Impedance measurement of loudspeaker lines

Graduate

Silvan Bernhardsgrütter

Introduction: Public address systems serve to relay information and are mainly used in public buildings. These systems must also function safely in the event of a fire or power failure. Therefore, the functionality is checked by monitoring devices. Existing systems measure the impedance at high frequencies outside the audible spectrum. The measurement results in this range are influenced by parasitic effects of the transmission paths. The aim of this project is to develop a measurement system to be able to reliably monitor the condition of the system.

Approach: In the concept phase, the basics of measurement technology and acoustics were acquired. The I-V-method was chosen for the impedance measurement, whereby the impedance is determined by measuring voltage and current. To ensure that the excitation of the measuring circuit is as inaudible as possible, low-frequency and high-frequency sinusoidal signals should be used. In the case of an existing audio signal on the loudspeaker line, the impedance is to be determined by means of fast fourier transform (FFT). A typical curve of the impedance and phase of a loudspeaker line is shown in Figure 1.
Two different concepts were followed for the isolation measurement. One concept is based on insulation monitoring devices in isolated networks. For this purpose, an analogue-digital converter is used to measure the voltage dropping across a shunt in the event of a fault. In the other concept the existing hardware of the I-V-method for impedance measurement is used to measure the voltage across the insulation fault.
The concept was put together in a block diagram (Figure 2), which served as the basis for developing the circuit.
The next step was to develop the schematic and layout, which was followed by the production of the PCB. In the final phase, the circuit was put into operation and tested.

Result: For the impedance measurement, a linear calibration of the voltage and current measurement was carried out. The relative measurement error was a maximum of 3.61 %. The software to determine the impedance could not be implemented on the hardware within the project. Therefore, no statement can be made about the effect of the measurement error on the impedance measurement.
It was recognised that the isolation cannot be measured with the HiFiBerry board because the measurement inputs are AC-coupled. The measuring voltage used is a DC signal and is blocked by capacitors at the inputs. Removing the capacitors could lead to offset and gain errors of the impedance measurement and was therefore not carried out.
During the start-up of the insulation measurement based on the principle of insulation monitoring devices, communication errors occurred between the Raspberry Pi and the analogue-digital converter. The error could not be corrected within the scope of the work, which meant that the measurement procedure could not be tested.

Figure 1: Impedance and phase of a loudspeaker line
Own presentment

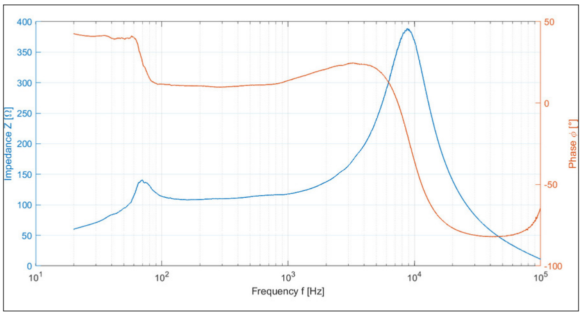


Figure 2: Block diagram
Own presentment

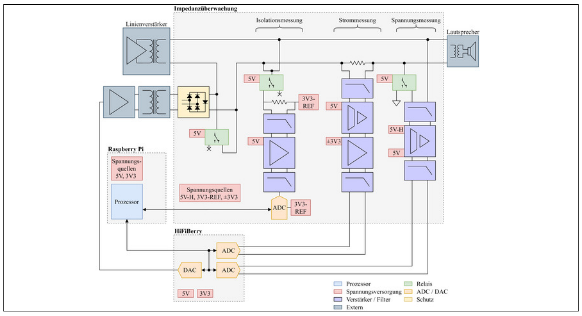
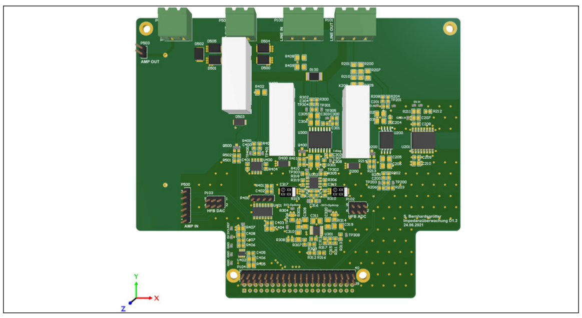


Figure 3: 3D-view of the PCB
Own presentment



Advisor
Prof. Adrian Eugen Weitnauer

Co-Examiner
Prof. Guido Piai

Subject Area
Electronics and Control Engineering

Project Partner
g+m elektronik AG, Oberbüren, St. Gallen