**Introduction**

The design of RF receivers requires low power consumption, small area, high performance and, at the same time, the shortest "time-to-market". To accelerate the design time, our work proposes:

- To automate some calculations and transitions between design steps;
- To gain a significant time-saver by using the optimization instead of the simulation in the specifications calculation phase;
- To automate the circuit sizing of the receiver's blocks.

We have solved the problem of finding the optimal blocs parameters with constraints, by using the genetic algorithm NSGA-II. Currently, this algorithm is one of the most powerful tools used for optimizing a large number of engineering problems. Its effectiveness was proven through many scientific publications [1].

**Methodology**

**Standard (e.g. IEEE 802.15.4)**

**Proposed methodology**

- **Traditional methodology**
  - Requires a lot of time (in order of hours or days), because it needs parametric simulation;
  - Leads to hundreds of solutions (blocs parameters), not all of them are achievable.

- **Proposed methodology**
  - Very time-saver because optimization takes a few seconds;
  - Yields optimal and realistic blocs parameters by taking into account the constraints imposed by designers without any simulation.

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**Optimal specifications of other blocs**

**Rapid Top-Down Specification of an RF Receiver using Genetic Multi-Objective Optimization Method**

The NSGA-II algorithm is based on the biological evolution theory of natural selection. From a set of initial solutions, the algorithm randomly selects some of these solutions to produce another set called new generation. Through the successive generations, the set of solutions evolves towards an optimum that minimizes the cost functions (both noise figure and linearity, in this case).

At each step, the algorithm creates a new generation from the current one by applying three types of operations:

- The selection, for choosing some solutions from the current set to produce a new set of solutions;
- The crossover, for combining two current solutions to create the next generation;
- The mutation, for applying random changes to current solutions to form new solutions;

This work presents a novel approach to refine the parameters of an RF receiver to satisfy a standard specification by using a genetic algorithm for multi-objective optimization. The interest of this approach is to come rapidly up with a feasible solution avoiding a hard time-consuming iterative simulation procedure. The methodology has been applied to the design of an LNA for complying with the IEEE 802.15.4 standard. In particular, it provided feasible design parameters for an inductively-degenerated common-source cascode LNA with LGe tank load, which was implemented on a CMOS 150nm process. Compared to previously reported works, this approach shows a very low noise figure, acceptable power consumption and a excellent trade-off between linearity and gain.

**Results**

Example of analog design flow

The Metadial-Optimization tool is used to optimize both, NF and IIP3, cost functions.

**Optimal design of LNA**

- **Gain (dB)**: 26.96 dB
- **NF (dB)**: 25.82 dB
- **IIP3 (dBm)**: 16.46

**Performance comparison**

- **This work**
  - **F (GHz)**: 2.4
  - **CMOS Technology**: 0.35 µm
  - **G (dB)**: 19.8
  - **NF (dB)**: 3.6
  - **IIP3 (dBm)**: 4.7
  - **Pd (dBm)**: -2.7
  - **Pc (mW)**: 22.4

**Conclusion**

This work presents a novel approach to refine the parameters of an RF receiver to satisfy a standard specification by using a genetic algorithm for multi-objective optimization. The interest of this approach is to come rapidly up with a feasible solution avoiding a hard time-consuming iterative simulation procedure. The methodology has been applied to the design of an LNA for complying with the IEEE 802.15.4 standard. In particular, it provided feasible design parameters for an inductively-degenerated common-source cascode LNA with LC tank load, which was implemented on a CMOS 150nm process. Compared to previously reported works, this approach shows a very low noise figure, acceptable power consumption and a excellent trade-off between linearity and gain.

**Antagonistic global parameters**: F and IIP3

- Better noise factor (F)  \( \Rightarrow \) Increase the Gains
- Better linearity (IIP3)  \( \Rightarrow \) Decrease the Gains