X JORNADA DE JÓVENES INVESTIGADORES DEL I3A

Design of a Digitally Programmable Phase Shifter for Active Antenna Arrays

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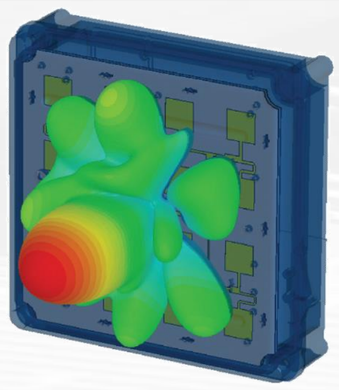
GDE Grupo de Diseño Electrónico

Millimeter Band:

- ✓ More bandwidth available
- ✓ Less interference and safer
- ✓ Beamforming is needed

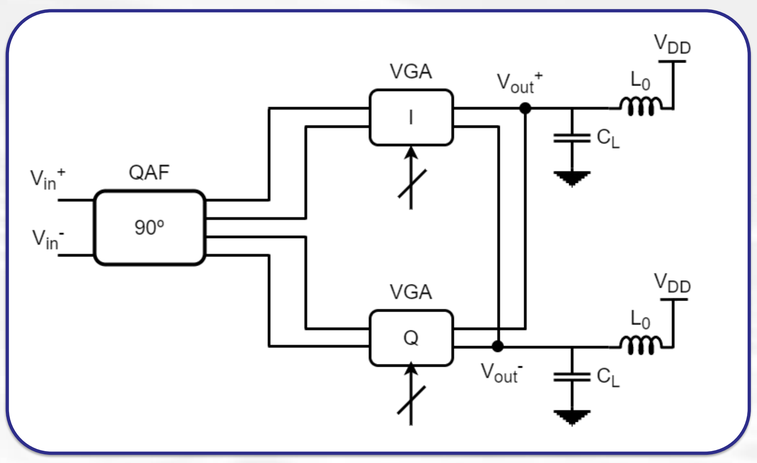


Antenna Arrays:

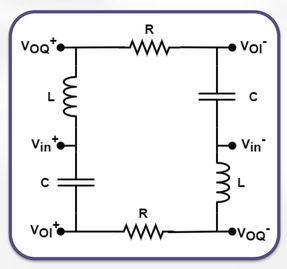
- ✓ Electronically steerable
- ✓ Multiple beams
- ✓ Faster and cheaper

Topology

Phase Shifter:

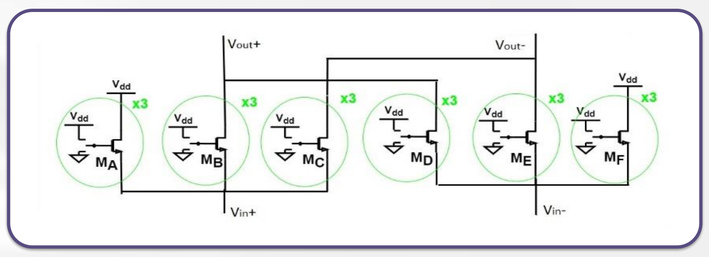


➢ Quadrature All-Pass Filter (QAF):



Generates in-phase and quadrature signals using monolithic RLC resonators

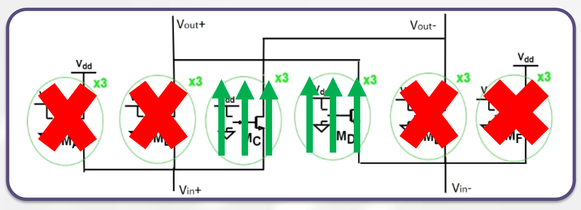
➢ Variable Gain Amplifier (VGA):



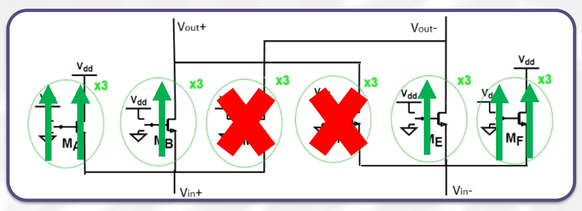
In-phase and quadrature signals weighted by digitally programmable VGAs

Results

I :



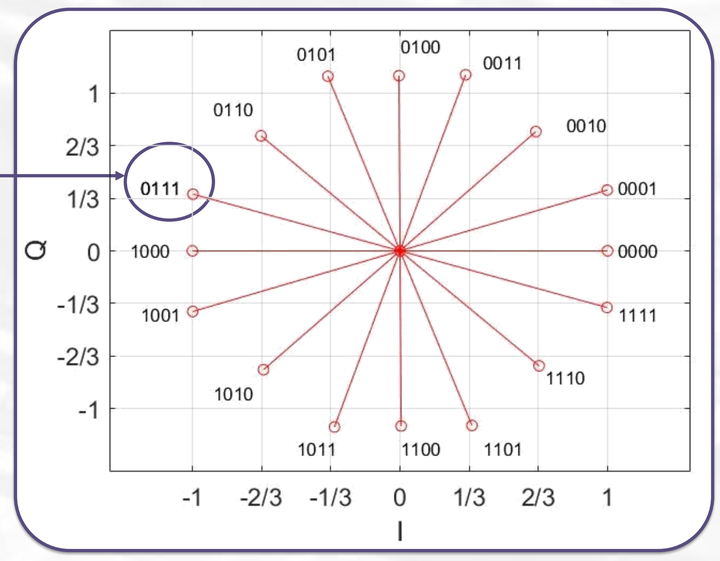
Q :



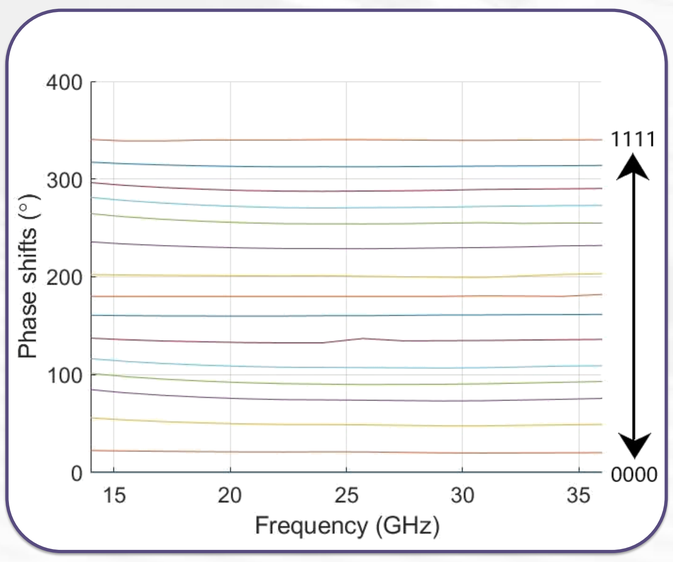
A_r= -1

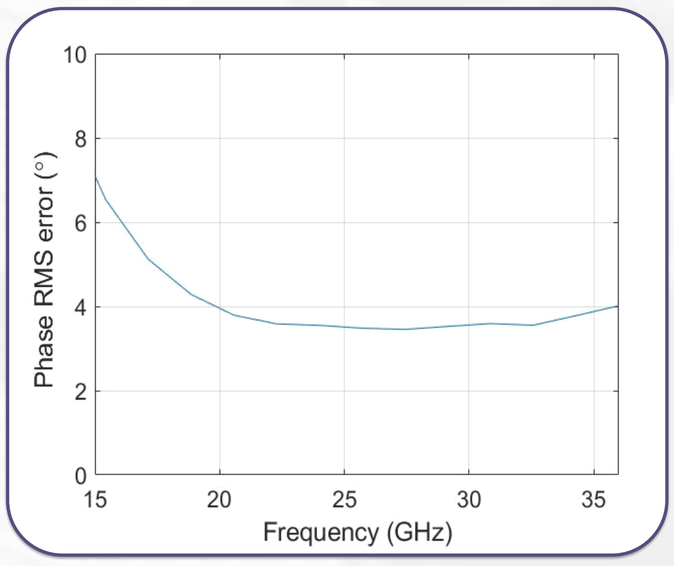
A_j= 1/3

A_j/A_r= -1/3 ➡ $\phi = \text{atan}(A_j/A_r)$ ➡ ϕ = 157,5°



Frequency (GHz)	Technology / Supply	$\Delta\phi_{RMS}$ (°)	ΔA_{RMS} (dB)	Power Consumption (mW)
15 - 36	CMOS 65 nm / 1.2 V	5.5 - 11	1.12 – 0.72	5.2 @ 24 GHz





Conclusions

- ➢ The proposed topology allows to get the desired phase states for active antenna arrays working in millimeter band
- ➢ Dummy transistors are necessary to keep input and output impedances invariant between different configurations
- ➢ This design can be generalizable to other frequency bands and it´s compatible with integration technologies