Flexible stripline I/O with embedded filtering: scalable signal delivery platform with proven qubit performance

Nikolai Drobotun
Kiefer Vermeulen
Wouter Bos
Marc de Voogd
Daan Kuitenbrouwer
Jakob Kammhuber
Artem Nikitin
Sal Bosman

Delft Circuits, Schieweg 15A,2627 AN, Delft, The Netherlands

nikolai@delft-circuits.com

Scaling up the cryogenic wiring for transmon qubit experiments became a vital challenge in building multiqubit quantum computers [1]. Existing conventional wiring in combination with general-purpose microwave components has a low ability for scaling due to the mechanical dimensions and thermal properties of the material.[2]
Our work demonstrates a novel approach to making a quantum I/O. Fully embedded channels for transmon qubit Drive, Flux/Bias, and Pump signals are based on stripline transmission lines with integrated conditioning/filtering components.
We optimized the performance of the proposed I/O to reach high signal integrity in combination with specific filtering to reject high-frequency modes and photonic noise.
Another important aspect we studied is the thermal properties of a physical transmission line based on our stripline stack-up.
We demonstrate the results of the superconducting qubit experiments (T1, T2, T2echo). The obtained results show that our flexible I/O is not a limiting factor for transmon coherence below a value of 40 us.

References

[1] S. Krinner, S. Storz, P. Kurpiers, P. Magnard, J. Hein-soo, R. Keller, J. Lütolf, C. Eichler, and A. Wallraff, Engineering cryogenic setups for 100-qubit scale superconducting circuit systems, EPJ Quantum Technol. 6, 2 (2019).

[2] J. C. Bardin, D. H. Slichter, and D. J. Reilly, "Microwaves in quantum computing," IEEE Journal of Microwaves 1, 403–427 (2021) IEEE Journal of Microwaves 1, 403–427 (2021).

Figures

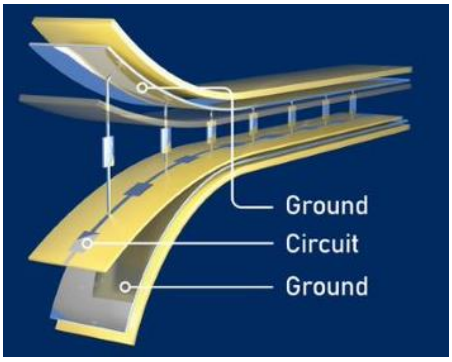

Figure 1: Flexible stripline structure

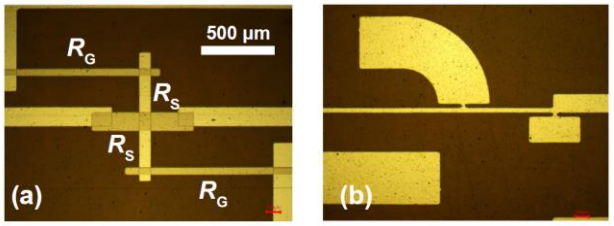

Figure 2: Signal conditioning layout structures: (a) – integrated attenuator, (b) – integrated low-pass filter