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Analysis of Nonlinear Gyromagnetic Line Operation Using LLG Equation*

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Nowadays gyromagnetic nonlinear transmission lines (NLTL) have been studied with great interest [1] since they can generate RF up to frequencies up to 2-4 GHz at high power (hundreds of MW) as demonstrated recently [2]. As they are all solid-state devices, they can be used as compact RF sources. On these devices, microwaves are induced by the damped gyromagnetic precession of the magnetic moments in the ferromagnetic material as their coaxial structure are loaded with ferrite material as a magnetic medium. As observed, the gyromagnetic NLTLs strongly depend on the amplitude of the incident pulse and on the static magnetic bias. In principle, this phenomenon could be predicted using the precession Larmor frequency, which is proportional to the effective magnetic field. However, as shown in [2] the NLTL performance does not confirm this result. As not expected the experimental trend observed indicates that the center frequency decreases with static axial magnetic, but increases with the incident input pulse amplitude because of the azimuthal field. A possible explanation for this is that the TEM mode wave propagates down the coaxial line coupled to the azimuthal magnetic field. Thus, the objective of this paper is to address this problem correctly by doing a mathematical analysis using the LLG equation for the TEM mode without the damping term. With this proper formulation, it will be demonstrated the experimental frequency dependence observed for the gyromagnetic NLTL.

1) F.S. Yamasaki, E. Schamiloglu, J.O. Rossi, J.J. Barroso, "Simulation studies of distributed nonlinear gyromagnetic lines based on LC lumped model". IEEE Trans. Plasma Sci. 44 (10), pp. 2232-2239, 2016.

2) J-W. B. Bragg, J.C. Dickens, and A.A. Neuber, "Material selection considerations for coaxial, ferrimagnetic-based nonlinear transmission lines,"Journal of Applied Physics 113, 064904 (2013).

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