

Self-Cancellation of Undesired Resistance of Negative Impedance Converters for Purely Reactive Non-Foster Elements

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Recently, negative impedance converters (NICs) have been focused as a new technology to realize broadband impedance matching of electrically small antennas beyond theoretical limitations between impedance-matched bandwidth and electrical size of the antenna, and many papers have shown successful impedance matching performance. However, most of the papers do not refer to a resistance of the NIC circuit which is induced simultaneously with negative capacitance or negative inductance. Therefore, even if the perfect matching is established in terms of return loss, the NIC circuit might provide $50\ \Omega$ resistance so as to absorb the most of excited energy by the NIC resistance, not to be radiated to the free space.

We believe that the bipolar-transistor-based NIC, optimized by a group of OHIO State University, is one of the most reliable Linvills' NICs (K.S.Song, *Dissertation of Elec. Comp. Eng.*, The Ohio State University, 2011). Apart from their excellent results, we found through our experimental verifications that the circuit provided a large resistance of about $50\ \Omega$ at the lower bias voltage $V_{cc}=3.8\ \text{V}$ (originally 12V) (see red line in Fig.2a), and then the most of the RF power was absorbed by the NIC, leading to an insertion loss of 34dB (see red lines in Fig.2b).

To reduce or cancel out such an undesired resistance of the NIC, we propose two strategies; one is to tune the bias voltage to an appropriate level and the other is connect another resistance in series to the sign-reversed impedance element (a capacitor at this time). At this moment, the newly introduced resistance provides a negative resistance so as to cancel out the undesired resistance of the NIC by itself, and then the NIC works as a purely reactive circuit (blue lines in Fig. 2b).

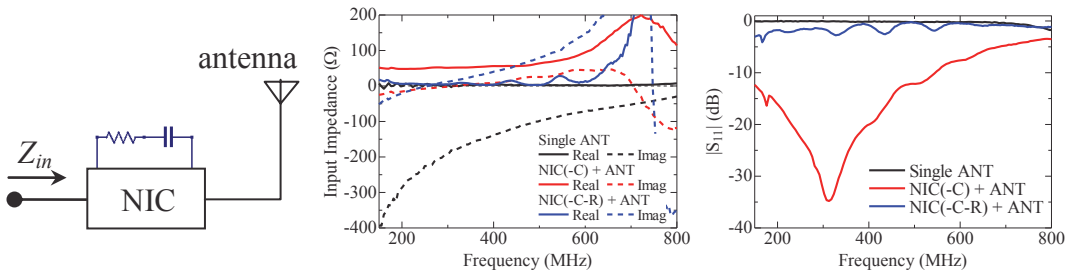


Fig. 1 Configuration of non-Foster matching with an antenna.

Fig. 2 Measured input impedance (a) and return loss characteristics.