UNIVERSITÄT DUISBURG ESSEN

# Fachgebiet Hochfrequenztechnik

H F T

Fachbereich Ingenieurwissenschaften
Abteilung Elektrotechnik und Informationstechnik

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## Aufgabe der Abschlussarbeit im ISE Masterstudiengang

**für:** Frau Mona **Parsamoghadam**

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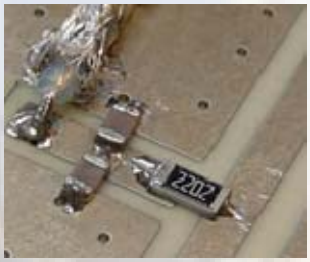
**Thema:** **Investigation of a Voltage Probe in Microstrip Technology**

### Beschreibung:

As part of the present research project MRexcite, the department has designed a power amplifier for the Magnetic Resonance Imaging system at the Erwin L. Hahn Institute in Essen. The amplifier generates an RF output power of about 1 kW which is radiated into the patient in order to excite the hydrogen nuclei in the tissue of the patient. The power amplifier concept requires the feed-back of a signal which is a sample of the current in the radiator coil. This signal is derived by probing the transmission line voltage at a distance of a multiple of one quarter-wave in front of the coil. This position of the voltage probe is at the output section of the power amplifier circuit close to the output connector. The amplifier circuit uses printed circuit board technology and the transmission line is designed as a coplanar grounded microstrip line. The voltage probe uses a high-resistance resistor connecting the signal on the high-power microstrip line to a second microstrip line which extends under an angle of 90° away from the junction. This microstrip line is terminated by a coaxial transmission line which leads the probe signal to a matched load of 50 Ohm (the feed-back circuit).

The combination of the probe resistor and the load resistance creates a voltage divider. Due to the parasitic capacitance of the probe resistor, the voltage division ratio is frequency dependent. This can be compensated by a corresponding capacitor in shunt to the 50 Ohm load resistor (a concept which is well-known from oscilloscope voltage probes). In the realized circuit, this capacitor is placed in shunt to the second microstripline, see the figures, either as a single capacitor or as a symmetrically arranged pair.



The problem:
Experiments have shown that the coupling circuit can couple out the line voltage plus a small part of the line current or in terms of waves, the probe output signal level changes with the direction of the wave on the high-power line. The obvious explanation is that a current on the high-power line generates a magnetic field around the line which induces a voltage across the loop created by the capacitor and the coaxial transmission line connection to the second microstrip line. The extent of such non-ideal coupling properties is found to depend on the arrangement of the capacitor(s) and their distance from the junction and the orientation of the coaxial cable connection.

The task:
The task of the thesis is to use an Electro-Magnetic (EM) field simulator to model this coupling circuit and investigate the variation of the coupling in a systematic manner. An experimental verification using a suitable microstrip test board (similar the design shown in the figures) is required to support the results of the study.

**After delivery of the thesis, a public presentation of the results is to be given at the HFT department.**