

# Solving Structured Electronic Design of Negative Feedback Amplifiers as Nonlinear Programming Problems

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## Abstract

*This paper searches the best solution for the stages of noise and bandwidth of negative feedback amplifiers by resorting to Structured Electronic Design, through optimization methods. On one side, noise optimization is achieved by establishing the noise-characteristic as a function of bias current. On the other side, bandwidth optimization is obtained by establishing the equation for the open loop gain pole-product (LP product). Both aspects are defined as nonlinear programming (NLP) problems, where the design variables are related with the parameters of the device (bipolar transistors) used to synthesize the amplifiers. Differential Evolution is used to solve the noise NLP problem and the Hooke-Jeeves method is used to solve the bandwidth NLP problem. The obtained results are presented and some conclusions are established.*

## 1 Introduction

Nowadays, some activities in engineering design are still lead by experience. Regarding Electronics, Structured Electronic Design is a methodology that starts from a set of assumptions and rules. A step-by-step modification of an ideal solution is performed until a real solution, which satisfies all initial requirements, is generated. In the present work, we will focus in the case of negative feedback amplifiers.

The negative feedback amplifiers are composed of an active circuit connected to a feedback network built by passive devices (see Figure 1). The active circuit is implemented by a nullor, which is synthesized by transistors, while the spec's are kept [8]. The main aspects of design to be considered are: noise, distortion and bandwidth. The way a so-

lution (design) is found rests on a search based on an ideal solution (the nullor), and by applying a synthesis procedure, the ideal solution is converted into a real one that fulfills the specifications [9]. Noise, distortion and bandwidth are the user specifications; subsequently these have to be satisfied when the new amplifier is designed.

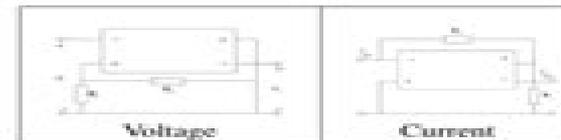


Figure 1. Voltage and current amplifier with resistive devices on the feedback network.

In this work, two of the three design stages: (1) noise and (2) bandwidth are modeled as NLP problems and solved with two techniques. The aim is to avoid designer-participation in the process and to let the optimization techniques do the search for the best design values (this activity is typically made by the designer) in Structured Electronic Design. To the best of our knowledge, this is the first attempt to solve Structured Electronic Design stages as NLP problems.

This paper is organized as follows: Section 2 presents an introduction to Structured Electronic Design, Section 3 includes the steps followed to define the elements of the optimization problems for noise and bandwidth stages. Furthermore, the two complete NLP problems are detailed. The two techniques used to solve each one of the problems and their corresponding results are presented in Section 4. Finally, some conclusions and future work are established in

# Structured Electronic Design Negativefeedback Amplifiers

**Robert R. Redfield**



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