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Modeling Bloch oscillations in ultra-small Josephson junctions
HELI VORA, NIST Boulder, RICHARD KAUTZ, Retired, SAE WOO NAM, JOSE AUMENTADO, NIST Boulder — In a seminal paper, Likharev et al. [1] developed a theory for ultra-small Josephson junctions with Josephson coupling energy (E_j) less than the charging energy (E_c) and showed that such junctions demonstrate Bloch oscillations which could be used to make a fundamental current standard that is a dual of the Josephson volt standard. Here, based on the model of Geigenmüller and Schön [2], we numerically calculate the current-voltage relationship of such an ultra-small junction which includes various error processes present in a nanoscale Josephson junction such as random quasiparticle tunneling events and Zener tunneling between bands. This model allows us to explore the parameter space to see the effect of each process on the width and height of the Bloch step and serves as a guide to determine whether it is possible to build a quantum current standard of a metrological precision using Bloch oscillations.
[1] K. K. Likharev and A. B. Zorin. Journal of Low Temperature Physics 59, 347 (1985)
[2] U. Geigenmüller and G. Schön, Physica B 152, 186 (1988)

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