UNIVERSITÄT DUISBURG ESSEN

Fachgebiet Hochfrequenztechnik

H F T

Fachbereich Ingenieurwissenschaften
Abteilung Elektrotechnik und Informationstechnik

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Aufgabe der Abschlussarbeit im ISE Masterstudiengang

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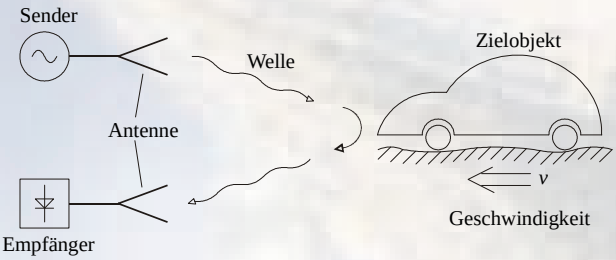
Thema: **Self-Mixing Amplifier for CW Sensors/Selbstmischender Verstärker**

Description:

Microwave receivers based on the super-heterodyne principle employ a mixer stage to convert the received signal to a (lower) frequency for further amplification and subsequent demodulation. In FMCW- and Doppler (CW)-sensors, a portion of the transmit signal power is used as the local oscillator (LO) signal which pumps the mixer stage. When the transmit power is generated by a power amplifier stage which has to be separate from the mixer, either a circulator is needed for isolation between the receiver input- and the transmitter-output port or two separate antennas (e.g., side-by-side) are employed.



A new concept to avoid the isolation of transmitter and receiver is to employ the transmitter as the mixer in one: The self-mixing amplifier. The principle of operation behind this concept is that the power amplifier output port, when the amplifier is driven into the nonlinear regime, represents an impedance that periodically varies with time, which can be used as the parametric small-signal impedance in a mixer circuit. The received signal will be connected to the output port of the amplifier due to the reciprocal antenna (transmits and receives at the same time) while the intermediate frequency (IF) mixing product will appear at the terminals of the amplifier active elements (transistors). This concept is related to the concept of self-mixing oscillators which have been used for inexpensive Doppler-sensors: In this case, the active element (e.g., a Gun-diode, a Tunnel-diode or a transistor with feed back circuit) represents a negative conductance which is used to create an oscillation. The oscillation amplitude is limited (stabilized) by the nonlinear V-I curve of the negative conductance and thus the oscillation creates a pumping of the differential (small-signal) conductance which is used as the parametric conductance to convert (mix) the incoming receive signal.

The task of the thesis is to investigate the new concept by simulation and experiment. A number of steps are foreseen:

- Building a single stage transistor amplifier with adjustable bias (operating point) at RF (e.g., 100 MHz or even lower) and measure the achievable conversion loss as a function of drive- and output power, operating points and extraction method and impedance of the IF signal.
- Simulation of self-mixing amplifier circuits using the Advanced Design System (ADS) and employing available large-signal transistor models at microwave frequencies
- Extracting the parametric conductance at the amplifier output terminals either from simulation or measurements and applying parametric conversion theory to find the conversion matrix
- Design of a self-mixing amplifier for the Doppler-Radar project at 10 GHz or 24 GHz

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