

## Wideband Nonfoster Microstrip Patch Antenna

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Wideband patch antenna design is difficult to achieve in part due to the Bode-Fano limit. The Bode-Fano limit states that there is a limitation between antenna size and bandwidth, thereby rendering an electrically small wideband patch design impossible. However, the Bode-Fano limit can be circumvented through implementation of non-Foster principles. According to Foster's theorem (which is a consequence of conservation of energy), the slope of a reactance (or susceptance) versus frequency must be strictly positive. As such, a non-Foster element is an active component with a negative slope as a function of frequency. Such components also consume energy from a power supply other than the signal source, and can be modeled as a negative inductance or capacitance (-L and -C). To fabricate non-Foster elements, a negative inverter circuit (NIC) has to be used. Recently, it was shown that NIC can be used at the input of dipole antennas to cancel the imaginary term of the equivalent antenna input impedance. In doing this, wideband performance can be achieved. Another option for achieving wideband performance of a normally-resonant antenna is to integrate a NIC within the antenna instead of the antenna input port. In this paper, a patch antenna is designed to operate at 550 MHz. In order to integrate the NIC circuit within the antenna, a tuning capacitance is added along the length of the patch (i.e., in the direction of surface current). By increasing the tuning capacitance from 0 pF to ~20 pF will shift the resonant frequency from 550 MHz to 450 MHz. By using only tuning element, the antenna can be assumed as frequency reconfigurable design. However, to achieve wideband performance from the patch antenna, the trend of decreasing the frequency by increasing the susceptance can be modeled and substituted with non-Foster elements. As such, a NIC will be used with the proper load configuration of L and C instead of a tuning element. Therefore, the entire frequency range of 450 MHz - 550 MHz (20% bandwidth) can be covered by a single patch antenna. While this approach achieves the goal of a wideband patch antenna design, stability issues due to the negative resistance seen at the output of the NIC become a concern and will be studied. Also, sensitivity of the elements to the bandwidth as well as stability issue has to be studied in order to ensure the design remains stable with variation in L and C.