# Impedance Measurement of Non-Linear Loads: Test Bench

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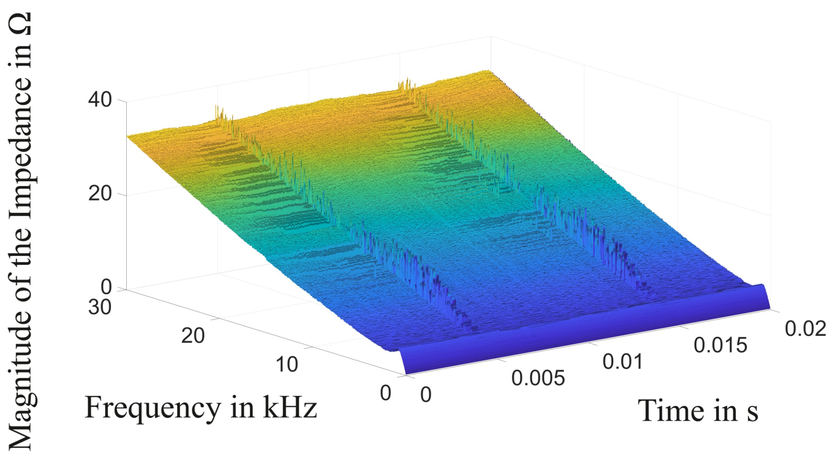


**Figure 1** Impedance measurement result of a sub periodic load up to 30 kH [3].

## Introduction

Broadband Impedance measurement is one significant area of research at the Department of Electrical Power Systems at the Helmut Schmidt University, the method and the devices are patented in [1]. The spectral impedance can be can be utilized to improve the power quality of electrical grids and to optimize the integration of renewable energy sources [2]. Another application is structural health monitoring of a grid, which can be used on large-scale distribution systems as well as on smaller grids such as ship systems. Due to a increasing number of power electronic, grids are getting more and more nonlinear. These nonlinearities affect the measurements [3]. The change of the grid impedance of a nonlinear system during one base period is shown in Fig. 1.


**Figure 2** Non-linear load test bench, frontside left, backside right.

## Time- and Frequency-Dependant Impedance Measurement

A given LTI network may be interpreted as a Thevenin equivalent with an inner impedance describing the systems behavior. In order to interpret the broadband characteristics of the grid, it needs to be excited. Therefore, a rPWM method is used. This is executed with a parallel impedance, which is connected and disconnected at random intervals. To interpret the spectrum of voltage and current a FFT is used [4]. Such measurements can be done for one or three phase systems. The devices used can measure the impedance in a frequency range from DC up to 150 kHz [5]. Prototypes are built and used at low- and medium voltage levels. A container-based device for the high voltage level is in development [6]

## Non-Linear Load Test Bench

This test bench, as shown in Fig. 2, consists of an adjustable resistive load with forced cooling and a phase control device. The circuit consists of eight resistors with 25 Ω each, these are wired as shown in Fig. 3. This allows a range of load from 12.5 Ω to 100 Ω when connected to a 50 Hz source. The load-network is designed to be operated at 230 V and thus reaches electrical power levels up to 4 kW. The load is depicted via a small TFT-screen connected to an Arduino, which reads out the switch position. The added phase control devise is operational up to 7 kW.

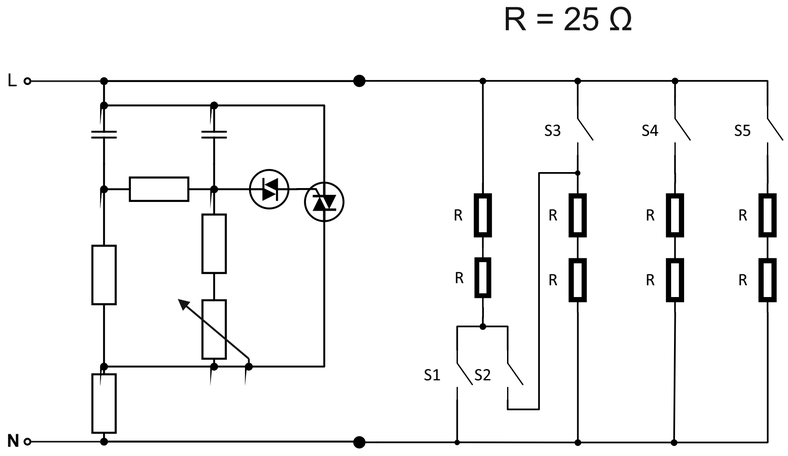


**Figure 3** Non-linear load test bench, circuit diagram.

## Outlook

The test bench will be used in a series of experiments evaluating the impact of sub-periodic effects on the impdance measurement by comparing the frequency sweep method [7, 8] and the rPWM method at different power levels.

## Acknowledgment

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### References

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