EPFL

MAG Microwaves and Antennas Group

Semester Project Proposal

Project title: Impedance measurements of differential antennas for in-body environments

Faculty and Laboratory: STI, Microwaves and Antennas Group (MAG)

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Project description

Antennas with low input impedance may find large relative impedance deviations between numerical expectations and fabricated prototypes. While the measurement approach in question works for antennas in free space, **the purpose of this project is to measure the impedance of electrically small antennas in human-like environments.** In this pursuit, the student is asked to **create an alternative design to the differential probe** shown in the picture below. The differential probe substitute, i.e., the device to be designed, should function independently of the surrounding medium and be scalable in electrical size to cover different frequency bands.

An ideal differential antenna comes with a perfectly balanced feed, i.e., a perfect differential mode excitation. A mismatch between feed and antenna using an unbalanced feed (e.g., a coaxial cable) will result in a finite common mode excitation due to leaking currents to ground[1]. A balun is one typical solution to reduce the common mode excitation, however, inclusion of a balun is problematic if the impedance introduced by the balun is comparable to the antenna's input impedance.

[1] Balanis, C.A., 2016. *Antenna theory: analysis and design*. John wiley & sons.

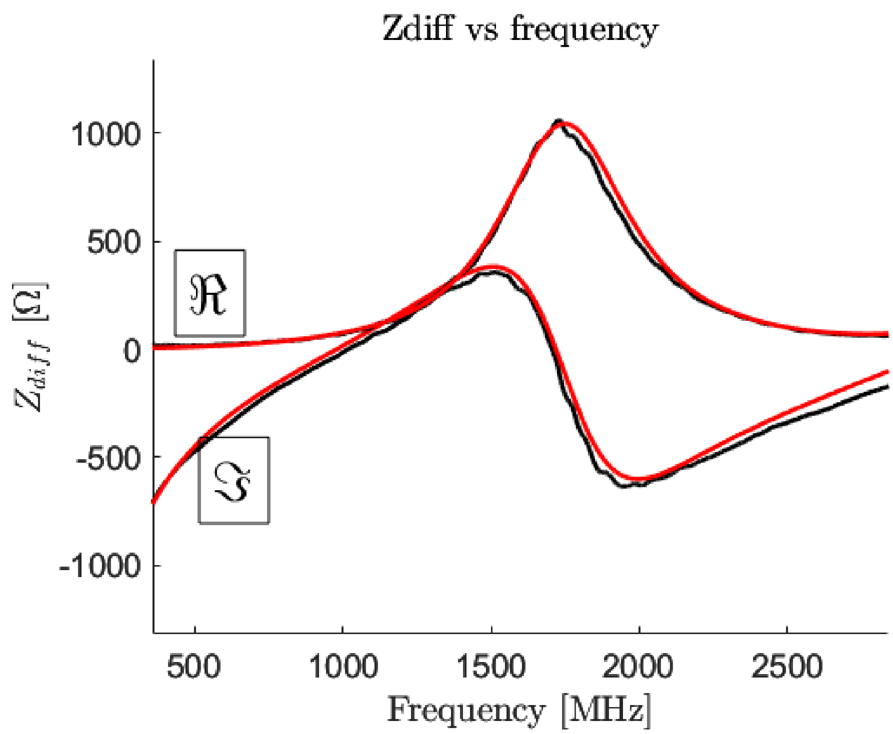
An in-house MATLAB code was developed to perform the de-embedding aspect of the impedance measurement. De-embedding serves to remove outside influence in the measurement setup. Upon interest, the student can choose to **improve the usability of the code,** which, in combination with the device, would constitute an impedance measurement kit. **With a functional device and available time**, the student can perform **comparative measurements of the differential probe method and another method (TRL),** which performs the de-embedding aspect via calibration down to the antenna terminals using a VNA. As closing remarks, the theory and methodology of the measurement process are known, but an accurate and convenient probe design is missing.

Type of work: theory and simulation 50%; fabrication and measurements 30%; documentation and reporting 20%.

Student tasks:

- Design of a convenient differential probe within ≈100 MHz to ≈3 GHz using EM software (preferably a design with electrically scalable dimensions)
- Fabrication of a prototype and insight into the de-embedding code are provided.
- Calibration and de-embedding of the device
- **Create an easy-to-use impedance measurement kit.**

A previous result for a differential free-space antenna is shown below. The black line shows the measured impedance of a half-wave dipole in relation to the numerical result indicated in red.



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