Chair of Nano and Quantum Sensors
TUM School of Computation, Information and Technology
Technical University of Munich

Master Thesis

Design, Integration and Evaluation of RF PCB for optical and all-electrical spin wave measurements

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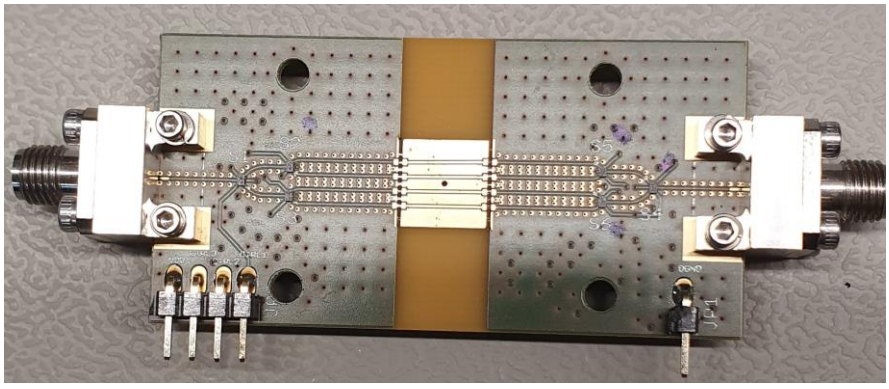
Description

Propagating spin waves (magnons) are a very promising technology to enhance future hybrid-CMOS-spin-wave devices that are able to solve computationally intense tasks in machine learning or artificial intelligence. Spin-wave-based devices are also researched in order to form magnetically tunable basic building blocks for radio-frequency (RF) applications that are highly integrated. For such applications Yittrium-Iron-Garnet (YIG) is one of the most promising material systems due to its significantly low Gilbert damping constants.

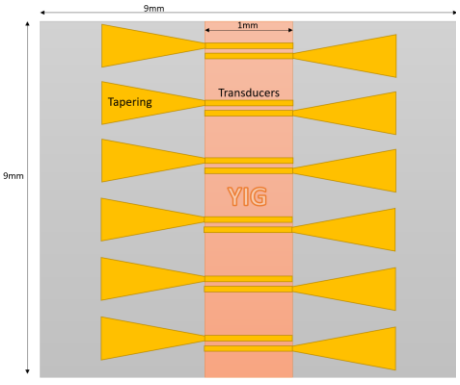
Currently we are investigating the propagation characteristics of spin waves in 100nm thin YIG films for a wide variety of on-chip spin wave transducer geometries. The characterization can be done either optically with time-resolved Kerr microscopy (trMOKE) or electrically with the help of a Vector-Network-Analyzer (VNA). The samples (chips) are carried by an external platform (the PCB) that provides the electrical infrastructure to connect the transducers to the RF source and read-out via coaxial cables. Until now, it is necessary to re-bond the electrical connections from the PCB to the chip each time the spin wave transducer under investigation changes. This approach takes a lot of time and decreases the repeatability of the experiments due to uncertainties in the bonding process.

In future, we want to solve this problem via and additional electrical circuit on the PCB that contains several RF antenna switches to change the measurement channel electrically while all spin wave antennas are permanently bonded. Recently a bachelor's thesis laid the foundation for a new PCB design and electrical control of the antenna switches. Your task will be the redesign and realization of a PCB on this basis, propose a sophisticated soldering process and characterize the overall quality of the logic and RF components.

This thesis is closely related to our current research and we are looking forward to take together the next step towards miniaturized applications for spin-wave-based devices.



Top view of first design of the new PCB without mounted devices. Edge launches enable connection to sensing tools. Logic pins at bottom left side enable antenna switch manipulation.



Schematic representation of a sample measured on the PCB instead of the Copper inlay in the left figure.

Work packages

- Dive in previous work
- Propose and realize new/better design
- Propose and realize sophisticated soldering process
- Characterization of logic and RF components (DAQ & VNA)
- Underpin quality of design with spin wave measurements (VNA) and compare results to current results

Topic areas

PCB design, RF measurements, antenna switches, spin wave metrology

Begin

- Possible at any time
- Can be combined with a research internship (Forschungspraxis) in our group