

Initial Evaluation of an Evolvable Microwave Circuit

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Abstract: EHW-based microwave circuit can automatically adjust its performance better than experienced engineers.

Motivation & Goal

Motivation

Design difficulty of microwave circuits due to distributed-constant circuits

Standard approach: calibration circuitry
increase circuit size and complexity

Goal

Realize autonomous adjustment of microwave circuits

Solution

EHW-based microwave circuit

example; image-rejection mixer

How to Evolve Image-rejection Mixer

Point

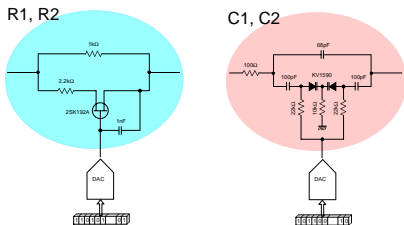
Evolve the phase-shifter in image-rejection mixer

Detail

Resistance and capacitance are evolved by GA on the PC

Resistance:
FET bias is genetically controlled

Capacitance:
Varicap bias is genetically controlled



Fitness function in GA

Sum of 3 image rejection ratios at 3 frequency points; (0.9 MHz, 1.0 MHz, and 1.1 MHz).

What is Image-rejection Mixer ?

1. Application

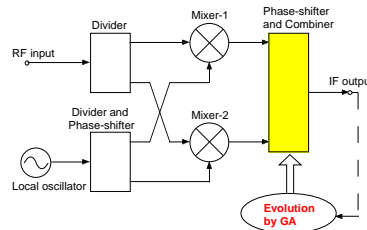
Microwave communication
(e.g. watching TV program of satellite broadcasting)

2. Purpose

Selection of IF signal from RF signal

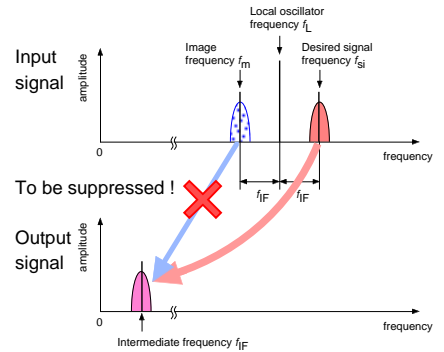
3. Organization

Consist of 2 mixers and phase-shifters



4. Problem

Selection process yields harmful image frequency signal



5. Requirement

Suppress image frequency signal as much as possible
i.e. high image rejection ratio

6. Solution

Autonomous adjustment toward high image rejection ratio

EHW-based microwave circuit

Results and Conclusions

Results

EHW results

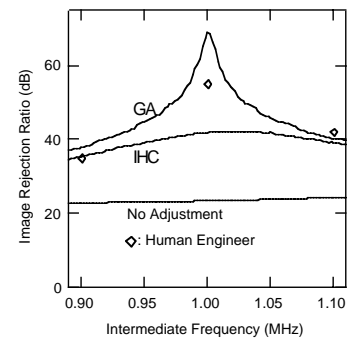
Obtained image rejection ratio:
69 dB at band center
39 dB at band edge

Comparison with other methods

GA was better than hill-climbing methods or manual adjustments

Hill-climbing methods:
maximum 60 dB
average 48 dB

Manual adjustments by experienced engineer:
55 dB



Conclusions

EHW-based microwave circuit can automatically adjust its performance better than experienced engineers.

e.g. EHW: 69 dB
manual adjustment: 55dB
before adjustment: 23dB

Further work

Enhance signal bandwidth and reducing size