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11.11.2024

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 a larger radar bandwidth (up to 30 GHz) and cope with state-of-the-art radar receivers.

A receiver implemented as SiGe MMIC (Silicon-germanium monolithic microwave integrated circuit) must 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 feeding of the wideband signal in the D-band received with, e.g., a substrate-integrated waveguide (SIW) horn antenna 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 bond wire, the SIW itself, and an SIW-horn antenna, must be scaled from the E-band to the 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 to 140 GHz.

Geometric variances and their influence (e.g., due to manual chip placement, glue height, manufacturing errors, 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, a decrease of mechanical length, e.g., by a pouch for the MMIC, etc.

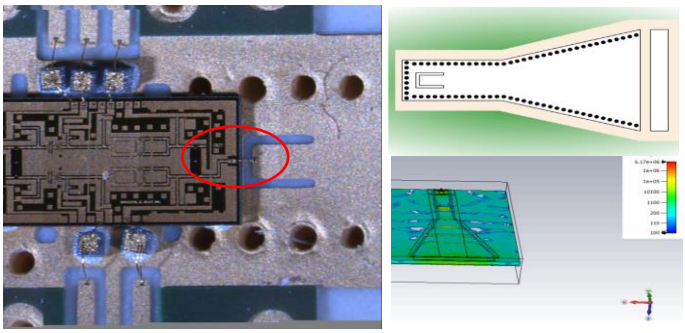
A manufacturable PCB layout should be proposed, manufactured, assembled, and tested.

Requirement:

You will need to research and gain an understanding of sophisticated theories, such as microwave and waveguide theory, transmission lines, dielectrics, antenna theory, impedance matching, etc.

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

Self-managed contact with 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.

The already existing handheld E-band radar demonstrator is to be scaled to D-band. The frontend comprises a transmitter and receiver. On-PCB antennas are 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