Data Descriptor

Impedance Spectra of RC Model as a Result of Testing Pulse Excitation Measurement Method Dataset

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Abstract

The dataset titled Impedance spectra of RC model as a result of testing pulse excitation measurement method contains the impedance spectrum of an exemplary test RC model obtained using pulse excitation. The dataset allows presentation of the accuracy of the impedance spectroscopy measuring instrument, which uses the pulse excitation method to shorten the time of the whole spectrum acquisition.

Keywords: impedance measurement; impedance spectroscopy; pulse excitation

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Specification table (data records)

Subject area	Metrology, Electronics, Non-destructive testing
More specific subject area	Impedance spectroscopy measurement
Type of data	Text
How the data was acquired	The data was collected at the Gdańsk University of Technology using a custom-built impedance spectroscopy analyser using pulse excitation and when measuring the RC test object model
Data format	The tables are in text format (Solartron)
Experimental factors	The data contained in the dataset were processed using linear approximation and after that, integrals were calculated to obtain the Fourier transform-based spectrum

Experimental features	The pulse time was set to 0.1 s, total acquisition time was set to 1000 s and excitation pulse amplitude was set to 1 V
Data source location	MOST Wiedzy Open Research Catalog, Gdańsk University of Technology, Gdańsk, Poland
Data accessibility	The dataset is accessible and is publicly and freely available for any research or educational purposes

Background

One of the important applications of impedance spectroscopy is the diagnostics of protective anticorrosion coatings on the basis of their impedance spectra (O'Donoghue M. et al, 2003). Modern high-thickness anticorrosion coatings testing requires determination of the impedance spectrum in a wide frequency range, including very low frequencies (e.g., from 1 mHz). Due to the long measurement time at very low frequencies, traditional impedance spectroscopy cannot be used in field-worthy instruments (the total measurement time is longer than 1h). For this reason, the authors used square-pulse excitation to shorten spectrum determination down to a few minutes. (Hoja and Lentka, 2011). Unfortunately, for higher frequencies of the spectrum, the pulse signal energy decreases quickly (Fig. 32.1a).

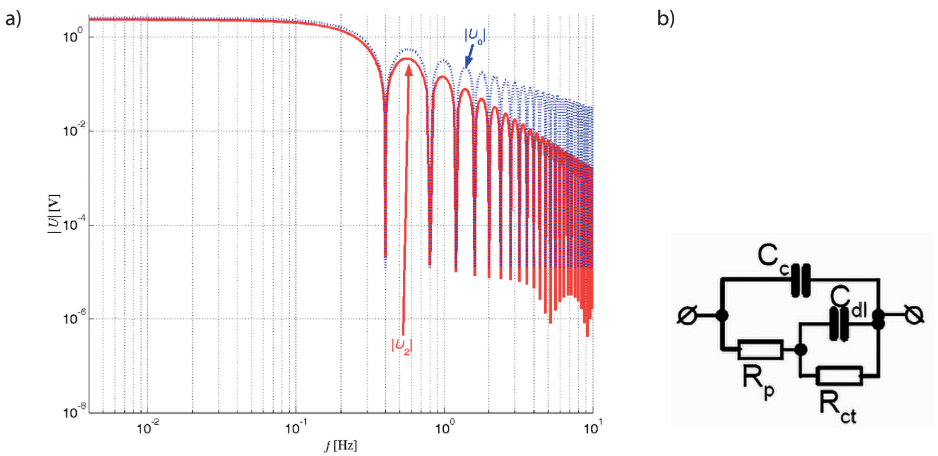

Fig. 32.1. a) Spectra of modulus of two signals: (Blue) Ideal square pulse |Uo| and (red) voltage across Zx |U2|, b) Baunier's RC model used as an object under test

The dataset, Impedance spectra of RC model as a result of testing pulse excitation measurement method, has been prepared to show the results of the impedance measurement technique employing pulse excitation and custom-made measuring instruments. The dataset contains the results for the test object (Fig. 32.1b) representing Bauniers model built using reference resistors and capacitors with known values thus allowing the accuracy of the measurement method to be estimated. The used components are Cc = 314.6 pF, Rp = 9.935 GΩ, Cdl = 2.22 nF, and Rct = 4.969 GΩ. The tolerance of the components is 0.01% for the resistors and 0.1% for the capacitors, respectively. Highly stable components were used to assure the long-term repeatability and stability of the model.

Methods

A square pulse with an amplitude of 1 V and a duration equal to 0.1 s was generated using an LTC1668 16-bit digital-to-analog converter and analog output buffer using BUF634. The response signals: voltage across and current through the measured object were extracted using analog input circuitry using OPA627 amplifiers and then sampled using two LTC1420 12-bit analog-to-digital converters working simultaneously and storing the acquired signals into two separate blocks of RAM. The total duration of the acquisition is 1000 s. The samples are then taken from the memory buffer by the ARM processor to perform the calculations and to produce the final results – the impedance spectrum at the required frequency points (determined during the calculation phase). The calculation assumes three operations: in the first one, the linear approximation of the both acquired signals is performed, then the integral is calculated to obtain the Fourier transform of the voltage and current signal, e.g. the spectra of the voltage and the current, finally the impedance modulus spectrum is calculated by dividing point-by-point the modulus of the voltage by the modulus of the current as well as the calculation of the difference between the phase spectrum of the voltage and the phase spectrum of the current leading to the impedance phase spectrum. To estimate the resulting spectrum errors, the reference spectrum was calculated using the known values of the components.

Data quality and availability

All measurements were collected at laboratory temperature using a custom-built impedance analyser employing the pulse excitation impedance measurement method. The acquired data (voltage across and current through the test object) was used to calculate the impedance spectrum of the object under test. For calculation, the linearly interpolated data was integrated representing the Fourier transform. The obtained results were compared with the theoretically calculated impedance spectrum of the test object using the known reference values of the RC components.

Dataset DOI
10.34808/4gns-yv68

Acknowledgements
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References

O'Donoghue, M. et al. (2003) 'Electrochemical impedance spectroscopy: Testing coatings for rapid immersion service', *Materials Performance,* 42(9), pp. 36–41.

Hoja, J. and Lentka, G. (2011) 'Method using square-pulse excitation for high-impedance spectroscopy of anticorrosion coatings', *IEEE Transactions on Instrumentation and Measurement*, 60(3), pp. 957–964, DOI: 10.1109/TIM.2010.2060219.