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MA thesis

to assign

ILH RF-group

EM Simulation and Layout: Scaling, Verifying and Redesigning an E-band SIW-to-MMIC Transition and SIW-Horn Antenna into the D-band

Motivation:

At the ILH a novel radar technique is demonstrated using an E-band demonstrator at ca. 75 GHz.

A secondary step is to extend this into the D-Band at around 140 GHz to cover larger radar bandwidth (up to 30 GHz) and to cope with state-of-the-art radar receivers.

For this, a receiver implemented as SiGe MMIC (Silicon-germanium monolithic microwave integrated circuit) needs to be assembled on a sophisticated carrier-RF-PCB. All MMIC connections (RF, IF, DC) are made in our facilities with wire bonding. The RF-PCB must feature the supplementary DC-supply and most importantly passive RF structures for the RF-signal, like SIW-to-MMIC transition. Those allow to feed the wideband signal in D-band received with e.g., a substrate-integrated-waveguide (SIW) horn antenna all the way to the RF input-pads of the MMIC. The comparably low-frequency IF output of the receiver (DC – 2 GHz) will be fed via a transmission line to a standard connector, e.g., SMP.

Starting Point:

A similar RF-PCB featuring the supplementary RF structures designed in E-Band already exists. Further, the workbenches and drawings of the structures in EM-simulation tools are available.

Goals:

The SIW-to-chip transition, formed by a bondwire, the SIW itself and a SIW-horn antenna must be scaled from E-band to D-band.

The existing E-band workspace and layout of EM-simulation tools like CST can be used as a reference.

Several substrate materials may need to be investigated to fulfill the significant frequency step from 75 up to 140 GHz.

Geometric variances and their influence (e.g., due to manual chip placement, glue height, manufacturing errors and process variations etc.) should be examined.

The RF-bondwire will be a crucial element and must be investigated w.r.t single vs. triple (coplanar) bond, i.a. bondwire impedance compensation, decrease of mechanical length e.g., by a pouch for the MMIC, etc.

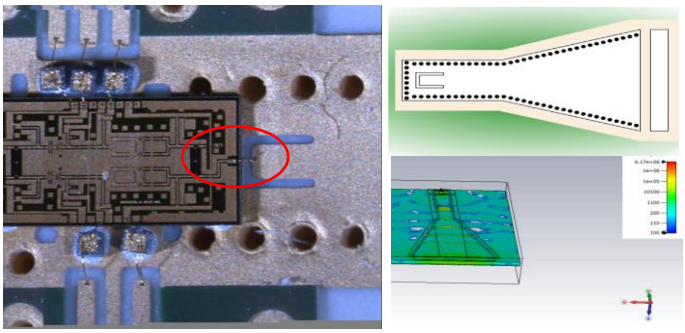
At the end, a manufacturable PCB-layout should be proposed, manufactured, assembled and tested.

Requirement:

You will need to research and gain understanding of sophisticated theory regarding i.e., microwave and waveguide theory, transmission lines, dielectrics, antenna theory, impedance matching etc.

You should have experience in – and possibly learn the handling with ease - to work with powerful CAD and EM-simulation tools (CST Studio and/or EMPro, and Altium for PCB-design) and should feel comfortable with self-study.

Probably self-managed contact to PCB manufacturers/ CAM engineers is necessary to assess questions and options about manufacturability.



(l) Photography of the existing reference E-band PCB-to-MMIC transition using a bondwire (red) and DC-supply bonds. (r) Drawing of the E-band SIW horn antenna and visualized field simulation results.

Already existing handheld E-band radar demonstrator to be be scaled to D-band. The frontend comprises a transmitter and receiver. On-PCB antennas situated on the right-hand-side of the PCB.

Your Qualifications:

- Existing knowledge/experience and a “feeling” in layout and manufacturing of PCBs and understanding of mechanical constraints
- Existing RF-background is required. You should be familiar at least with basic RF-theory already
- Feel comfortable with independent work on problems and contribution of own ideas and initiative
- Passion for good work and the motivation to go beyond your already existing skills