Tailoring Stability Properties of One-dimensional Non-Foster Electromagnetic Structures

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'Negative' non-Foster elements have many potential applications in electromagnetics such as broadband matching of small antennas, design of broadband dispersionless metamaterials, and thin broadband absorbers, just to name a few. Since all non-Foster 'elements' are active physical systems, they may suffer from stability problems. This inevitable fact makes a design of stable non-Foster electromagnetic structures very challenging (E.Ugarte-Muñoz, S. Hrabar, D, Segovia-Vargas, A. Kiricenko, *IEEE Tran. on AP-S*, Vol. 60, No. 7, pp. 3490-3494, 2012., S.D. Stearns, *IEEE Int. Symp. AP-S*, pp. 1942-1945, 2011). However, some recent studies have shown that *dispersion* (i.e. realistic properties) of non-Foster elements can assure a stable operation of practical systems. This applies both to lumped networks (S.D. Stearns, *IEEE Int. Symp. AP-S*, pp. 1386 - 1387, 2015) and to 1D electromagnetic structures that can be analyzed as a transmission line loaded with negative elements (S. R. Rengarajan, C. R. White, *IEEE Ant. Wirell. Propag. Lett.*, vol. 15, pp. 1426–142, 2016, J. Loncar, S. Hrabar, D. Muha, *IEEE Tran. on AP-S*, Vol. 65, No. 1, pp. 390-395, 2017).

On the other hand, there is a very recent idea of perfectly matched broadband self-oscillating radiating structure (S. Hrabar, A. Kiricenko, *Proc, on Metamaterials 2016*, pp. 414-415, 2016). This approach turns *instability* of a network that contains non-Foster element into a useful feature. However, it is not clear whether this idea of tunable 'non-Foster oscillator' loaded by a small dipole can be extended to Fabry-Pérot antenna (T. Debogovic, S. Hrabar; J. Perruisseau-Carrier, *Electronics Letters*, Vol. 49, No. 4, pp. 239-240) and similar systems. Therefore, we present analysis of a *generic one-dimensional self-oscillating structure* that can be modelled as an ordinary impedance and non-Foster impedance, mutually connected via a transmission line. The oscillation process has been analyzed by two different methods. The first one is based on a pole analysis of the network transfer function in Laplace domain. Here, the non-Foster elements are modeled using a one-pole amplifier. The second approach employs a transient simulation using non-linear SPICE model of active device. The main goal of this study is to find a clear connection of the frequency and amplitude of oscillating signal to the dispersion and non-linear properties of the non-Foster device. Currently, a simple 1D experimental demonstrator is being constructed, and preliminary measurement results will be presented at the conference. It is believed that this investigation can pave a way towards a construction of practical self-oscillating Fabry-Pérot antennas and laser-like metasurface systems.