UNIVERSITÄT DUISBURG ESSEN

Fachgebiet Hochfrequenztechnik

Fachbereich Ingenieurwissenschaften
Abteilung Elektrotechnik und Informationstechnik

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Aufgabe der Abschlussarbeit im ISE Bachelorstudiengang

für: Herr Serhat **Kayik**

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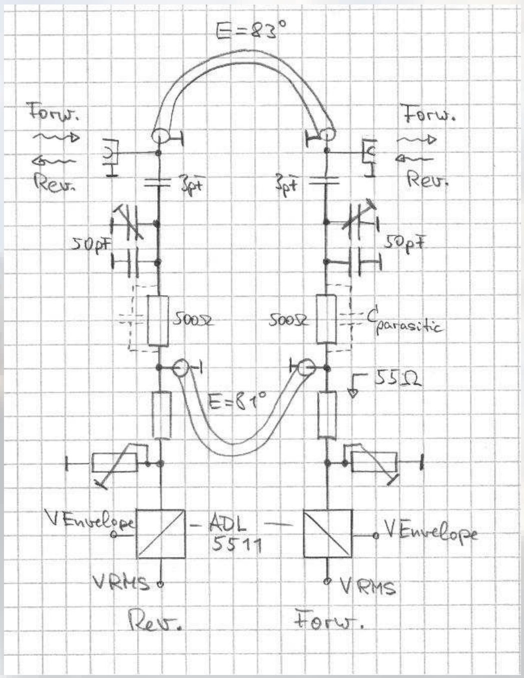
Thema: **Directional Coupler for 7-Tesla MRI Power Amplifier**

Beschreibung:

In a research project, the department develops a high pulse-power amplifier for a 7-Tesla Magnetic Resonance Imaging (MRI) system. The power amplifier employs a high pulse-power final stage with a maximum of 1 kW output power into a 50 Ohm load at an operating frequency of 298 MHz. In case of a mismatched load, the forward wave from the amplifier is partially reflected. The reflection coefficient can be calculated from the voltages of the forward and reflected waves. Measurement of the two voltages is accomplished using a directional coupler which separates the two waves and couples a small portion of both signals out. Due to the present high power level, a coupling factor of about -45 db is required in order not to overload the detector circuits. The detector circuits for the present application are selected such that a measurement of the peak amplitude of the forward and reflected waves can be measured and also the RMS average voltage over time using an integrated circuit ADL5511.
A suitable directional coupler circuit is shown in the schematic: The directional coupler is based on the branch line coupler concept with two transmission lines (coaxial cable) of about a quarter-wave length and two coupling circuits which use a capacitive voltage divider and a resistive attenuator. The electronic detector circuits are connected to both coupled ports of the coupler using a resistive impedance adjustment.



<u>Thesis Task:</u>
The task of the thesis is to build a this directional coupler circuit and demonstrate its performance parameters, like impedance match, insertion loss, directivity and the proper functioning of the electronic circuits.
In particular, the task entails the following steps:

- Make a simulation of the passive circuit using the Advanced Design System (ADS)network simulation tool and optimize the component values.
- Design a circuit layout using SMA board connectors, flexible coaxial cables and circuit components in surface mount technology (SMD) as far as possible; select suitable components (attention: high voltage due to high RF power!) and include optional test points and RF test connectors in the design. Include the two detector integrated circuits in the layout based on the manufacturer data sheet.
- Assemble the circuit after production of the PCB at our workshop.
- Test the circuit regarding impedance match, insertion loss and directivity; adjust the circuit for optimum performance at 298 MHz.
- Verify the proper functioning of the electronic detector circuits using a high-power signal generator with CW- and pulsed excitation and using a variable attenuator mismatched load.

At the end of the work, a public presentation of results is to be given