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 Bachelorstudiengang

für: Herrn Muhammad **Waqas**

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

Thema: **Analogue Vector Modulator Circuit for 7-Tesla Magnetic Resonance Tomograph (MRT)**

Description:

Our research project “7-Tesla MRT Ganzkörperspule” aims at the development of an array of coils (antennas) which can be electronically steered in phase and amplitude in order to compensate inhomogeneous field distributions inside the patient body. One work package requires the design of an electronic vector modulator for the small-signal radio frequency (RF) signals at 300 MHz which excite eight high-power amplifier stages. The required phase shift is 360° and amplitude range is 0 to 1 to be realized in an analogue RF-circuit. The realization technology is to be RF-printed circuit technology using voltage controlled attenuators in a network for the splitting of the RF input signal into in-phase (I) and quadrature phase (Q) signals. I- and Q-signals are separately controlled in amplitude between -1 and +1 and ultimately are recombined (sum of signals) to give the output signal.

The thesis task is to design a printed circuit vector modulator circuit, using commercially available balanced mixer circuits as voltage controlled bi-phase attenuators and commercially available 0° / 90° - power dividers (hybrid) and 0° / 0°- power combin ers together with control bias components (low-pass filter), resistors for a fixed attenuator and input / output coaxial connectors in surface mount technology (SMT) on a dielectric substrate board. A bank of eight vector modulators (8-channel) is to be realized and characterized with respect to the voltage-amplitude and voltage-phase conversion properties.

In particular the task is to

- select the applicable components from the MiniCircuits (vendor) catalogue
- design the circuit and lay-out a microstrip (or grounded coplanar) circuit realization on Rogers RO4003 laminate
- simulate in ADS (Advanced Design System, a microwave circuit analysis tool) the circuit using available system component models (modified as required) and investigate the degradations of the vector modulator function due to non-idealities in the circuit components
- prepare the data files for production of printed circuit boards
- assemble and test the circuits (match, insertion loss, insertion phase) using the network analyzer
- if necessary and feasible, optimize the circuits for correct I/Q performance and calibrate the DC voltage-to-phase/amplitude relationship

After successful tests of a single channel vector modulator, design and realize an eight-channel parallel vector modulator on one board. If time allows, add a 1:8 power divider (commercially available SMD component) to feed the RF input signal to the eight channels out of a single RF signal supplied by the MRT synthesizer generator.

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