UNIVERSITÄT DUISBURG ESSEN

Fachgebiet Hochfrequenztechnik

H F T

Fachbereich Ingenieurwissenschaften
Abteilung Elektrotechnik und Informationstechnik

Prof. Dr.-Ing. K. Solbach
Prof. Dr.-Ing. A. Beyer

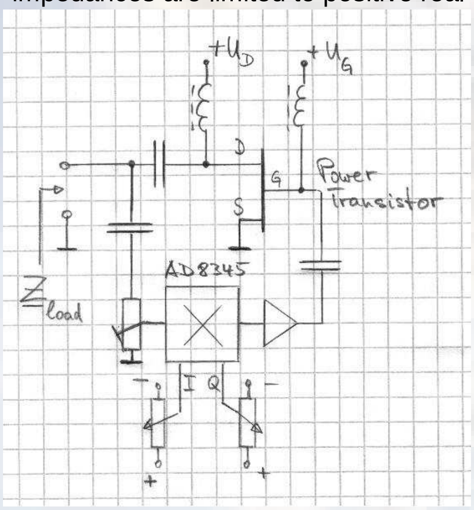
Aufgabe der Abschlussarbeit im ISE Masterstudiengang

für: Herr Kabir **Hasanzadeh**

gestellt von: Prof. Dr.-Ing. Klaus Solbach
Fakultät für Ingenieurwissenschaft - Hochfrequenztechnik

Thema: **RF Electronic Active Load for 7-Tesla MRI Smart Power Amplifier**

Beschreibung:
In a research project, the department develops a high pulse-power amplifier for a 7-Tesla Magnetic Resonance Imaging (MRI) system. In order to test the power amplifier under various load conditions, conventionally, resistive loads of different resistance are used with transmission line transformers of various lengths to provide reactive components. The number of different terminations provided by this approach is the number of different resistance values times the number of transmission line lengths and the resulting impedances are limited to positive real parts (passive).



In power electronics (dc and low frequencies), a similar problem of testing a power supply is solved by using an electronic “active” load which is realized by the Collector-Emitter (Drain-Source) impedance of a power transistor. This impedance is controlled by applying a current (voltage) at the Base (Gate). This concept was transferred to RF by using an RF power FET as a load and driving the Gate by a suitable signal. This drive signal is a sample of the power signal incident to the transistor and is controlled in amplitude and phase in order to steer the complex impedance. Complex control of the driving signal can be realized using a vector modulator which is controlled by a set of dc voltages.

The task of the thesis is to realize a first demonstration of the new concept of an RF electronic active load at 300 MHz. This encompasses the design, simulation, building and testing of a circuit suitable for a low to moderate power. The power transistor to be used as a load is the MRF6V2010 LDMOS transistor and the complex control is to use the AD 8345 vector modulator IC. Investigations of the realized circuit should concentrate on the range of achievable complex load impedances (including negative real part), the large signal properties and the problem of network stability. Investigations may start with a first easy step using, e.g., small signal amplifiers at lower frequencies.

In particular, the task entails the following steps:

- Design and analysis of initial circuits using simplified equivalent circuits (low frequency).
- Set-up of a network model for the components of the circuit and for the complete circuit, based on S-parameters and equivalent circuits, representing realistic RF properties.
- Simulations of circuit behavior using the ADS network simulator in order to understand the function and limitations of the circuits.
- Layout of a printed circuit, assembly (after production of the PCB at our workshop) and functional testing of one selected circuit design.
- Characterizing the circuit using a Vector Network Analyzer (using external high-power attenuator) regarding the small-signal properties.
- Introduction of directional couplers as an external high-power test set and using a low to medium power amplifier as a generator for the test of large-signal properties.

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