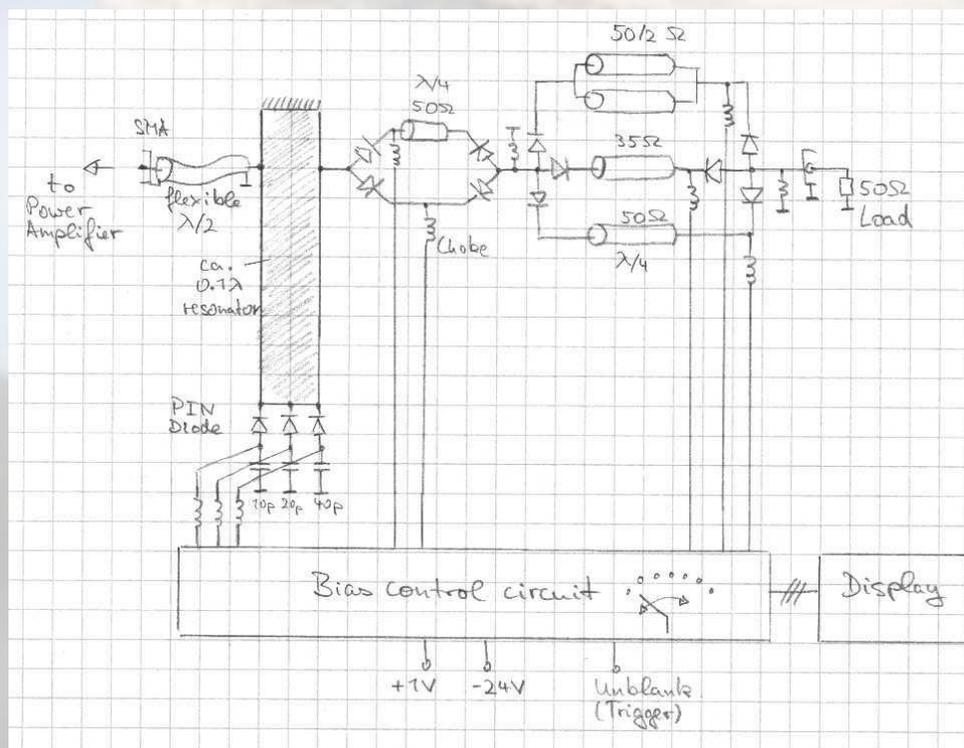


## Bachelorarbeit

## Switched Load Circuit for Power Amplifier in a 7 Tesla MRI System

In our project *MRexcite* we develop a 32-channel RF transmit power amplifier array for a 7 Tesla MR scanner operating at around 298 MHz. The design of the amplifiers includes a feedback circuit which could create instability depending on the load impedance. It is therefore necessary to test the amplifier circuit at high power with a variable load impedance. A widely used approach to the realization of a variable impedance for high power is to use a fixed high-power load, e.g., an attenuator capable of processing 1 kW of pulse power, and combine it with a quarter-wave transmission line transformer circuit for up- or down-transformation of the matched load impedance ( $50\ \Omega$ ). In our application we also want to control the imaginary part of the load impedance in a similar way as we see the impedance variation of the actual MR coils in the MR scanner. This variation is characterized by a parallel resonant circuit of a Q-factor around 50 to 100 and detuning range of several MHz. The variable load circuit therefore requires a resonant circuit which can be realized by a quarter-wave resonator with variable resonant frequency and connection to the resistive load. Several switchable options for the detuning of the resonator in combination with several switchable options for the quarter-wave transformer can offer a wide range of impedances with variation of real- and imaginary part.



The quarter-wave transformer line may be realized by coaxial lines or employing microstrip-lines on a circuit board; the resonator may be realized by a strip transmission line on the same circuit board. The switches may be preferably realized by PIN diodes which are biased by either forward current or reverse voltage, allowing

single pole triple throw switch topology in order to realize a selection of three different transmission line transformers. In order to generate more selectable impedances, a second stage of transmission line transformation is assumed which can be switched to turn the up-transformation of the first stage into down transformation. A preliminary design of a suitable circuit is shown in the schematic.

The task of this thesis is to design and simulate a suitable circuit, generate a circuit board layout, and build and test the circuit. In a project the task could be extended to the realization of a suitable electronic bias control circuit, preferably including a Matlab GUI as the interface and display function.

The task (only the RF part) entails the following steps:

1. Familiarize with the function of the circuit components, in particular the PIN diodes, using the data sheet of the manufacturer.
2. Design a suitable schematic for the circuit.
3. Familiarize with the ADS simulation tool for microwave circuits and simulate the designed circuit.
4. Familiarize with EAGLE, the CAD tool for the design of printed circuits boards, using the EAGLE tutorial.
5. Transfer the circuit to the board layout in EAGLE and optimize positions of components.
6. Deliver the PCB data set to the in-house PCB workshop which will provide the PCB. Assemble the components to the fabricated PCB and test the functionality of the circuit. In particular:
  - a. test the current consumption and the dc voltages at the switch diodes of the circuit in all switch positions,
  - b. measure the realized reflection coefficient in all switch positions and compare to the simulated (design) predictions using a Vector Network Analyzer
7. In case of any flaw in the circuit, redesign and repeat the production process.

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