

Design and Optimization of Radio-Frequency Receiver with Modified Genetic Algorithm

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I. Introduction



RF Receiver (RX) Overview:

- Core front-end: Amplifies signals (LNA) & converts frequency (Mixer)
- Critical for extracting weak signals reliably from noisy environments
- **Needs Optimization:** To meet stringent, simultaneous goals

• Key Challenges:

- **High Sensitivity:** Performance heavily depends on circuit parameter values
- **Trade-off**: Conflicting metrics (PC, CG, NF) and strong interdependencies
- > Automation Difficulty: Prior methods often computationally expensive (PSO/ACO) or ineffective (Std. GA) for complex RF circuits





Performance Table

Method	Minimum	Maximum	Mean	Std*
CGA	25	224	92.4	73.29
GA	24	3671	439.2	1078.07
DDPG	19	2318	797	735.48
PSO	52	3603	440.5	1054.60

Next Population								
X _{best,FOM}	X _{new,PC}	X _{new,CG}	X _{new,NF}	X _{mut1}	X _{mut2}	•••		

Optimization Process

Circuit-Centric GA (CGA):

- Proposed method for efficient RF circuit optimization.
- Focuses on: Mutation, Metric-Guidance, & Preservation (No. Crossover)

*Standard deviation

Optimization goals and worst-case RX by CGA

Performance Metric	Target Value	Final Value	Hand-Tuned
Power Consumption (mW)	8	6.31	7.32
Conversion Gain (dB)	15	17.54	15.57
Noise Figure (dB)	3	2.59	2.72
FoM	0.05	0.05	0.05

