UNIVERSITÄT DUISBURG ESSEN

Fachgebiet Hochfrequenztechnik

H F T

Fachbereich Ingenieurwissenschaften
Abteilung Elektrotechnik und Informationstechnik

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Aufgabe der Abschlussarbeit im EIT Bachelorstudiengang

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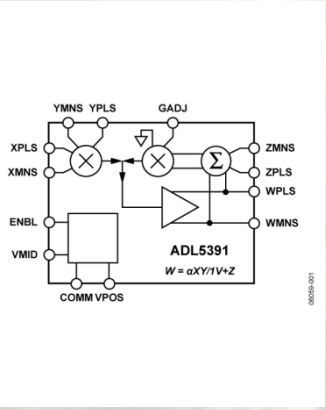
Thema: **Frequency-Doubling Limiting Amplifier Circuit for 7-Tesla MRI Smart Power Amplifier**

Beschreibung:

In a research project, the department develops a high pulse-power amplifier for a 7-Tesla Magnetic Resonance Imaging (MRI) system. The power amplifier employs a high pulse-power final stage with a driver amplifier chain and a Cartesian feedback loop to control amplitude and phase of the generated power signal. The feedback loop is based on the translation of the RF signal at 300 MHz to baseband (zero frequency) with in-phase and quadrature-phase components.
One component of the smart pulse power amplifier to be developed is a frequency-doubling limiting amplifier which provides a constant envelope Local Oscillator (LO) signal at twice the RF input signal frequency. Since in an MRI system, the RF input signal of the amplifier is amplitude modulated (amplitude varies during the RF pulse) this signal has to be processed in order to keep its envelope constant with time – a limiting amplifier can provide this function. Also, the I/Q demodulator requires a constant amplitude LO signal at twice the RF frequency so that the limiter circuit has to be preceded by a frequency-doubler circuit which receives the original RF signal and delivers a signal of double the frequency.



Task:
The task of the thesis is to build the frequency-doubling limiting amplifier. The doubler circuit is to be realized by an analogue multiplier circuit ADL5391 which is fed at its X- and Y-inputs by the same RF signal (the square of a sinusoidal signal provides double the frequency and a dc term). The limiter circuit is to be realized by a limiter amplifier integrated circuit AD8309. Circuit design for both stages may be derived from examples given by the manufacturer data sheets. Modifications are required to adapt the fully differential multiplier circuit to an unbalanced source of 50 Ohm impedance and to couple the multiplier to the input of the limiting amplifier through a 300 MHz band-pass filter.

In particular, the task entails the following steps:

- Design a circuit layout and assemble (after production of the PCB at our workshop) a frequency-doubler circuit using the ADL5391 integrated circuit and using a buffer amplifier MAX2470 (“active balun”) at the input and a band-pass filter for 600 MHz at the output.
- Test the doubler circuit regarding the dynamic range, gain and linearity.
- Build a limiter amplifier using the AD8309 integrated circuit and test the functionality of the circuit.
- Combine the layouts of the frequency-doubler and the limiting amplifier using as little as possible board area.
- Assemble the circuit (after fabrication of the PCB) and demonstrate the functionality using a 300 MHz continuous and pulsed RF generator with amplitude modulation.

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