

Peer Review

Review of: "A Review of Design Concerns in Superconducting Quantum Circuits"

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Dear authors,

I found your manuscript titled "A Review of Design Concerns in Superconducting Quantum Circuits" to be a very well-written, detailed paper about how to design a superconducting quantum chip from the ground up. This paper can serve as an excellent primer for newcomers and a valuable reference for experienced researchers in superconducting quantum circuit design. Its structured approach, practical insights, and focus on addressing design challenges make it a significant contribution to the field. Experienced experts in the field can also benefit from it by cross-comparing their approach to designing a quantum chip with yours. Before recommending it for publication, I do have a few comments I wish could be addressed.

1. You have called it a short review in the intro; however, I think it's not really a "short" one. I guess you meant it was not supposed to be very detailed in every aspect, but I think it's already a very useful review and instruction. I would drop the word "short."
2. I do recommend that you use a qubit with certain given f_0 and α as an example for your paper. You can give the E_j and E_c values that are associated with the given qubit parameters in Sec. II and how to design it in other sections. Fig. 7 and Fig. 9 may be the layout of such a qubit, and the capacitances, coupling strength, and other parameters can be given in the text. In this way, I believe it can help guide newcomers better when they are trying to follow your design flow.
3. There's an extra "the" in between Eq. 5 and Eq. 6: "one can extract the parameters of the *the* original effective Hamiltonian."
4. In Sec. IV B, you said "causing unwanted rotations." You didn't introduce the Bloch sphere or any quantum operations in terms of rotation before or after. I think you can't just use the term

“rotation” here without further explanation if you are targeting a group of readers outside of experts in the quantum computing field.

5. In Sec. IV B, you said “When they are significant, couplings cause crosstalk between different circuit elements.” I think it can be merged with the sentence before it instead of being an independent one.
6. In Sec. IV B, you said “For instance, two co-planar waveguide (CPW) transmission lines that cross each other at right angles without touching will nominally have 0 coupling.” I have a hard time understanding it. How could two CPWs that cross each other have no coupling? There will be a mismatch at the intersection, and the signals cannot be guided as wished. Please explain.
7. I really like that you have included some very useful results in this review, like Eq. 14 for how to calculate kinetic inductances; excellent!
8. In the sub-section Simulation accuracy, you gave very specific numbers for elements across certain features in order to get accurate results. I personally think it's a little bit of overkill, and I do worry about the computational resources required for such fine mesh size. Can you elaborate on it, maybe say a little bit about how much memory is typically required to simulate a design with HFSS? Also, I think you can drop the word “seem to be” at the end of the first paragraph of this sub-section.
9. I think the subsection of Black-box quantization requires a little bit more detail. It's very important for designing a chip, and the fact that there's no figure in it makes it a little bit hard to follow. Personally, I would include a figure of how the simulation is set up and the port admittance across a wide frequency range before and after plugging in a nonlinear part. Although you said using Eq. 4 and Eq. 10 for calculation, it's still very helpful if you can include what I have suggested here.
10. Again, if you can use a certain device as an example for designing, and then simulation, and maybe eventually give a picture of such a device after fabrication, it would greatly improve the significance of your paper. It can even benefit from comparing the simulation with measurements if possible.

Thank you!

Declarations

Potential competing interests: No potential competing interests to declare.