Practical Issues of Using Negative Impedance Circuits as an Antenna Matching Element

by

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Contents

Abstract

In the design of antenna systems, it is well known that there are trade-offs between bandwidth and size. As the size of an antenna reduces, in proportion to wavelength, there is a reduction in bandwidth. Wavelength at HF is of the order of tens of meters and so practical HF antennas either have narrow bandwidth or are very large in size. This conclusion holds when passive matching circuits are used, but it is possible that active circuits could provide improved bandwidth. Negative Impedance Converters (NICs) are active circuits that provide a promising avenue for achieving a high bandwidth with electrically small HF antennas. This thesis focuses on tackling the practical issues of using NIC based matching networks for HF reception.

The work presented in this thesis contributes to the research on NICs as HF matching networks in several ways: (i) the interaction of the environment with the non-linearity in the NIC circuit; (ii) a comparison between the external and internal noise effects; and (iii) the stability of the NICs when operated as matching circuits at HF frequencies.

In this thesis, a brief introduction is presented to the previous work to reduce the size of antennas. This includes a short summary on the development of the NIC and its application as a matching network. The thesis then continues with a theoretical analysis of the NIC and its application as an antenna matching circuit.

The thesis also provides an investigation on various practical issues namely the stability of the circuit, device variations, noise and the effects of non-linearity. It was found that device variations, noise and non-linearity did not pose a serious problem. Stability, however, was found to be an important issue and that the NIC circuit had to be carefully loaded to maintain stability. This research is a contribution towards the use of NICs in HF receive systems and could help bring to fruition the dream of small sized HF antennas with high bandwidth. In particular, HF radios for domestic purposes could benefit from such a research outcome.

Statement of Originality

I, Fu Tian Wong, certify that this work contains no material that has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published written by another person, except where due reference has been made in the text.

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Signed Date

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Fu Tian Wong (June 2010)

Thesis Conventions

Typesetting

This thesis is typeset using Microsoft Word 2007.
The fonts used in this thesis are Times New Roman and Arial.

Referencing

The referencing and citation style adopted in this thesis are based on the Institute of Electrical and Electronics Engineers (IEEE) Transaction style.
For electronic references, the last accessed date is shown at the end of a reference.

Units

The units used in this thesis are based on the International System of Units (SI units).

Prefixes

In this thesis, the commonly used numerical prefixes to the SI units are "p" (pico; 10^{-12}), "n" (nano; 10^{-9}), "μ" (micro; 10^{-6}), "m" (milli; 10^{-3}), "k" (kilo; 10^{3}), "M" (mega; 10^{6}) and "G" (giga; 10^{9}).

Spelling

The Australian English spelling is adopted throughout this thesis

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