MCCX02-21-11

WACQT | Wallenberg Centre for Quantum Technology

Electronics development for scalable signal mixer stages in quantum processors

Background

Google showed [1] that a quantum processor (QPU) based on superconducting circuits can outperform a supercomputer at a particular computation. But, QPUs have not reached the quality and size required for being practical. The Quantum Technology Laboratory (QTL) is therefore developing a large QPU, heading for 40 quantum bits before 2024.

Problem description

Quantum algorithms are run by sending microwave pulses into the QPU. Quantum interaction occurs in the low-GHz regime which is too high for many pulse generators. RF mixers are thus used for frequency conversion. Running calculations on a usable QPU is a problem not addressed by any existing solution, partly due to size, price, and synchronisation issues of the necessary mixers.

Workflow

Together with our team, you will design mixer stages for Chalmers' largest QPU. You will develop electronics professionally, send your PCB design to manufacture and assemble the prototype. You will evaluate its performance versus competing solutions and attempt to formally verify the design. Constraints are set by surface-mount component footprints, power and thermal management, and price. The finished project will become part of the hardware ecosystem at QTL.

Team size

3-6 students.

Your background

- Student in Engineering Physics (F) or Electrical Engineering (E)
- Like PCB design and microwave electronics
- Typically have or plan to attend courses in high-frequency engineering

Literature

- F. Arute *et. al*, **Nature 574**, doi.org/10.1038/s41586-019-1666-5
- F. Marki & C. Marki, markimicrowave.com/assets/appnotes/mixer_basics_primer.pdf
- M. Pechal, *Microwave photonics in superconducting circuits*, **Ch. 2.3**, PhD thesis, doi.org/10.3929/ethz-a-010735338

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