Microwave generator based on the Josephson junction

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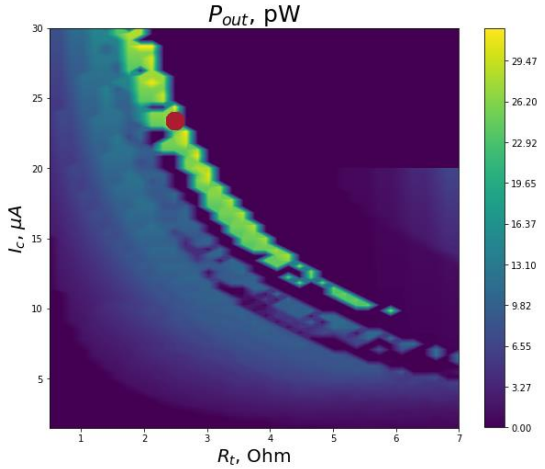
Physical systems used for quantum computing operating in the microwave range require advanced control electronics, and the use of integrated components operating at the temperature of quantum devices is potentially beneficial.

In this paper, we consider a generator consisting of a Josephson junction, a microwave resonator, a shunt capacitance and a resistance. Such a generator operates at a temperature of 20 mK at a frequency corresponding to the control of qubits. The aim of the work is to determine the range of generator parameters in which stable generation is possible by numerical solution of the system dynamics equations, the manufacture of individual generator elements, as well as the search for its optimal parameters using modeling taking into account the obtained generator elements.

As a criterion for the appearance of alternating current generation, the condition described in [1], [2] was used. To calculate the impedance, the method proposed in [3] was used, in normalized values:

$$Z_w = R_w + jX_w = \left(\frac{1}{Ti_w}\right) \int_0^{T\to\infty} \dot{\varphi} e^{jwt} dt \qquad (1)$$

As a result of this work, an analysis of the possibility of generation at different values of the McCumber parameters and the generator frequency normalized to the critical frequency of the Josephson transition is provided. During the work, samples of planar capacitors and normal resistance were manufactured and measured. Using the measured characteristics, the possibility of generating and the power of such a generator manufactured with a simpler planar technology is estimated using simulation.



Pic. 1: The dependence of the AC generation power (indicated by color) on the actual system parameters obtained during operation. The maximum possible power is highlighted with a red dot.

Bibliography

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