02
5.00E+01	3.06E+03	-4.90E+02	2.75E+03	-4.83E+02
3.97E+01	3.11E+03	-5.98E+02	2.79E+03	-5.84E+02
3.15E+01	3.15E+03	-7.19E+02	2.84E+03	-6.94E+02
2.51E+01	3.20E+03	-8.63E+02	2.89E+03	-8.25E+02
1.99E+01	3.26E+03	-1.04E+03	2.96E+03	-9.79E+02
1.58E+01	3.34E+03	-1.24E+03	3.03E+03	-1.16E+03
1.26E+01	3.43E+03	-1.48E+03	3.13E+03	-1.38E+03
9.98E+00	3.55E+03	-1.77E+03	3.23E+03	-1.64E+03
7.92E+00	3.69E+03	-2.10E+03	3.37E+03	-1.95E+03
6.29E+00	3.85E+03	-2.50E+03	3.51E+03	-2.31E+03
5.00E+00	4.03E+03	-2.98E+03	3.67E+03	-2.75E+03
3.97E+00	4.25E+03	-3.55E+03	3.88E+03	-3.27E+03
3.15E+00	4.49E+03	-4.24E+03	4.10E+03	-3.90E+03
2.51E+00	4.80E+03	-5.07E+03	4.38E+03	-4.66E+03
1.99E+00	5.15E+03	-6.08E+03	4.68E+03	-5.60E+03
1.58E+00	5.59E+03	-7.30E+03	5.08E+03	-6.73E+03
1.26E+00	6.16E+03	-8.78E+03	5.57E+03	-8.12E+03
9.98E-01	6.91E+03	-1.06E+04	6.18E+03	-9.75E+03
7.92E-01	7.83E+03	-1.27E+04	7.00E+03	-1.18E+04
6.29E-01	9.07E+03	-1.52E+04	8.12E+03	-1.42E+04
5.00E-01	1.07E+04	-1.81E+04	9.55E+03	-1.69E+04
3.97E-01	1.28E+04	-2.15E+04	1.16E+04	-2.04E+04
3.15E-01	1.56E+04	-2.53E+04	1.40E+04	-2.40E+04
2.51E-01	1.92E+04	-2.95E+04	1.74E+04	-2.81E+04
1.99E-01	2.38E+04	-3.39E+04	2.16E+04	-3.27E+04
1.58E-01	2.93E+04	-3.84E+04	2.68E+04	-3.74E+04
1.26E-01	3.62E+04	-4.27E+04	3.34E+04	-4.21E+04
1.00E-01	4.40E+04	-4.67E+04	4.10E+04	-4.65E+04

	07		06	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.26E+03	-8.96E+02	2.16E+03	-8.04E+02
3.97E+06	2.33E+03	-7.43E+02	2.22E+03	-6.62E+02
3.15E+06	2.38E+03	-6.04E+02	2.27E+03	-5.37E+02
2.51E+06	2.43E+03	-4.86E+02	2.30E+03	-4.30E+02
1.99E+06	2.45E+03	-3.77E+02	2.32E+03	-3.33E+02
1.58E+06	2.47E+03	-2.94E+02	2.33E+03	-2.57E+02
1.26E+06	2.47E+03	-2.29E+02	2.34E+03	-2.00E+02
9.98E+05	2.47E+03	-1.14E+02	2.33E+03	-9.53E+01
7.92E+05	2.47E+03	-9.22E+01	2.33E+03	-7.73E+01
6.29E+05	2.47E+03	-7.36E+01	2.34E+03	-6.15E+01
5.00E+05	2.47E+03	-5.92E+01	2.34E+03	-4.96E+01
3.97E+05	2.47E+03	-4.68E+01	2.34E+03	-3.88E+01
3.15E+05	2.47E+03	-3.64E+01	2.34E+03	-3.03E+01
2.51E+05	2.47E+03	-3.00E+01	2.34E+03	-2.51E+01
1.99E+05	2.48E+03	-2.54E+01	2.34E+03	-2.15E+01
1.58E+05	2.48E+03	-1.97E+01	2.34E+03	-1.65E+01
1.26E+05	2.48E+03	-1.49E+01	2.34E+03	-1.25E+01
9.98E+04	2.48E+03	-1.04E+01	2.34E+03	-8.65E+00
7.92E+04	2.48E+03	-7.39E+00	2.34E+03	-5.73E+00
6.29E+04	2.48E+03	-7.38E+00	2.34E+03	-6.29E+00
5.00E+04	2.48E+03	-4.45E+00	2.34E+03	-3.59E+00
3.97E+04	2.48E+03	-1.14E+00	2.34E+03	-9.66E-01
3.15E+04	2.48E+03	2.80E-02	2.34E+03	3.44E-01
2.51E+04	2.48E+03	3.57E+00	2.34E+03	3.28E+00
1.99E+04	2.48E+03	6.72E+00	2.34E+03	6.69E+00
1.58E+04	2.48E+03	9.62E+00	2.34E+03	8.84E+00
1.26E+04	2.48E+03	1.31E+01	2.34E+03	1.17E+01
9.98E+03	2.48E+03	1.63E+01	2.34E+03	1.54E+01
7.92E+03	2.48E+03	1.99E+01	2.33E+03	1.77E+01
6.29E+03	2.47E+03	2.15E+01	2.33E+03	1.93E+01
5.00E+03	2.46E+03	2.24E+01	2.32E+03	2.03E+01
3.97E+03	2.46E+03	2.20E+01	2.32E+03	1.94E+01
3.15E+03	2.45E+03	1.97E+01	2.31E+03	1.62E+01
2.51E+03	2.44E+03	1.43E+01	2.31E+03	1.01E+01
1.99E+03	2.44E+03	6.27E+00	2.30E+03	3.46E+00
1.58E+03	2.43E+03	-3.63E+00	2.30E+03	-4.61E+00
1.26E+03	2.43E+03	-1.35E+01	2.30E+03	-1.52E+01
9.98E+02	2.43E+03	-2.58E+01	2.30E+03	-2.64E+01
7.92E+02	2.43E+03	-3.81E+01	2.30E+03	-4.01E+01
6.29E+02	2.44E+03	-5.13E+01	2.30E+03	-5.15E+01
5.00E+02	2.44E+03	-6.75E+01	2.30E+03	-6.87E+01
3.97E+02	2.44E+03	-8.48E+01	2.31E+03	-8.69E+01
3.15E+02	2.45E+03	-1.07E+02	2.31E+03	-1.09E+02
2.51E+02	2.46E+03	-1.34E+02	2.32E+03	-1.33E+02

f / Hz	07 Z´ / Ω	07 Z´´/ Ω	06 Z´/ Ω	06 Z´´/ Ω
1.99E+02	2.47E+03	-1.63E+02	2.33E+03	-1.63E+02
1.58E+02	2.48E+03	-1.99E+02	2.34E+03	-1.99E+02
1.26E+02	2.49E+03	-2.38E+02	2.36E+03	-2.39E+02
9.98E+01	2.51E+03	-2.88E+02	2.38E+03	-2.90E+02
7.92E+01	2.53E+03	-3.47E+02	2.40E+03	-3.48E+02
6.29E+01	2.56E+03	-4.15E+02	2.42E+03	-4.18E+02
5.00E+01	2.59E+03	-4.87E+02	2.46E+03	-4.99E+02
3.97E+01	2.63E+03	-5.90E+02	2.49E+03	-5.98E+02
3.15E+01	2.68E+03	-7.04E+02	2.54E+03	-7.14E+02
2.51E+01	2.74E+03	-8.36E+02	2.60E+03	-8.52E+02
1.99E+01	2.80E+03	-9.94E+02	2.67E+03	-1.01E+03
1.58E+01	2.88E+03	-1.18E+03	2.74E+03	-1.20E+03
1.26E+01	2.98E+03	-1.40E+03	2.84E+03	-1.43E+03
9.98E+00	3.09E+03	-1.67E+03	2.95E+03	-1.70E+03
7.92E+00	3.21E+03	-1.98E+03	3.08E+03	-2.02E+03
6.29E+00	3.37E+03	-2.35E+03	3.24E+03	-2.40E+03
5.00E+00	3.53E+03	-2.79E+03	3.41E+03	-2.84E+03
3.97E+00	3.74E+03	-3.32E+03	3.62E+03	-3.38E+03
3.15E+00	3.97E+03	-3.96E+03	3.85E+03	-4.03E+03
2.51E+00	4.24E+03	-4.73E+03	4.14E+03	-4.81E+03
1.99E+00	4.54E+03	-5.67E+03	4.44E+03	-5.77E+03
1.58E+00	4.93E+03	-6.82E+03	4.84E+03	-6.93E+03
1.26E+00	5.41E+03	-8.22E+03	5.30E+03	-8.38E+03
9.98E-01	6.05E+03	-9.89E+03	5.94E+03	-1.01E+04
7.92E-01	6.85E+03	-1.19E+04	6.74E+03	-1.21E+04
6.29E-01	7.97E+03	-1.44E+04	7.85E+03	-1.47E+04
5.00E-01	9.37E+03	-1.72E+04	9.23E+03	-1.76E+04
3.97E-01	1.13E+04	-2.07E+04	1.11E+04	-2.11E+04
3.15E-01	1.38E+04	-2.44E+04	1.36E+04	-2.50E+04
2.51E-01	1.72E+04	-2.88E+04	1.70E+04	-2.95E+04
1.99E-01	2.13E+04	-3.36E+04	2.13E+04	-3.46E+04
1.58E-01	2.65E+04	-3.86E+04	2.65E+04	-3.97E+04
1.26E-01	3.32E+04	-4.35E+04	3.31E+04	-4.50E+04
1.00E-01	4.10E+04	-4.82E+04	4.10E+04	-5.01E+04

	05		04	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.09E+03	-7.42E+02	2.02E+03	-6.97E+02
3.97E+06	2.13E+03	-6.08E+02	2.07E+03	-5.70E+02
3.15E+06	2.17E+03	-4.90E+02	2.10E+03	-4.59E+02
2.51E+06	2.20E+03	-3.92E+02	2.12E+03	-3.65E+02
1.99E+06	2.21E+03	-3.02E+02	2.14E+03	-2.82E+02
1.58E+06	2.22E+03	-2.34E+02	2.15E+03	-2.18E+02
1.26E+06	2.23E+03	-1.80E+02	2.15E+03	-1.68E+02
9.98E+05	2.22E+03	-8.24E+01	2.14E+03	-7.45E+01
7.92E+05	2.22E+03	-6.70E+01	2.14E+03	-6.05E+01
6.29E+05	2.22E+03	-5.32E+01	2.14E+03	-4.81E+01
5.00E+05	2.22E+03	-4.28E+01	2.14E+03	-3.88E+01
3.97E+05	2.22E+03	-3.35E+01	2.14E+03	-3.02E+01
3.15E+05	2.22E+03	-2.60E+01	2.14E+03	-2.35E+01
2.51E+05	2.22E+03	-2.17E+01	2.14E+03	-1.97E+01
1.99E+05	2.22E+03	-1.85E+01	2.14E+03	-1.68E+01
1.58E+05	2.22E+03	-1.42E+01	2.14E+03	-1.30E+01
1.26E+05	2.23E+03	-1.06E+01	2.15E+03	-9.68E+00
9.98E+04	2.23E+03	-7.23E+00	2.15E+03	-6.55E+00
7.92E+04	2.23E+03	-4.72E+00	2.15E+03	-4.15E+00
6.29E+04	2.23E+03	-5.37E+00	2.15E+03	-4.91E+00
5.00E+04	2.23E+03	-2.93E+00	2.15E+03	-2.52E+00
3.97E+04	2.23E+03	-5.13E-01	2.15E+03	-3.31E-01
3.15E+04	2.23E+03	4.80E-01	2.15E+03	6.28E-01
2.51E+04	2.23E+03	3.54E+00	2.15E+03	3.55E+00
1.99E+04	2.23E+03	6.12E+00	2.15E+03	5.74E+00
1.58E+04	2.23E+03	8.75E+00	2.15E+03	8.25E+00
1.26E+04	2.23E+03	1.07E+01	2.15E+03	1.06E+01
9.98E+03	2.23E+03	1.39E+01	2.15E+03	1.32E+01
7.92E+03	2.22E+03	1.61E+01	2.14E+03	1.52E+01
6.29E+03	2.22E+03	1.82E+01	2.14E+03	1.65E+01
5.00E+03	2.21E+03	1.85E+01	2.13E+03	1.73E+01
3.97E+03	2.21E+03	1.82E+01	2.13E+03	1.66E+01
3.15E+03	2.20E+03	1.38E+01	2.12E+03	1.30E+01
2.51E+03	2.20E+03	8.90E+00	2.12E+03	9.13E+00
1.99E+03	2.19E+03	1.51E+00	2.11E+03	8.59E-01
1.58E+03	2.19E+03	-6.89E+00	2.11E+03	-8.34E+00
1.26E+03	2.19E+03	-1.62E+01	2.11E+03	-1.84E+01
9.98E+02	2.19E+03	-2.74E+01	2.11E+03	-2.91E+01
7.92E+02	2.19E+03	-3.92E+01	2.11E+03	-4.14E+01
6.29E+02	2.19E+03	-5.31E+01	2.11E+03	-5.52E+01
5.00E+02	2.20E+03	-7.03E+01	2.12E+03	-7.13E+01
3.97E+02	2.20E+03	-8.81E+01	2.12E+03	-9.05E+01
3.15E+02	2.21E+03	-1.09E+02	2.13E+03	-1.11E+02
2.51E+02	2.21E+03	-1.36E+02	2.14E+03	-1.36E+02

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	2.22E+03	-1.65E+02	2.15E+03	-1.67E+02
1.58E+02	2.23E+03	-2.01E+02	2.16E+03	-2.02E+02
1.26E+02	2.25E+03	-2.42E+02	2.17E+03	-2.45E+02
9.98E+01	2.27E+03	-2.93E+02	2.19E+03	-2.96E+02
7.92E+01	2.29E+03	-3.52E+02	2.21E+03	-3.55E+02
6.29E+01	2.32E+03	-4.22E+02	2.24E+03	-4.26E+02
5.00E+01	2.34E+03	-4.95E+02	2.27E+03	-5.22E+02
3.97E+01	2.39E+03	-6.05E+02	2.31E+03	-6.09E+02
3.15E+01	2.44E+03	-7.21E+02	2.36E+03	-7.26E+02
2.51E+01	2.49E+03	-8.60E+02	2.42E+03	-8.64E+02
1.99E+01	2.56E+03	-1.02E+03	2.49E+03	-1.03E+03
1.58E+01	2.64E+03	-1.22E+03	2.57E+03	-1.22E+03
1.26E+01	2.74E+03	-1.45E+03	2.66E+03	-1.46E+03
9.98E+00	2.85E+03	-1.72E+03	2.77E+03	-1.73E+03
7.92E+00	2.98E+03	-2.04E+03	2.91E+03	-2.06E+03
6.29E+00	3.13E+03	-2.43E+03	3.06E+03	-2.44E+03
5.00E+00	3.32E+03	-2.88E+03	3.23E+03	-2.90E+03
3.97E+00	3.52E+03	-3.43E+03	3.44E+03	-3.46E+03
3.15E+00	3.76E+03	-4.09E+03	3.66E+03	-4.13E+03
2.51E+00	4.04E+03	-4.88E+03	3.95E+03	-4.94E+03
1.99E+00	4.33E+03	-5.86E+03	4.25E+03	-5.93E+03
1.58E+00	4.74E+03	-7.05E+03	4.64E+03	-7.13E+03
1.26E+00	5.22E+03	-8.52E+03	5.09E+03	-8.62E+03
9.98E-01	5.80E+03	-1.03E+04	5.71E+03	-1.04E+04
7.92E-01	6.61E+03	-1.24E+04	6.50E+03	-1.26E+04
6.29E-01	7.74E+03	-1.50E+04	7.59E+03	-1.52E+04
5.00E-01	9.08E+03	-1.79E+04	8.96E+03	-1.82E+04
3.97E-01	1.10E+04	-2.16E+04	1.08E+04	-2.20E+04
3.15E-01	1.34E+04	-2.56E+04	1.33E+04	-2.62E+04
2.51E-01	1.68E+04	-3.03E+04	1.67E+04	-3.10E+04
1.99E-01	2.11E+04	-3.56E+04	2.09E+04	-3.65E+04
1.58E-01	2.63E+04	-4.11E+04	2.61E+04	-4.23E+04
1.26E-01	3.31E+04	-4.68E+04	3.30E+04	-4.82E+04
1.00E-01	4.10E+04	-5.22E+04	4.12E+04	-5.41E+04

	03		02	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
5.00E+06	2.02E+03	-6.81E+02	1.97E+03	-6.39E+02
3.97E+06	2.06E+03	-5.58E+02	2.01E+03	-5.23E+02
3.15E+06	2.09E+03	-4.49E+02	2.04E+03	-4.21E+02
2.51E+06	2.11E+03	-3.56E+02	2.06E+03	-3.34E+02
1.99E+06	2.12E+03	-2.76E+02	2.07E+03	-2.58E+02
1.58E+06	2.13E+03	-2.13E+02	2.07E+03	-1.98E+02
1.26E+06	2.13E+03	-1.64E+02	2.07E+03	-1.52E+02
9.98E+05	2.13E+03	-7.19E+01	2.07E+03	-6.40E+01
7.92E+05	2.13E+03	-5.84E+01	2.07E+03	-5.20E+01
6.29E+05	2.13E+03	-4.63E+01	2.07E+03	-4.13E+01
5.00E+05	2.13E+03	-3.75E+01	2.07E+03	-3.32E+01
3.97E+05	2.13E+03	-2.91E+01	2.07E+03	-2.58E+01
3.15E+05	2.13E+03	-2.26E+01	2.07E+03	-2.00E+01
2.51E+05	2.13E+03	-1.90E+01	2.07E+03	-1.69E+01
1.99E+05	2.13E+03	-1.62E+01	2.07E+03	-1.45E+01
1.58E+05	2.13E+03	-1.25E+01	2.07E+03	-1.13E+01
1.26E+05	2.13E+03	-9.16E+00	2.07E+03	-8.24E+00
9.98E+04	2.13E+03	-6.24E+00	2.07E+03	-5.56E+00
7.92E+04	2.14E+03	-4.05E+00	2.07E+03	-3.44E+00
6.29E+04	2.14E+03	-4.76E+00	2.08E+03	-4.15E+00
5.00E+04	2.14E+03	-2.50E+00	2.08E+03	-2.07E+00
3.97E+04	2.14E+03	-3.41E-01	2.08E+03	-6.90E-02
3.15E+04	2.14E+03	6.56E-01	2.08E+03	7.00E-01
2.51E+04	2.14E+03	3.46E+00	2.08E+03	3.50E+00
1.99E+04	2.14E+03	5.85E+00	2.08E+03	5.60E+00
1.58E+04	2.13E+03	7.89E+00	2.08E+03	7.49E+00
1.26E+04	2.13E+03	1.01E+01	2.08E+03	1.00E+01
9.98E+03	2.13E+03	1.29E+01	2.07E+03	1.23E+01
7.92E+03	2.13E+03	1.56E+01	2.07E+03	1.47E+01
6.29E+03	2.12E+03	1.68E+01	2.07E+03	1.51E+01
5.00E+03	2.12E+03	1.74E+01	2.06E+03	1.65E+01
3.97E+03	2.11E+03	1.64E+01	2.06E+03	1.50E+01
3.15E+03	2.11E+03	1.23E+01	2.05E+03	1.20E+01
2.51E+03	2.10E+03	7.98E+00	2.04E+03	6.02E+00
1.99E+03	2.10E+03	4.93E-01	2.04E+03	-8.62E-01
1.58E+03	2.10E+03	-7.93E+00	2.04E+03	-9.22E+00
1.26E+03	2.09E+03	-1.79E+01	2.04E+03	-1.89E+01
9.98E+02	2.10E+03	-2.92E+01	2.04E+03	-2.95E+01
7.92E+02	2.10E+03	-4.11E+01	2.04E+03	-4.35E+01
6.29E+02	2.10E+03	-5.38E+01	2.04E+03	-5.59E+01
5.00E+02	2.10E+03	-7.05E+01	2.05E+03	-7.29E+01
3.97E+02	2.11E+03	-8.75E+01	2.05E+03	-9.24E+01
3.15E+02	2.11E+03	-1.10E+02	2.06E+03	-1.14E+02
2.51E+02	2.12E+03	-1.34E+02	2.07E+03	-1.39E+02

f / Hz	03		02	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	2.13E+03	-1.64E+02	2.08E+03	-1.69E+02
1.58E+02	2.14E+03	-2.00E+02	2.09E+03	-2.06E+02
1.26E+02	2.16E+03	-2.43E+02	2.11E+03	-2.50E+02
9.98E+01	2.18E+03	-2.92E+02	2.12E+03	-3.00E+02
7.92E+01	2.20E+03	-3.52E+02	2.15E+03	-3.61E+02
6.29E+01	2.23E+03	-4.21E+02	2.17E+03	-4.32E+02
5.00E+01	2.27E+03	-4.98E+02	2.21E+03	-5.31E+02
3.97E+01	2.30E+03	-6.03E+02	2.25E+03	-6.18E+02
3.15E+01	2.34E+03	-7.21E+02	2.30E+03	-7.38E+02
2.51E+01	2.40E+03	-8.58E+02	2.35E+03	-8.79E+02
1.99E+01	2.46E+03	-1.02E+03	2.42E+03	-1.05E+03
1.58E+01	2.54E+03	-1.22E+03	2.51E+03	-1.25E+03
1.26E+01	2.63E+03	-1.45E+03	2.60E+03	-1.48E+03
9.98E+00	2.74E+03	-1.72E+03	2.71E+03	-1.76E+03
7.92E+00	2.88E+03	-2.05E+03	2.85E+03	-2.09E+03
6.29E+00	3.03E+03	-2.43E+03	3.01E+03	-2.48E+03
5.00E+00	3.19E+03	-2.90E+03	3.18E+03	-2.95E+03
3.97E+00	3.40E+03	-3.45E+03	3.38E+03	-3.50E+03
3.15E+00	3.61E+03	-4.13E+03	3.64E+03	-4.18E+03
2.51E+00	3.88E+03	-4.94E+03	3.91E+03	-5.01E+03
1.99E+00	4.17E+03	-5.94E+03	4.22E+03	-6.00E+03
1.58E+00	4.55E+03	-7.17E+03	4.60E+03	-7.23E+03
1.26E+00	5.02E+03	-8.66E+03	5.09E+03	-8.75E+03
9.98E-01	5.64E+03	-1.05E+04	5.66E+03	-1.06E+04
7.92E-01	6.42E+03	-1.27E+04	6.46E+03	-1.28E+04
6.29E-01	7.42E+03	-1.53E+04	7.59E+03	-1.54E+04
5.00E-01	8.76E+03	-1.85E+04	8.93E+03	-1.85E+04
3.97E-01	1.06E+04	-2.23E+04	1.08E+04	-2.24E+04
3.15E-01	1.30E+04	-2.67E+04	1.32E+04	-2.67E+04
2.51E-01	1.63E+04	-3.17E+04	1.66E+04	-3.16E+04
1.99E-01	2.04E+04	-3.73E+04	2.08E+04	-3.73E+04
1.58E-01	2.58E+04	-4.34E+04	2.61E+04	-4.35E+04
1.26E-01	3.25E+04	-4.98E+04	3.28E+04	-4.96E+04
1.00E-01	4.08E+04	-5.62E+04	4.09E+04	-5.60E+04

Tab. A. 8 Frequency dispersion of K_2SO_4 solutions

	15		14	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	-5.19E+01	-7.13E+03	9.14E+02	-6.80E+03
3.97E+06	3.30E+02	-8.67E+03	1.72E+03	-8.03E+03
3.15E+06	8.05E+02	-1.06E+04	2.78E+03	-9.46E+03
2.51E+06	1.35E+03	-1.30E+04	4.12E+03	-1.11E+04
1.99E+06	2.25E+03	-1.60E+04	5.96E+03	-1.28E+04
1.58E+06	3.46E+03	-1.98E+04	8.23E+03	-1.45E+04
1.26E+06	5.16E+03	-2.41E+04	1.10E+04	-1.61E+04
9.98E+05	8.34E+03	-2.90E+04	1.49E+04	-1.69E+04
7.92E+05	1.17E+04	-3.51E+04	1.86E+04	-1.76E+04
6.29E+05	1.63E+04	-4.21E+04	2.25E+04	-1.75E+04
5.00E+05	2.24E+04	-4.98E+04	2.62E+04	-1.66E+04
3.97E+05	3.08E+04	-5.76E+04	2.94E+04	-1.51E+04
3.15E+05	4.18E+04	-6.53E+04	3.19E+04	-1.32E+04
2.51E+05	5.54E+04	-7.21E+04	3.39E+04	-1.12E+04
1.99E+05	7.11E+04	-7.67E+04	3.53E+04	-9.42E+03
1.58E+05	8.81E+04	-7.79E+04	3.63E+04	-7.75E+03
1.26E+05	1.05E+05	-7.56E+04	3.70E+04	-6.30E+03
9.98E+04	1.20E+05	-7.01E+04	3.75E+04	-5.07E+03
7.92E+04	1.33E+05	-6.24E+04	3.78E+04	-4.06E+03
6.29E+04	1.43E+05	-5.43E+04	3.80E+04	-3.31E+03
5.00E+04	1.51E+05	-4.57E+04	3.81E+04	-2.62E+03
3.97E+04	1.56E+05	-3.77E+04	3.82E+04	-2.06E+03
3.15E+04	1.59E+05	-3.08E+04	3.83E+04	-1.62E+03
2.51E+04	1.62E+05	-2.47E+04	3.83E+04	-1.22E+03
1.99E+04	1.63E+05	-1.96E+04	3.84E+04	-8.93E+02
1.58E+04	1.65E+05	-1.53E+04	3.83E+04	-6.07E+02
1.26E+04	1.65E+05	-1.18E+04	3.83E+04	-3.62E+02
9.98E+03	1.65E+05	-8.81E+03	3.83E+04	-1.47E+02
7.92E+03	1.65E+05	-6.37E+03	3.82E+04	4.63E+01
6.29E+03	1.65E+05	-4.40E+03	3.81E+04	1.93E+02
5.00E+03	1.65E+05	-2.80E+03	3.80E+04	3.24E+02
3.97E+03	1.64E+05	-1.58E+03	3.79E+04	4.02E+02
3.15E+03	1.64E+05	-7.27E+02	3.77E+04	4.41E+02
2.51E+03	1.63E+05	-4.56E+02	3.76E+04	4.18E+02
1.99E+03	1.63E+05	1.07E+01	3.75E+04	4.04E+02
1.58E+03	1.62E+05	9.34E+01	3.74E+04	3.39E+02
1.26E+03	1.62E+05	1.48E+02	3.74E+04	2.74E+02
9.98E+02	1.62E+05	1.06E+02	3.73E+04	2.07E+02
7.92E+02	1.62E+05	6.51E+01	3.73E+04	1.44E+02
6.29E+02	1.62E+05	-1.26E+02	3.73E+04	9.10E+01
5.00E+02	1.62E+05	-9.50E+01	3.73E+04	1.66E+01
3.97E+02	1.62E+05	-1.33E+02	3.73E+04	-3.09E+01
3.15E+02	1.62E+05	-1.49E+02	3.73E+04	-8.42E+01

	15		14	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
2.51E+02	1.62E+05	-3.17E+02	3.73E+04	-1.92E+02
1.99E+02	1.62E+05	-3.76E+02	3.73E+04	-2.47E+02
1.58E+02	1.62E+05	-4.68E+02	3.74E+04	-3.17E+02
1.26E+02	1.62E+05	-6.04E+02	3.74E+04	-4.04E+02
9.98E+01	1.62E+05	-6.54E+02	3.74E+04	-5.06E+02
7.92E+01	1.62E+05	-7.70E+02	3.74E+04	-6.20E+02
6.29E+01	1.62E+05	-8.80E+02	3.75E+04	-7.71E+02
5.00E+01	1.63E+05	-1.78E+03	3.75E+04	-8.00E+02
3.97E+01	1.63E+05	-1.21E+03	3.76E+04	-1.15E+03
3.15E+01	1.63E+05	-1.48E+03	3.76E+04	-1.42E+03
2.51E+01	1.63E+05	-1.81E+03	3.77E+04	-1.72E+03
1.99E+01	1.63E+05	-2.17E+03	3.79E+04	-2.09E+03
1.58E+01	1.63E+05	-2.58E+03	3.80E+04	-2.54E+03
1.26E+01	1.63E+05	-3.02E+03	3.82E+04	-3.07E+03
9.98E+00	1.64E+05	-3.63E+03	3.85E+04	-3.67E+03
7.92E+00	1.64E+05	-4.35E+03	3.88E+04	-4.42E+03
6.29E+00	1.65E+05	-4.98E+03	3.92E+04	-5.26E+03
5.00E+00	1.65E+05	-5.77E+03	3.96E+04	-6.26E+03
3.97E+00	1.66E+05	-6.87E+03	4.02E+04	-7.42E+03
3.15E+00	1.66E+05	-7.85E+03	4.09E+04	-8.77E+03
2.51E+00	1.67E+05	-9.26E+03	4.16E+04	-1.04E+04
1.99E+00	1.68E+05	-1.09E+04	4.25E+04	-1.22E+04
1.58E+00	1.69E+05	-1.28E+04	4.36E+04	-1.44E+04
1.26E+00	1.70E+05	-1.54E+04	4.48E+04	-1.70E+04
9.98E-01	1.71E+05	-1.77E+04	4.62E+04	-2.00E+04
7.92E-01	1.73E+05	-2.12E+04	4.79E+04	-2.36E+04
6.29E-01	1.75E+05	-2.51E+04	4.98E+04	-2.80E+04
5.00E-01	1.77E+05	-2.99E+04	5.21E+04	-3.32E+04
3.97E-01	1.79E+05	-3.55E+04	5.48E+04	-3.93E+04
3.15E-01	1.83E+05	-4.26E+04	5.82E+04	-4.67E+04
2.51E-01	1.87E+05	-5.06E+04	6.22E+04	-5.53E+04
1.99E-01	1.92E+05	-5.99E+04	6.72E+04	-6.58E+04
1.58E-01	1.98E+05	-7.21E+04	7.32E+04	-7.84E+04
1.26E-01	2.04E+05	-8.65E+04	8.03E+04	-9.33E+04
1.00E-01	2.14E+05	-1.03E+05	8.97E+04	-1.10E+05

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	1.78E+03	-6.35E+03	2.65E+03	-5.13E+03
3.97E+06	2.77E+03	-7.20E+03	3.64E+03	-5.49E+03
3.15E+06	4.00E+03	-8.07E+03	4.82E+03	-5.69E+03
2.51E+06	5.49E+03	-8.98E+03	6.02E+03	-5.78E+03
1.99E+06	7.39E+03	-9.65E+03	7.27E+03	-5.50E+03
1.58E+06	9.44E+03	-1.01E+04	8.33E+03	-5.09E+03
1.26E+06	1.16E+04	-1.01E+04	9.25E+03	-4.51E+03
9.98E+05	1.40E+04	-9.36E+03	1.00E+04	-3.59E+03
7.92E+05	1.58E+04	-8.68E+03	1.05E+04	-3.04E+03
6.29E+05	1.74E+04	-7.73E+03	1.09E+04	-2.52E+03
5.00E+05	1.86E+04	-6.69E+03	1.11E+04	-2.07E+03
3.97E+05	1.95E+04	-5.63E+03	1.13E+04	-1.68E+03
3.15E+05	2.02E+04	-4.64E+03	1.14E+04	-1.35E+03
2.51E+05	2.06E+04	-3.80E+03	1.14E+04	-1.09E+03
1.99E+05	2.09E+04	-3.09E+03	1.15E+04	-8.76E+02
1.58E+05	2.11E+04	-2.49E+03	1.15E+04	-6.98E+02
1.26E+05	2.12E+04	-1.99E+03	1.16E+04	-5.52E+02
9.98E+04	2.13E+04	-1.58E+03	1.16E+04	-4.35E+02
7.92E+04	2.14E+04	-1.26E+03	1.16E+04	-3.41E+02
6.29E+04	2.14E+04	-1.03E+03	1.16E+04	-2.85E+02
5.00E+04	2.15E+04	-8.04E+02	1.16E+04	-2.18E+02
3.97E+04	2.15E+04	-6.22E+02	1.16E+04	-1.62E+02
3.15E+04	2.15E+04	-4.82E+02	1.16E+04	-1.19E+02
2.51E+04	2.15E+04	-3.45E+02	1.16E+04	-7.41E+01
1.99E+04	2.15E+04	-2.29E+02	1.16E+04	-3.36E+01
1.58E+04	2.15E+04	-1.25E+02	1.16E+04	1.73E-01
1.26E+04	2.15E+04	-3.30E+01	1.16E+04	3.53E+01
9.98E+03	2.15E+04	5.43E+01	1.16E+04	6.77E+01
7.92E+03	2.14E+04	1.29E+02	1.16E+04	1.00E+02
6.29E+03	2.14E+04	1.89E+02	1.16E+04	1.26E+02
5.00E+03	2.13E+04	2.43E+02	1.15E+04	1.43E+02
3.97E+03	2.13E+04	2.73E+02	1.15E+04	1.56E+02
3.15E+03	2.12E+04	2.77E+02	1.14E+04	1.58E+02
2.51E+03	2.11E+04	2.78E+02	1.14E+04	1.42E+02
1.99E+03	2.10E+04	2.41E+02	1.14E+04	1.26E+02
1.58E+03	2.10E+04	1.97E+02	1.13E+04	9.75E+01
1.26E+03	2.10E+04	1.49E+02	1.13E+04	6.73E+01
9.98E+02	2.09E+04	1.03E+02	1.13E+04	3.48E+01
7.92E+02	2.09E+04	5.94E+01	1.13E+04	3.38E-01
6.29E+02	2.09E+04	2.56E+01	1.13E+04	-2.90E+01
5.00E+02	2.09E+04	-3.63E+01	1.13E+04	-6.45E+01
3.97E+02	2.09E+04	-7.64E+01	1.13E+04	-1.04E+02
3.15E+02	2.09E+04	-1.25E+02	1.13E+04	-1.45E+02
2.51E+02	2.09E+04	-2.08E+02	1.14E+04	-2.10E+02

f / Hz	13		12	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	2.10E+04	-2.56E+02	1.14E+04	-2.53E+02
1.58E+02	2.10E+04	-3.17E+02	1.14E+04	-3.14E+02
1.26E+02	2.10E+04	-3.95E+02	1.14E+04	-3.85E+02
9.98E+01	2.10E+04	-5.05E+02	1.14E+04	-4.93E+02
7.92E+01	2.10E+04	-6.10E+02	1.14E+04	-5.88E+02
6.29E+01	2.11E+04	-7.48E+02	1.15E+04	-7.21E+02
5.00E+01	2.12E+04	-9.71E+02	1.15E+04	-9.31E+02
3.97E+01	2.12E+04	-1.13E+03	1.16E+04	-1.07E+03
3.15E+01	2.12E+04	-1.38E+03	1.17E+04	-1.31E+03
2.51E+01	2.13E+04	-1.68E+03	1.18E+04	-1.58E+03
1.99E+01	2.14E+04	-2.04E+03	1.19E+04	-1.92E+03
1.58E+01	2.16E+04	-2.49E+03	1.20E+04	-2.30E+03
1.26E+01	2.17E+04	-3.02E+03	1.22E+04	-2.77E+03
9.98E+00	2.19E+04	-3.65E+03	1.24E+04	-3.31E+03
7.92E+00	2.22E+04	-4.40E+03	1.27E+04	-3.95E+03
6.29E+00	2.26E+04	-5.31E+03	1.30E+04	-4.73E+03
5.00E+00	2.30E+04	-6.36E+03	1.34E+04	-5.61E+03
3.97E+00	2.35E+04	-7.60E+03	1.39E+04	-6.65E+03
3.15E+00	2.42E+04	-9.03E+03	1.44E+04	-7.88E+03
2.51E+00	2.50E+04	-1.07E+04	1.50E+04	-9.34E+03
1.99E+00	2.59E+04	-1.27E+04	1.58E+04	-1.11E+04
1.58E+00	2.70E+04	-1.49E+04	1.66E+04	-1.31E+04
1.26E+00	2.82E+04	-1.76E+04	1.76E+04	-1.56E+04
9.98E-01	2.96E+04	-2.07E+04	1.88E+04	-1.86E+04
7.92E-01	3.11E+04	-2.45E+04	2.02E+04	-2.21E+04
6.29E-01	3.30E+04	-2.91E+04	2.19E+04	-2.63E+04
5.00E-01	3.52E+04	-3.46E+04	2.40E+04	-3.13E+04
3.97E-01	3.77E+04	-4.12E+04	2.63E+04	-3.73E+04
3.15E-01	4.08E+04	-4.92E+04	2.91E+04	-4.45E+04
2.51E-01	4.47E+04	-5.88E+04	3.26E+04	-5.32E+04
1.99E-01	4.95E+04	-7.03E+04	3.66E+04	-6.37E+04
1.58E-01	5.55E+04	-8.38E+04	4.18E+04	-7.60E+04
1.26E-01	6.31E+04	-1.00E+05	4.82E+04	-9.10E+04
1.00E-01	7.29E+04	-1.19E+05	5.61E+04	-1.09E+05

	11		10	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	3.12E+03	-4.19E+03	3.24E+03	-3.36E+03
3.97E+06	3.95E+03	-4.20E+03	3.88E+03	-3.21E+03
3.15E+06	4.82E+03	-4.05E+03	4.49E+03	-2.93E+03
2.51E+06	5.62E+03	-3.82E+03	5.00E+03	-2.62E+03
1.99E+06	6.33E+03	-3.37E+03	5.40E+03	-2.23E+03
1.58E+06	6.87E+03	-2.95E+03	5.71E+03	-1.87E+03
1.26E+06	7.29E+03	-2.48E+03	5.90E+03	-1.54E+03
9.98E+05	7.60E+03	-1.85E+03	6.05E+03	-1.09E+03
7.92E+05	7.78E+03	-1.53E+03	6.13E+03	-8.85E+02
6.29E+05	7.91E+03	-1.24E+03	6.19E+03	-7.13E+02
5.00E+05	8.00E+03	-1.01E+03	6.23E+03	-5.75E+02
3.97E+05	8.06E+03	-8.08E+02	6.26E+03	-4.60E+02
3.15E+05	8.09E+03	-6.43E+02	6.27E+03	-3.64E+02
2.51E+05	8.12E+03	-5.16E+02	6.28E+03	-2.92E+02
1.99E+05	8.14E+03	-4.17E+02	6.29E+03	-2.37E+02
1.58E+05	8.15E+03	-3.31E+02	6.30E+03	-1.87E+02
1.26E+05	8.17E+03	-2.59E+02	6.31E+03	-1.45E+02
9.98E+04	8.18E+03	-2.02E+02	6.32E+03	-1.11E+02
7.92E+04	8.19E+03	-1.56E+02	6.33E+03	-8.62E+01
6.29E+04	8.19E+03	-1.34E+02	6.32E+03	-7.49E+01
5.00E+04	8.19E+03	-1.00E+02	6.33E+03	-5.53E+01
3.97E+04	8.20E+03	-7.17E+01	6.33E+03	-3.80E+01
3.15E+04	8.20E+03	-5.14E+01	6.33E+03	-2.58E+01
2.51E+04	8.20E+03	-2.61E+01	6.33E+03	-9.32E+00
1.99E+04	8.20E+03	-3.84E+00	6.33E+03	5.26E+00
1.58E+04	8.20E+03	1.43E+01	6.33E+03	1.81E+01
1.26E+04	8.19E+03	3.80E+01	6.33E+03	3.15E+01
9.98E+03	8.18E+03	5.43E+01	6.32E+03	4.31E+01
7.92E+03	8.17E+03	7.71E+01	6.31E+03	6.07E+01
6.29E+03	8.15E+03	9.09E+01	6.29E+03	6.78E+01
5.00E+03	8.13E+03	1.03E+02	6.28E+03	7.74E+01
3.97E+03	8.10E+03	1.11E+02	6.25E+03	8.16E+01
3.15E+03	8.07E+03	1.06E+02	6.24E+03	7.29E+01
2.51E+03	8.04E+03	1.03E+02	6.22E+03	5.90E+01
1.99E+03	8.02E+03	8.01E+01	6.19E+03	5.57E+01
1.58E+03	8.00E+03	5.77E+01	6.18E+03	3.63E+01
1.26E+03	7.99E+03	3.38E+01	6.17E+03	1.61E+01
9.98E+02	7.98E+03	5.73E+00	6.17E+03	-7.06E+00
7.92E+02	7.98E+03	-1.95E+01	6.16E+03	-3.21E+01
6.29E+02	7.98E+03	-4.05E+01	6.17E+03	-5.23E+01
5.00E+02	7.98E+03	-7.84E+01	6.17E+03	-8.60E+01
3.97E+02	7.98E+03	-1.12E+02	6.17E+03	-1.19E+02
3.15E+02	8.00E+03	-1.51E+02	6.18E+03	-1.55E+02
2.51E+02	8.00E+03	-2.13E+02	6.19E+03	-2.07E+02

	11		10	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
1.99E+02	8.01E+03	-2.48E+02	6.20E+03	-2.55E+02
1.58E+02	8.02E+03	-3.11E+02	6.22E+03	-3.11E+02
1.26E+02	8.04E+03	-3.84E+02	6.23E+03	-3.85E+02
9.98E+01	8.07E+03	-4.84E+02	6.25E+03	-4.66E+02
7.92E+01	8.09E+03	-5.80E+02	6.29E+03	-5.77E+02
6.29E+01	8.13E+03	-7.14E+02	6.33E+03	-7.06E+02
5.00E+01	8.14E+03	-8.59E+02	6.40E+03	-8.39E+02
3.97E+01	8.22E+03	-1.06E+03	6.44E+03	-1.03E+03
3.15E+01	8.30E+03	-1.30E+03	6.51E+03	-1.25E+03
2.51E+01	8.38E+03	-1.57E+03	6.60E+03	-1.50E+03
1.99E+01	8.49E+03	-1.89E+03	6.72E+03	-1.80E+03
1.58E+01	8.64E+03	-2.28E+03	6.85E+03	-2.17E+03
1.26E+01	8.81E+03	-2.76E+03	7.02E+03	-2.58E+03
9.98E+00	9.02E+03	-3.32E+03	7.22E+03	-3.09E+03
7.92E+00	9.28E+03	-3.96E+03	7.47E+03	-3.69E+03
6.29E+00	9.62E+03	-4.73E+03	7.75E+03	-4.38E+03
5.00E+00	1.00E+04	-5.61E+03	8.09E+03	-5.19E+03
3.97E+00	1.04E+04	-6.65E+03	8.48E+03	-6.15E+03
3.15E+00	1.10E+04	-7.89E+03	8.95E+03	-7.31E+03
2.51E+00	1.16E+04	-9.34E+03	9.48E+03	-8.69E+03
1.99E+00	1.23E+04	-1.11E+04	1.01E+04	-1.04E+04
1.58E+00	1.31E+04	-1.31E+04	1.07E+04	-1.24E+04
1.26E+00	1.40E+04	-1.57E+04	1.15E+04	-1.48E+04
9.98E-01	1.52E+04	-1.87E+04	1.25E+04	-1.78E+04
7.92E-01	1.65E+04	-2.23E+04	1.36E+04	-2.13E+04
6.29E-01	1.81E+04	-2.67E+04	1.50E+04	-2.56E+04
5.00E-01	2.00E+04	-3.19E+04	1.67E+04	-3.09E+04
3.97E-01	2.23E+04	-3.82E+04	1.87E+04	-3.71E+04
3.15E-01	2.51E+04	-4.58E+04	2.11E+04	-4.48E+04
2.51E-01	2.86E+04	-5.48E+04	2.43E+04	-5.40E+04
1.99E-01	3.31E+04	-6.56E+04	2.82E+04	-6.50E+04
1.58E-01	3.84E+04	-7.86E+04	3.34E+04	-7.86E+04
1.26E-01	4.52E+04	-9.38E+04	3.97E+04	-9.45E+04
1.00E-01	5.41E+04	-1.11E+05	4.78E+04	-1.13E+05

	09		08	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	3.19E+03	-2.87E+03	3.12E+03	-2.33E+03
3.97E+06	3.70E+03	-2.66E+03	3.49E+03	-2.09E+03
3.15E+06	4.17E+03	-2.36E+03	3.81E+03	-1.80E+03
2.51E+06	4.55E+03	-2.06E+03	4.06E+03	-1.54E+03
1.99E+06	4.83E+03	-1.72E+03	4.23E+03	-1.26E+03
1.58E+06	5.02E+03	-1.42E+03	4.35E+03	-1.02E+03
1.26E+06	5.16E+03	-1.15E+03	4.43E+03	-8.20E+02
9.98E+05	5.25E+03	-7.89E+02	4.48E+03	-5.38E+02
7.92E+05	5.30E+03	-6.41E+02	4.51E+03	-4.35E+02
6.29E+05	5.34E+03	-5.15E+02	4.53E+03	-3.48E+02
5.00E+05	5.36E+03	-4.14E+02	4.55E+03	-2.80E+02
3.97E+05	5.38E+03	-3.30E+02	4.56E+03	-2.22E+02
3.15E+05	5.39E+03	-2.61E+02	4.56E+03	-1.75E+02
2.51E+05	5.39E+03	-2.10E+02	4.57E+03	-1.41E+02
1.99E+05	5.40E+03	-1.71E+02	4.57E+03	-1.15E+02
1.58E+05	5.41E+03	-1.35E+02	4.57E+03	-8.95E+01
1.26E+05	5.41E+03	-1.04E+02	4.58E+03	-6.87E+01
9.98E+04	5.42E+03	-7.90E+01	4.59E+03	-5.23E+01
7.92E+04	5.43E+03	-6.21E+01	4.59E+03	-4.05E+01
6.29E+04	5.42E+03	-5.37E+01	4.58E+03	-3.57E+01
5.00E+04	5.42E+03	-3.90E+01	4.59E+03	-2.52E+01
3.97E+04	5.43E+03	-2.57E+01	4.59E+03	-1.56E+01
3.15E+04	5.43E+03	-1.70E+01	4.59E+03	-9.72E+00
2.51E+04	5.43E+03	-4.31E+00	4.59E+03	1.31E-01
1.99E+04	5.42E+03	7.10E+00	4.59E+03	8.13E+00
1.58E+04	5.42E+03	1.75E+01	4.58E+03	1.66E+01
1.26E+04	5.42E+03	2.95E+01	4.58E+03	2.32E+01
9.98E+03	5.42E+03	3.93E+01	4.58E+03	3.41E+01
7.92E+03	5.41E+03	5.22E+01	4.57E+03	4.32E+01
6.29E+03	5.40E+03	5.38E+01	4.56E+03	4.97E+01
5.00E+03	5.38E+03	6.18E+01	4.55E+03	5.11E+01
3.97E+03	5.36E+03	6.81E+01	4.53E+03	5.42E+01
3.15E+03	5.34E+03	6.77E+01	4.51E+03	5.39E+01
2.51E+03	5.31E+03	5.90E+01	4.51E+03	3.45E+01
1.99E+03	5.31E+03	4.37E+01	4.49E+03	3.30E+01
1.58E+03	5.30E+03	2.68E+01	4.48E+03	1.44E+01
1.26E+03	5.29E+03	5.34E+00	4.47E+03	-1.79E+00
9.98E+02	5.28E+03	-1.60E+01	4.47E+03	-2.40E+01
7.92E+02	5.29E+03	-4.02E+01	4.47E+03	-4.28E+01
6.29E+02	5.28E+03	-5.70E+01	4.47E+03	-6.21E+01
5.00E+02	5.29E+03	-8.94E+01	4.48E+03	-9.38E+01
3.97E+02	5.29E+03	-1.20E+02	4.48E+03	-1.23E+02
3.15E+02	5.30E+03	-1.56E+02	4.48E+03	-1.60E+02
2.51E+02	5.31E+03	-2.09E+02	4.49E+03	-2.09E+02

f / Hz	09		08	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	5.32E+03	-2.52E+02	4.50E+03	-2.49E+02
1.58E+02	5.34E+03	-3.05E+02	4.52E+03	-3.16E+02
1.26E+02	5.35E+03	-3.76E+02	4.53E+03	-3.81E+02
9.98E+01	5.38E+03	-4.47E+02	4.55E+03	-4.62E+02
7.92E+01	5.41E+03	-5.66E+02	4.59E+03	-5.68E+02
6.29E+01	5.45E+03	-6.90E+02	4.63E+03	-6.89E+02
5.00E+01	5.51E+03	-8.51E+02	4.66E+03	-8.59E+02
3.97E+01	5.55E+03	-1.01E+03	4.73E+03	-1.02E+03
3.15E+01	5.63E+03	-1.23E+03	4.79E+03	-1.23E+03
2.51E+01	5.72E+03	-1.47E+03	4.88E+03	-1.49E+03
1.99E+01	5.82E+03	-1.76E+03	4.98E+03	-1.79E+03
1.58E+01	5.97E+03	-2.12E+03	5.12E+03	-2.16E+03
1.26E+01	6.13E+03	-2.55E+03	5.27E+03	-2.60E+03
9.98E+00	6.34E+03	-3.03E+03	5.46E+03	-3.13E+03
7.92E+00	6.58E+03	-3.60E+03	5.69E+03	-3.76E+03
6.29E+00	6.88E+03	-4.30E+03	5.99E+03	-4.48E+03
5.00E+00	7.21E+03	-5.09E+03	6.35E+03	-5.33E+03
3.97E+00	7.62E+03	-6.04E+03	6.76E+03	-6.36E+03
3.15E+00	8.05E+03	-7.14E+03	7.29E+03	-7.55E+03
2.51E+00	8.57E+03	-8.49E+03	7.88E+03	-8.97E+03
1.99E+00	9.12E+03	-1.01E+04	8.52E+03	-1.07E+04
1.58E+00	9.76E+03	-1.21E+04	9.26E+03	-1.26E+04
1.26E+00	1.05E+04	-1.45E+04	1.01E+04	-1.51E+04
9.98E-01	1.14E+04	-1.74E+04	1.11E+04	-1.80E+04
7.92E-01	1.24E+04	-2.10E+04	1.22E+04	-2.15E+04
6.29E-01	1.38E+04	-2.53E+04	1.36E+04	-2.58E+04
5.00E-01	1.53E+04	-3.05E+04	1.53E+04	-3.11E+04
3.97E-01	1.73E+04	-3.69E+04	1.73E+04	-3.75E+04
3.15E-01	1.96E+04	-4.46E+04	1.97E+04	-4.53E+04
2.51E-01	2.28E+04	-5.41E+04	2.28E+04	-5.47E+04
1.99E-01	2.66E+04	-6.55E+04	2.66E+04	-6.61E+04
1.58E-01	3.17E+04	-7.91E+04	3.19E+04	-7.98E+04
1.26E-01	3.82E+04	-9.56E+04	3.83E+04	-9.62E+04
1.00E-01	4.66E+04	-1.15E+05	4.69E+04	-1.15E+05

	07		06	
f / Hz	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	3.01E+03	-2.08E+03	2.94E+03	-1.91E+03
3.97E+06	3.32E+03	-1.83E+03	3.22E+03	-1.66E+03
3.15E+06	3.58E+03	-1.56E+03	3.45E+03	-1.40E+03
2.51E+06	3.79E+03	-1.31E+03	3.61E+03	-1.18E+03
1.99E+06	3.91E+03	-1.06E+03	3.72E+03	-9.43E+02
1.58E+06	4.01E+03	-8.53E+02	3.80E+03	-7.59E+02
1.26E+06	4.06E+03	-6.80E+02	3.85E+03	-6.00E+02
9.98E+05	4.10E+03	-4.33E+02	3.87E+03	-3.76E+02
7.92E+05	4.12E+03	-3.50E+02	3.89E+03	-3.03E+02
6.29E+05	4.13E+03	-2.80E+02	3.90E+03	-2.42E+02
5.00E+05	4.14E+03	-2.24E+02	3.91E+03	-1.94E+02
3.97E+05	4.15E+03	-1.78E+02	3.91E+03	-1.54E+02
3.15E+05	4.15E+03	-1.40E+02	3.91E+03	-1.21E+02
2.51E+05	4.15E+03	-1.13E+02	3.92E+03	-9.70E+01
1.99E+05	4.16E+03	-9.19E+01	3.92E+03	-7.88E+01
1.58E+05	4.16E+03	-7.16E+01	3.92E+03	-6.15E+01
1.26E+05	4.17E+03	-5.48E+01	3.93E+03	-4.75E+01
9.98E+04	4.17E+03	-4.17E+01	3.93E+03	-3.57E+01
7.92E+04	4.18E+03	-3.25E+01	3.94E+03	-2.85E+01
6.29E+04	4.17E+03	-2.83E+01	3.93E+03	-2.47E+01
5.00E+04	4.17E+03	-1.97E+01	3.93E+03	-1.69E+01
3.97E+04	4.17E+03	-1.19E+01	3.93E+03	-9.92E+00
3.15E+04	4.17E+03	-6.90E+00	3.93E+03	-5.73E+00
2.51E+04	4.17E+03	1.17E+00	3.93E+03	1.63E+00
1.99E+04	4.17E+03	8.59E+00	3.93E+03	8.13E+00
1.58E+04	4.17E+03	1.54E+01	3.93E+03	1.42E+01
1.26E+04	4.17E+03	2.29E+01	3.93E+03	1.98E+01
9.98E+03	4.17E+03	2.77E+01	3.92E+03	2.72E+01
7.92E+03	4.16E+03	3.93E+01	3.92E+03	3.52E+01
6.29E+03	4.16E+03	3.97E+01	3.91E+03	4.12E+01
5.00E+03	4.14E+03	4.58E+01	3.90E+03	4.29E+01
3.97E+03	4.13E+03	4.84E+01	3.88E+03	4.44E+01
3.15E+03	4.12E+03	3.90E+01	3.86E+03	4.84E+01
2.51E+03	4.09E+03	4.04E+01	3.85E+03	3.43E+01
1.99E+03	4.09E+03	2.67E+01	3.85E+03	2.26E+01
1.58E+03	4.08E+03	1.26E+01	3.84E+03	6.28E+00
1.26E+03	4.07E+03	-5.72E+00	3.83E+03	-9.54E+00
9.98E+02	4.07E+03	-2.58E+01	3.82E+03	-2.56E+01
7.92E+02	4.06E+03	-4.60E+01	3.83E+03	-5.00E+01
6.29E+02	4.07E+03	-6.40E+01	3.83E+03	-6.73E+01
5.00E+02	4.08E+03	-9.50E+01	3.82E+03	-9.54E+01
3.97E+02	4.07E+03	-1.25E+02	3.84E+03	-1.31E+02
3.15E+02	4.08E+03	-1.60E+02	3.84E+03	-1.68E+02
2.51E+02	4.09E+03	-2.02E+02	3.85E+03	-2.16E+02

f / Hz	07		06	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	4.10E+03	-2.50E+02	3.86E+03	-2.64E+02
1.58E+02	4.11E+03	-3.09E+02	3.88E+03	-3.25E+02
1.26E+02	4.13E+03	-3.81E+02	3.90E+03	-3.97E+02
9.98E+01	4.15E+03	-4.53E+02	3.92E+03	-4.96E+02
7.92E+01	4.18E+03	-5.77E+02	3.95E+03	-5.92E+02
6.29E+01	4.21E+03	-7.08E+02	4.00E+03	-7.22E+02
5.00E+01	4.24E+03	-8.55E+02	4.03E+03	-8.73E+02
3.97E+01	4.31E+03	-1.05E+03	4.11E+03	-1.06E+03
3.15E+01	4.37E+03	-1.28E+03	4.18E+03	-1.28E+03
2.51E+01	4.45E+03	-1.55E+03	4.27E+03	-1.54E+03
1.99E+01	4.55E+03	-1.88E+03	4.39E+03	-1.85E+03
1.58E+01	4.68E+03	-2.26E+03	4.52E+03	-2.21E+03
1.26E+01	4.83E+03	-2.74E+03	4.70E+03	-2.65E+03
9.98E+00	5.01E+03	-3.30E+03	4.91E+03	-3.17E+03
7.92E+00	5.23E+03	-3.98E+03	5.16E+03	-3.77E+03
6.29E+00	5.52E+03	-4.78E+03	5.47E+03	-4.51E+03
5.00E+00	5.86E+03	-5.74E+03	5.84E+03	-5.36E+03
3.97E+00	6.27E+03	-6.89E+03	6.27E+03	-6.37E+03
3.15E+00	6.82E+03	-8.27E+03	6.80E+03	-7.56E+03
2.51E+00	7.46E+03	-9.89E+03	7.46E+03	-8.95E+03
1.99E+00	8.22E+03	-1.18E+04	8.19E+03	-1.06E+04
1.58E+00	9.13E+03	-1.41E+04	9.07E+03	-1.25E+04
1.26E+00	1.02E+04	-1.67E+04	1.00E+04	-1.48E+04
9.98E-01	1.15E+04	-1.99E+04	1.11E+04	-1.75E+04
7.92E-01	1.30E+04	-2.36E+04	1.24E+04	-2.08E+04
6.29E-01	1.46E+04	-2.80E+04	1.38E+04	-2.47E+04
5.00E-01	1.66E+04	-3.34E+04	1.55E+04	-2.95E+04
3.97E-01	1.90E+04	-3.99E+04	1.74E+04	-3.53E+04
3.15E-01	2.18E+04	-4.78E+04	1.97E+04	-4.24E+04
2.51E-01	2.53E+04	-5.73E+04	2.25E+04	-5.11E+04
1.99E-01	2.96E+04	-6.86E+04	2.59E+04	-6.16E+04
1.58E-01	3.51E+04	-8.22E+04	3.03E+04	-7.44E+04
1.26E-01	4.17E+04	-9.83E+04	3.61E+04	-8.99E+04
1.00E-01	5.05E+04	-1.17E+05	4.32E+04	-1.08E+05

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.82E+03	-1.65E+03	2.70E+03	-1.46E+03
3.97E+06	3.04E+03	-1.41E+03	2.88E+03	-1.24E+03
3.15E+06	3.22E+03	-1.17E+03	3.03E+03	-1.02E+03
2.51E+06	3.33E+03	-9.76E+02	3.12E+03	-8.44E+02
1.99E+06	3.42E+03	-7.72E+02	3.19E+03	-6.67E+02
1.58E+06	3.47E+03	-6.15E+02	3.23E+03	-5.29E+02
1.26E+06	3.50E+03	-4.85E+02	3.25E+03	-4.13E+02
9.98E+05	3.51E+03	-2.92E+02	3.26E+03	-2.43E+02
7.92E+05	3.53E+03	-2.36E+02	3.27E+03	-1.95E+02
6.29E+05	3.53E+03	-1.88E+02	3.27E+03	-1.56E+02
5.00E+05	3.54E+03	-1.50E+02	3.27E+03	-1.25E+02
3.97E+05	3.54E+03	-1.19E+02	3.28E+03	-9.86E+01
3.15E+05	3.54E+03	-9.33E+01	3.28E+03	-7.68E+01
2.51E+05	3.54E+03	-7.50E+01	3.28E+03	-6.19E+01
1.99E+05	3.55E+03	-6.11E+01	3.28E+03	-5.04E+01
1.58E+05	3.55E+03	-4.78E+01	3.28E+03	-3.93E+01
1.26E+05	3.55E+03	-3.67E+01	3.29E+03	-3.01E+01
9.98E+04	3.56E+03	-2.73E+01	3.29E+03	-2.25E+01
7.92E+04	3.56E+03	-2.19E+01	3.29E+03	-1.78E+01
6.29E+04	3.55E+03	-1.91E+01	3.29E+03	-1.57E+01
5.00E+04	3.56E+03	-1.29E+01	3.29E+03	-1.02E+01
3.97E+04	3.56E+03	-7.19E+00	3.29E+03	-5.40E+00
3.15E+04	3.56E+03	-3.75E+00	3.29E+03	-2.63E+00
2.51E+04	3.56E+03	2.38E+00	3.29E+03	2.58E+00
1.99E+04	3.56E+03	8.06E+00	3.29E+03	7.47E+00
1.58E+04	3.55E+03	1.33E+01	3.29E+03	1.22E+01
1.26E+04	3.55E+03	1.93E+01	3.29E+03	1.72E+01
9.98E+03	3.55E+03	2.56E+01	3.28E+03	2.40E+01
7.92E+03	3.55E+03	3.13E+01	3.28E+03	2.82E+01
6.29E+03	3.54E+03	3.01E+01	3.27E+03	3.31E+01
5.00E+03	3.53E+03	3.64E+01	3.26E+03	3.14E+01
3.97E+03	3.52E+03	3.81E+01	3.25E+03	3.31E+01
3.15E+03	3.50E+03	4.20E+01	3.24E+03	3.01E+01
2.51E+03	3.50E+03	2.16E+01	3.23E+03	1.96E+01
1.99E+03	3.48E+03	1.70E+01	3.22E+03	1.27E+01
1.58E+03	3.47E+03	4.57E+00	3.21E+03	-1.11E+00
1.26E+03	3.47E+03	-1.16E+01	3.21E+03	-1.63E+01
9.98E+02	3.47E+03	-3.02E+01	3.20E+03	-3.42E+01
7.92E+02	3.46E+03	-5.02E+01	3.21E+03	-5.56E+01
6.29E+02	3.47E+03	-7.16E+01	3.21E+03	-7.37E+01
5.00E+02	3.46E+03	-9.43E+01	3.21E+03	-1.01E+02
3.97E+02	3.48E+03	-1.27E+02	3.22E+03	-1.35E+02
3.15E+02	3.48E+03	-1.61E+02	3.22E+03	-1.71E+02
2.51E+02	3.49E+03	-2.00E+02	3.24E+03	-2.21E+02

f / Hz	05		04	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
1.99E+02	3.50E+03	-2.51E+02	3.25E+03	-2.62E+02
1.58E+02	3.52E+03	-2.98E+02	3.26E+03	-3.14E+02
1.26E+02	3.54E+03	-3.82E+02	3.28E+03	-3.91E+02
9.98E+01	3.56E+03	-4.64E+02	3.30E+03	-4.90E+02
7.92E+01	3.59E+03	-5.60E+02	3.34E+03	-5.79E+02
6.29E+01	3.62E+03	-6.86E+02	3.38E+03	-7.06E+02
5.00E+01	3.68E+03	-8.29E+02	3.42E+03	-8.73E+02
3.97E+01	3.72E+03	-1.01E+03	3.47E+03	-1.04E+03
3.15E+01	3.79E+03	-1.22E+03	3.54E+03	-1.25E+03
2.51E+01	3.87E+03	-1.47E+03	3.62E+03	-1.51E+03
1.99E+01	3.97E+03	-1.78E+03	3.72E+03	-1.82E+03
1.58E+01	4.08E+03	-2.14E+03	3.82E+03	-2.20E+03
1.26E+01	4.24E+03	-2.58E+03	3.98E+03	-2.65E+03
9.98E+00	4.42E+03	-3.09E+03	4.15E+03	-3.19E+03
7.92E+00	4.64E+03	-3.72E+03	4.36E+03	-3.86E+03
6.29E+00	4.91E+03	-4.46E+03	4.61E+03	-4.65E+03
5.00E+00	5.24E+03	-5.35E+03	4.92E+03	-5.60E+03
3.97E+00	5.64E+03	-6.40E+03	5.33E+03	-6.76E+03
3.15E+00	6.15E+03	-7.67E+03	5.80E+03	-8.14E+03
2.51E+00	6.77E+03	-9.14E+03	6.46E+03	-9.78E+03
1.99E+00	7.49E+03	-1.09E+04	7.26E+03	-1.17E+04
1.58E+00	8.37E+03	-1.29E+04	8.25E+03	-1.40E+04
1.26E+00	9.37E+03	-1.54E+04	9.45E+03	-1.67E+04
9.98E-01	1.06E+04	-1.82E+04	1.09E+04	-1.97E+04
7.92E-01	1.19E+04	-2.16E+04	1.26E+04	-2.33E+04
6.29E-01	1.35E+04	-2.56E+04	1.45E+04	-2.74E+04
5.00E-01	1.52E+04	-3.05E+04	1.66E+04	-3.24E+04
3.97E-01	1.72E+04	-3.64E+04	1.90E+04	-3.83E+04
3.15E-01	1.95E+04	-4.36E+04	2.18E+04	-4.54E+04
2.51E-01	2.24E+04	-5.23E+04	2.50E+04	-5.41E+04
1.99E-01	2.58E+04	-6.29E+04	2.85E+04	-6.46E+04
1.58E-01	3.03E+04	-7.59E+04	3.32E+04	-7.74E+04
1.26E-01	3.59E+04	-9.17E+04	3.89E+04	-9.29E+04
1.00E-01	4.30E+04	-1.10E+05	4.60E+04	-1.12E+05

f / Hz	03		02	
	Z´ / Ω	Z´´/ Ω	Z´/ Ω	Z´´/ Ω
5.00E+06	2.61E+03	-1.32E+03	2.52E+03	-1.19E+03
3.97E+06	2.77E+03	-1.12E+03	2.65E+03	-9.95E+02
3.15E+06	2.89E+03	-9.13E+02	2.75E+03	-8.12E+02
2.51E+06	2.97E+03	-7.53E+02	2.81E+03	-6.65E+02
1.99E+06	3.02E+03	-5.89E+02	2.86E+03	-5.22E+02
1.58E+06	3.05E+03	-4.67E+02	2.88E+03	-4.11E+02
1.26E+06	3.07E+03	-3.63E+02	2.90E+03	-3.21E+02
9.98E+05	3.07E+03	-2.07E+02	2.90E+03	-1.77E+02
7.92E+05	3.08E+03	-1.67E+02	2.91E+03	-1.43E+02
6.29E+05	3.08E+03	-1.33E+02	2.91E+03	-1.14E+02
5.00E+05	3.09E+03	-1.07E+02	2.91E+03	-9.16E+01
3.97E+05	3.09E+03	-8.44E+01	2.91E+03	-7.25E+01
3.15E+05	3.09E+03	-6.57E+01	2.92E+03	-5.65E+01
2.51E+05	3.09E+03	-5.27E+01	2.92E+03	-4.54E+01
1.99E+05	3.09E+03	-4.33E+01	2.92E+03	-3.73E+01
1.58E+05	3.09E+03	-3.39E+01	2.92E+03	-2.92E+01
1.26E+05	3.10E+03	-2.56E+01	2.93E+03	-2.19E+01
9.98E+04	3.10E+03	-1.93E+01	2.93E+03	-1.65E+01
7.92E+04	3.11E+03	-1.52E+01	2.93E+03	-1.33E+01
6.29E+04	3.10E+03	-1.35E+01	2.93E+03	-1.16E+01
5.00E+04	3.10E+03	-8.77E+00	2.93E+03	-7.33E+00
3.97E+04	3.10E+03	-4.39E+00	2.93E+03	-3.49E+00
3.15E+04	3.10E+03	-2.02E+00	2.93E+03	-1.44E+00
2.51E+04	3.10E+03	3.02E+00	2.93E+03	3.17E+00
1.99E+04	3.10E+03	7.36E+00	2.93E+03	7.08E+00
1.58E+04	3.10E+03	1.15E+01	2.93E+03	1.10E+01
1.26E+04	3.10E+03	1.42E+01	2.93E+03	1.64E+01
9.98E+03	3.10E+03	1.88E+01	2.93E+03	2.12E+01
7.92E+03	3.09E+03	2.56E+01	2.92E+03	2.47E+01
6.29E+03	3.09E+03	2.46E+01	2.92E+03	2.99E+01
5.00E+03	3.08E+03	3.01E+01	2.91E+03	2.64E+01
3.97E+03	3.07E+03	3.18E+01	2.90E+03	2.90E+01
3.15E+03	3.06E+03	2.43E+01	2.88E+03	2.90E+01
2.51E+03	3.05E+03	2.24E+01	2.89E+03	1.31E+01
1.99E+03	3.04E+03	1.11E+01	2.87E+03	8.75E+00
1.58E+03	3.04E+03	-3.21E+00	2.87E+03	-5.37E+00
1.26E+03	3.03E+03	-1.92E+01	2.87E+03	-2.09E+01
9.98E+02	3.02E+03	-3.38E+01	2.86E+03	-3.83E+01
7.92E+02	3.03E+03	-5.60E+01	2.86E+03	-5.72E+01
6.29E+02	3.03E+03	-7.49E+01	2.87E+03	-7.92E+01
5.00E+02	3.04E+03	-1.02E+02	2.88E+03	-1.03E+02
3.97E+02	3.04E+03	-1.31E+02	2.88E+03	-1.31E+02
3.15E+02	3.05E+03	-1.67E+02	2.89E+03	-1.67E+02
2.51E+02	3.05E+03	-2.05E+02	2.89E+03	-2.08E+02

	03		02	
f / Hz	**Z´ / Ω**	**Z´´/ Ω**	**Z´/ Ω**	**Z´´/ Ω**
1.99E+02	3.07E+03	-2.56E+02	2.91E+03	-2.56E+02
1.58E+02	3.08E+03	-3.07E+02	2.92E+03	-3.12E+02
1.26E+02	3.10E+03	-3.99E+02	2.94E+03	-3.89E+02
9.98E+01	3.12E+03	-4.82E+02	2.96E+03	-4.68E+02
7.92E+01	3.14E+03	-5.83E+02	2.99E+03	-5.74E+02
6.29E+01	3.18E+03	-7.08E+02	3.02E+03	-6.95E+02
5.00E+01	3.21E+03	-8.63E+02	3.07E+03	-8.45E+02
3.97E+01	3.28E+03	-1.06E+03	3.12E+03	-1.03E+03
3.15E+01	3.34E+03	-1.28E+03	3.18E+03	-1.25E+03
2.51E+01	3.42E+03	-1.55E+03	3.26E+03	-1.51E+03
1.99E+01	3.52E+03	-1.86E+03	3.35E+03	-1.82E+03
1.58E+01	3.64E+03	-2.25E+03	3.48E+03	-2.20E+03
1.26E+01	3.78E+03	-2.73E+03	3.60E+03	-2.66E+03
9.98E+00	3.95E+03	-3.29E+03	3.76E+03	-3.22E+03
7.92E+00	4.15E+03	-3.96E+03	3.95E+03	-3.88E+03
6.29E+00	4.42E+03	-4.80E+03	4.18E+03	-4.70E+03
5.00E+00	4.72E+03	-5.79E+03	4.47E+03	-5.69E+03
3.97E+00	5.13E+03	-7.00E+03	4.83E+03	-6.89E+03
3.15E+00	5.61E+03	-8.45E+03	5.31E+03	-8.36E+03
2.51E+00	6.27E+03	-1.02E+04	5.89E+03	-1.01E+04
1.99E+00	7.08E+03	-1.23E+04	6.65E+03	-1.22E+04
1.58E+00	8.12E+03	-1.47E+04	7.63E+03	-1.47E+04
1.26E+00	9.37E+03	-1.75E+04	8.86E+03	-1.76E+04
9.98E-01	1.09E+04	-2.08E+04	1.04E+04	-2.10E+04
7.92E-01	1.28E+04	-2.45E+04	1.23E+04	-2.49E+04
6.29E-01	1.49E+04	-2.89E+04	1.44E+04	-2.94E+04
5.00E-01	1.73E+04	-3.40E+04	1.71E+04	-3.46E+04
3.97E-01	1.99E+04	-4.00E+04	1.99E+04	-4.07E+04
3.15E-01	2.30E+04	-4.71E+04	2.32E+04	-4.79E+04
2.51E-01	2.65E+04	-5.58E+04	2.70E+04	-5.66E+04
1.99E-01	3.05E+04	-6.62E+04	3.09E+04	-6.68E+04
1.58E-01	3.54E+04	-7.89E+04	3.59E+04	-7.96E+04
1.26E-01	4.11E+04	-9.42E+04	4.20E+04	-9.52E+04
1.00E-01	4.82E+04	-1.13E+05	4.96E+04	-1.13E+05

B Guide for performing time-to-frequency domain Fourier transformation of TDR data using Origin ® software

In this section, a step-by-step guide for the analysis of TDR measuring data by using the commercial software OriginPro 9.1® will be given.

shows an overview of the spreadsheet that you see as you open the prepared analysis worksheet.

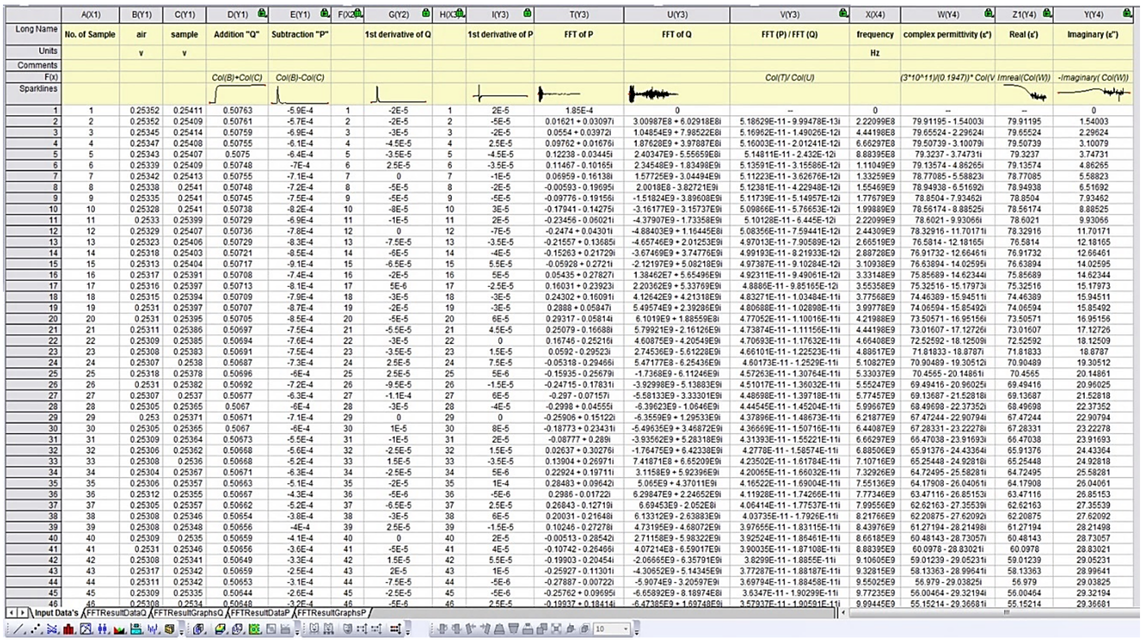

Fig. B.1 Overview of the TDR conversion program

The conversion program consists of 5 worksheets, as you see on the foot of the main window as shown in Fig. B.2:

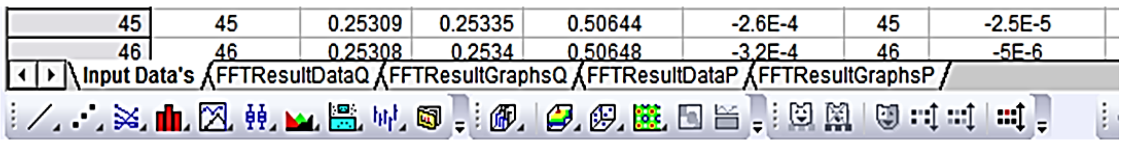

Fig. B.2 Magnification of the main window foot

The worksheets contain calculations concerning:

- **Input Data's:** for entering the time dependent data for the conversion.
- **FFTResultDataQ, FFTResultDataP:** contains the resultant of Fourier transforms of data "Q" and "P" respectively
- **FFTResultGraphsQ, FFTResultGraphsP:** contains the resultant graphs of Fourier transforms of Data "Q" and "P" respectively.

Input Data's: this is the primary worksheet where the main conversion process occurs. (see) The sheet has various columns with individual processes occurring simultaneously.

	A(X1)	B(Y1)	C(Y1)	D(Y1)	E(Y1)	F(X2)	G(Y2)	H(X3)	I(Y3)	T(Y3)
Long Name	No. of Sample	air	sample	Addition "Q"	Subtraction "P"		1st derivative of Q		1st derivative of P	FFT of P
Units		v	v							
Comments										
F(x)				Col(B)+Col(C)	Col(B)-Col(C)					

U(Y3)	V(Y3)	X(X4)	W(Y4)	Z1(Y4)	Y(Y4)
FFT of Q	FFT (P) / FFT (Q)	frequency	complex permittivity (ε*)	Real (ε')	Imaginary (ε")
		Hz			
	Col(T)/ Col(U)		(3*10^11)/(0.1947))* Col(V	Imreal(Col(W))	-Imaginary(Col(W))

Fig. B.3 Magnification of the head of the main calculation window

In the following, a description of data in each column is given:

No. of Sample: here, the number of raw data points recorded are introduced

air: in this column, the measurement data for reflected pulse in absence of sample must be introduced. These data are taken from respective data file present in an excel worksheet.

sample: in this column, the measurement data for reflected pulse in presence of sample, as taken from respective data file on an excel worksheet must be introduced.

Addition "Q": Column 2 and Column 3 are added and named as "Q".

Subtraction "P": Column 2 and Column 3 are subtracted and named as "P".

1st derivative of Q: Instead of taking the obtained voltage, 1st order time derivative of column 4 is calculated.

1st derivative of P: Instead of taking the obtained voltage, 1st order time derivative of column 5 is calculated.

FFT of P: Fourier transformation of column 7 is calculated using an *FFT function* and the "**complex permittivity**" results are extracted from the sheet **FFTResultDataP** and tabulated in column 8.

FFT of Q: Fourier transformation of column 6 is calculated using an *FFT function* and the "**complex permittivity**" results are extracted from the sheet **FFTResultDataQ)** and tabulated in column 9.

Since the calculation mode is set to auto, the FFT conversion occurs automatically. But, the program does not take function F(x) into account. To execute the function, first select the "**complex permittivity**" column and then press Ctrl+Q, the function dialogue box will be popped up, simply press "Apply".

FFT (P) / FFT (Q): Column 8 and Column 9 are divided.

frequency: Data for frequency can be extracted from one of the worksheets **FFTResultDataP** or **FFTResultDataQ.**

complex permittivity (ε*): The complex permittivity of the sample is calculated from the function written as *F(x) = [(3*10^{8}m/sec)/(pin length in mm)]*Column 10*. The pin length needs to be adjusted with respect to water for each set of electrolyte sample.

Real (ε'): is the real part of the complex permittivity separated using a function *F(x) = Imreal (Column)*.

Imaginary (ε''): is the imaginary part of the complex permittivity separated using a function *F(x) = Imaginary (Column)*.

How to conduct for a Fourier transformation:

For the Fourier transformation, a process dialog box must be activated as shown in Fig B.4.

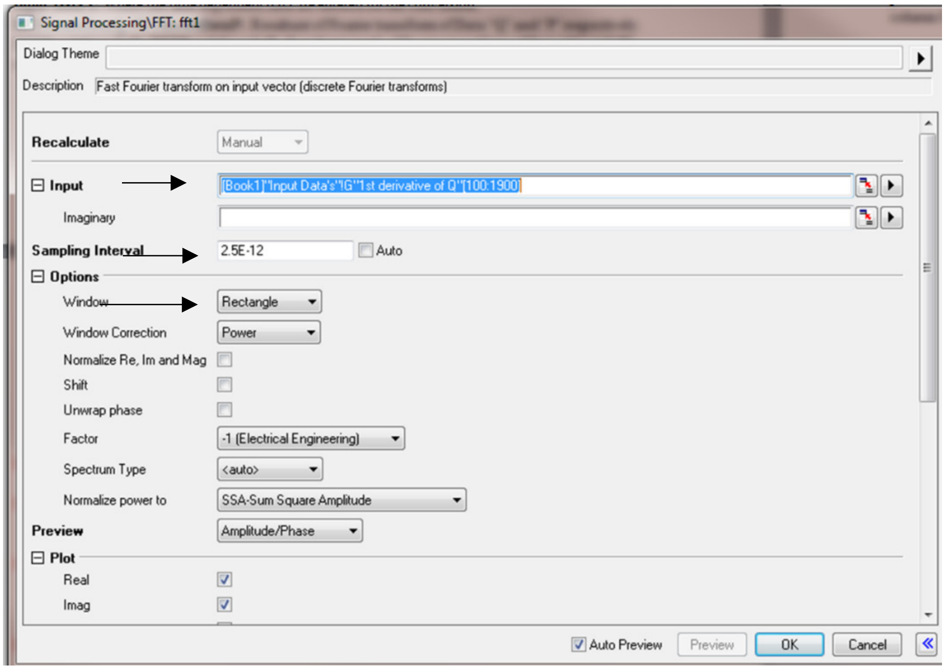

Fig. B.4 Signal processing dialogue box for FFT (fast Fourier transformation)

Following fundamentals points should be recalled by signal processing:

Input: is the time domain data to be used for Fourier transformation. The data to be taken into consideration depends on the type of signal. For example: Suppose 2000 raw data points are recorded. It might be possible that the first and the last 50 data points have noise or reflection due to the connector mismatch or due to some external factors. In such a case, the signals are conditioned accordingly and required data points are taken for further calculations.

Sampling interval: is the time interval between two data points. The information of this can be found in the raw data recorded excel sheet (Fig. B.5). These data, separated with comma, must be extracted in two columns using the common tools of excel as shown in Fig B.6.

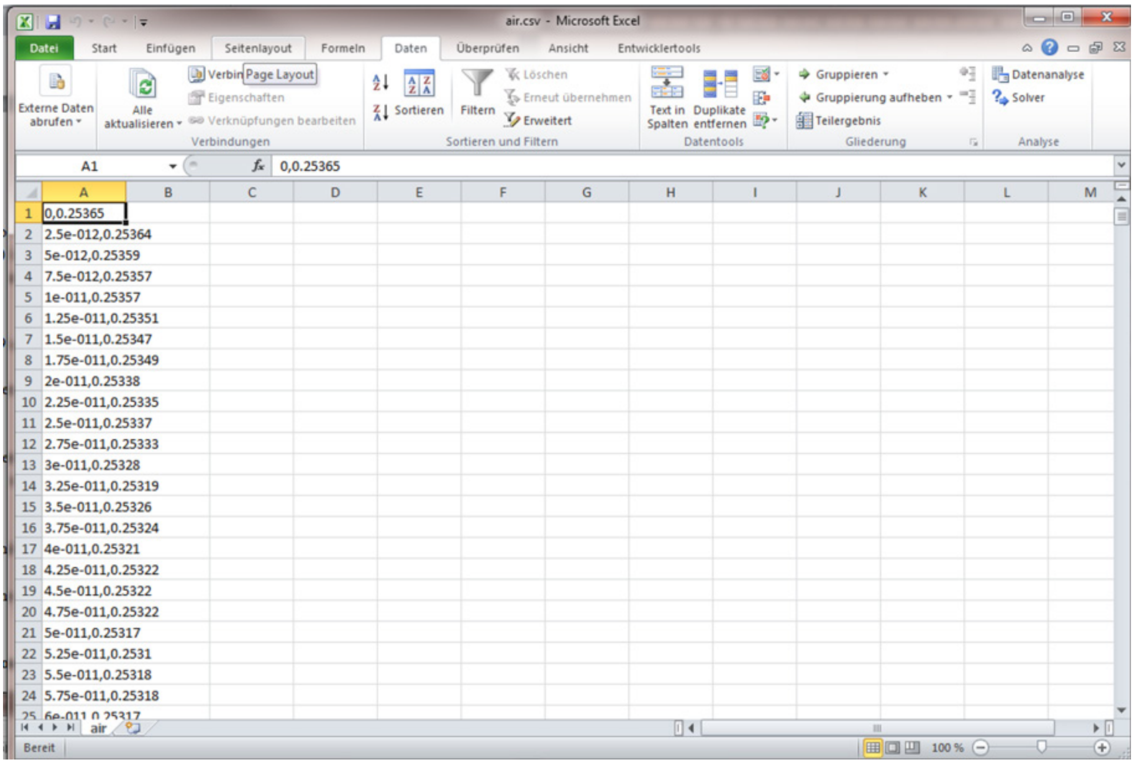

Fig. B.5 Raw data for reflected pulse without sample, denoted as "air.csv", after importing to excel

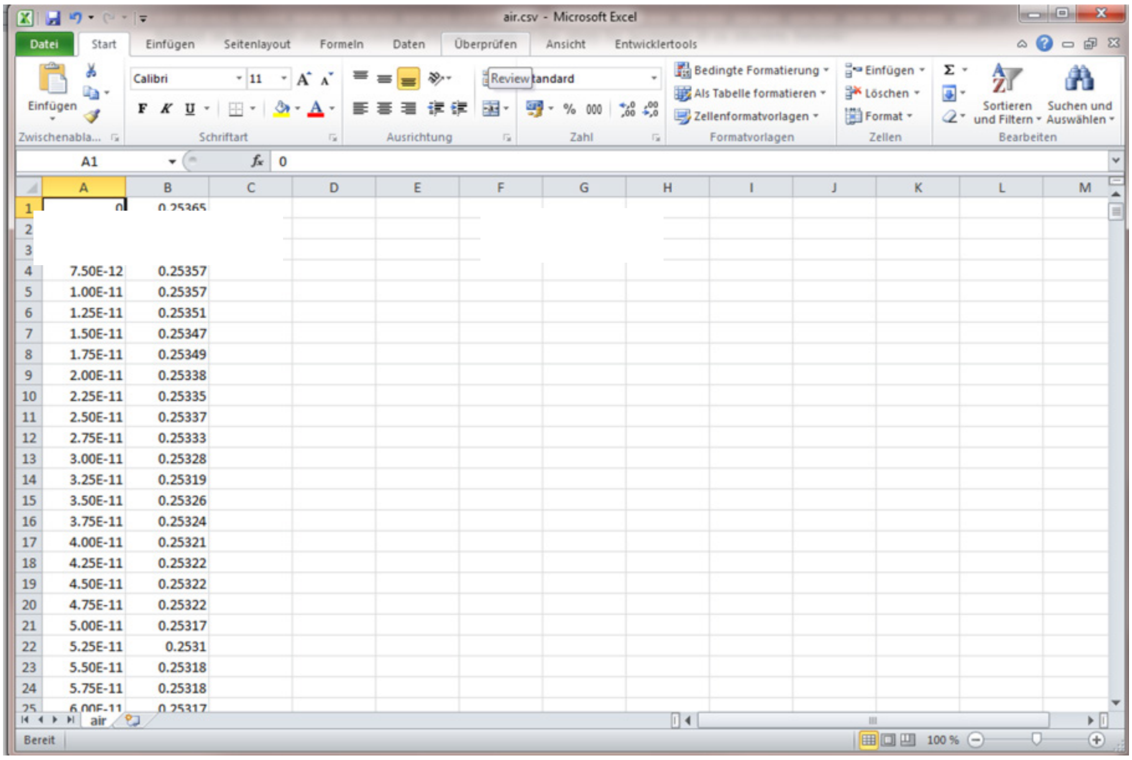

Fig. B.6 Processing of raw data to separate them in columns

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List of figures

List of tables

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