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Linear and transient operation regimes of a nano-scale spin-torque microwave detector

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When an input microwave signal is supplied to a spin-torque microwave detector (STMD) [1] it excites microwave-frequency oscillations of the structure resistance. These resistance oscillations mix with the driving microwave signal current and produce a rectified output dc voltage on the STMD. This effect called the spin-torgue diode effect [2] can be used for the development of STMDs with volt-watt sensitivity exceed that of a Schottky diode [3].

In typical experiments [2, 3] (see also Refs. in [1]) an STMD operates as a frequency-selective quadratic microwave detector (quadratic regime,). Other possible operation regimes of an STMD having non-quadratic dependence are unexplored yet and are a subject of our study.

In this work we report numerical macrospin simulations based on the solution of the Landau-Lifshits-Gilbert-Slonczewski equation describing magnetization dynamics in an STMD. We reveal that there are two distinct regimes of an STMD operation characterized by non-quadratic dependence of the detector's output dc voltage on its input microwave current , , where (linear regime) and (transient regime). The obtained results could be used for the calculation of dynamical range of powers of an STMD and are important for the development and application of microwave devices based on STMDs.

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