
Hardware Reduction for a Retrodirective System

UCLA

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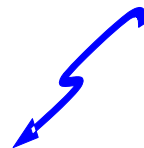
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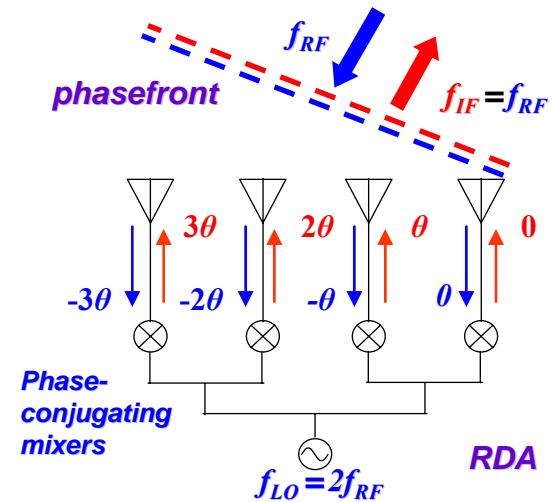
Motivation

- Increasing application for RFID – passive transponders with various functionality
- Identification Friend of Foe (IFF) – high speed secure source tracking
- Simple low-cost high-performance systems desired

Interrogator



Onboard transponder

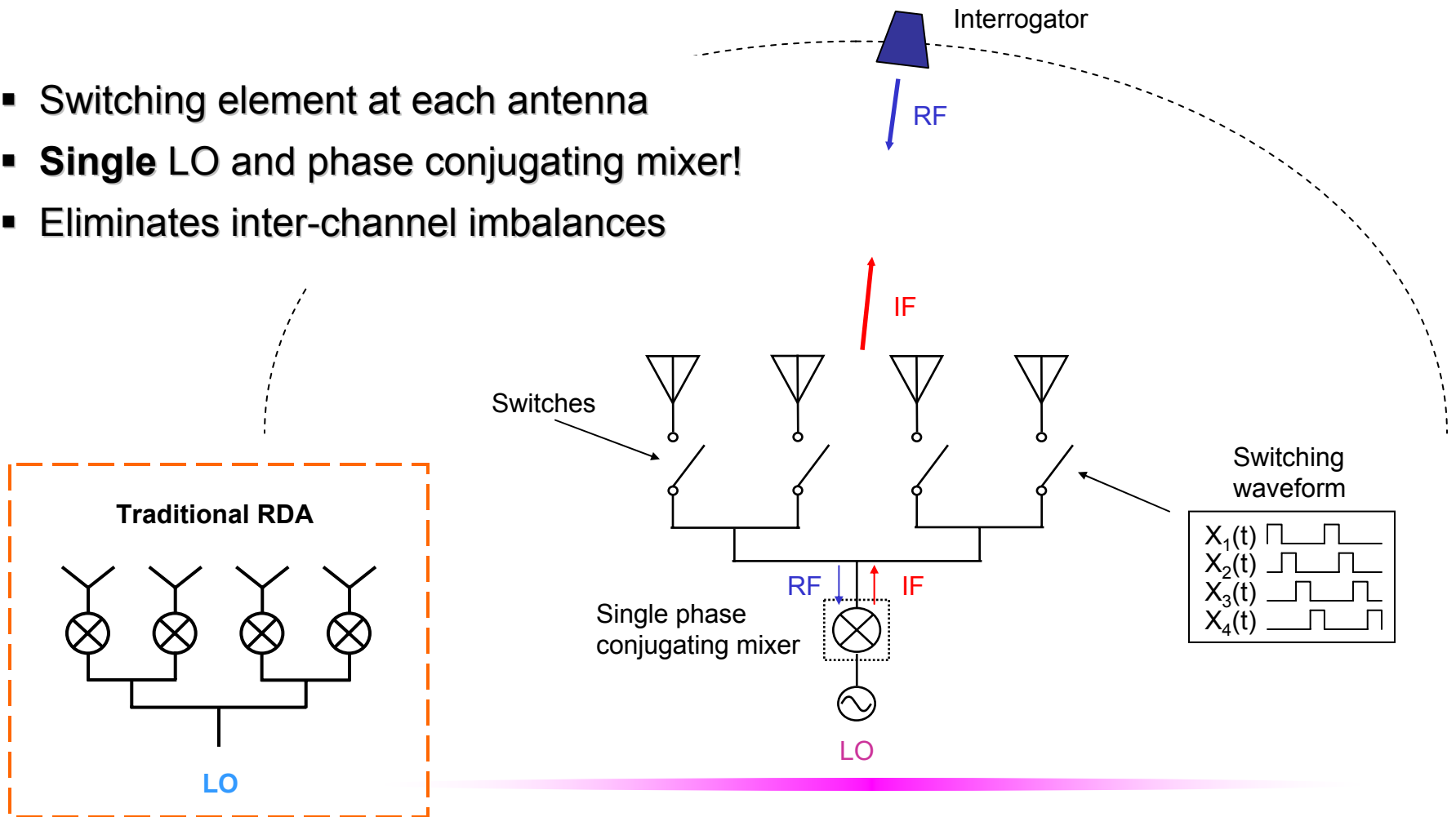


- ✓ Retrodirective arrays (RDAs) are ideal candidates for passive transponders
- ✓ Automatic high-speed directive response to interrogation over omni-directional coverage
- ✓ Goal: reduce/simplify hardware requirement



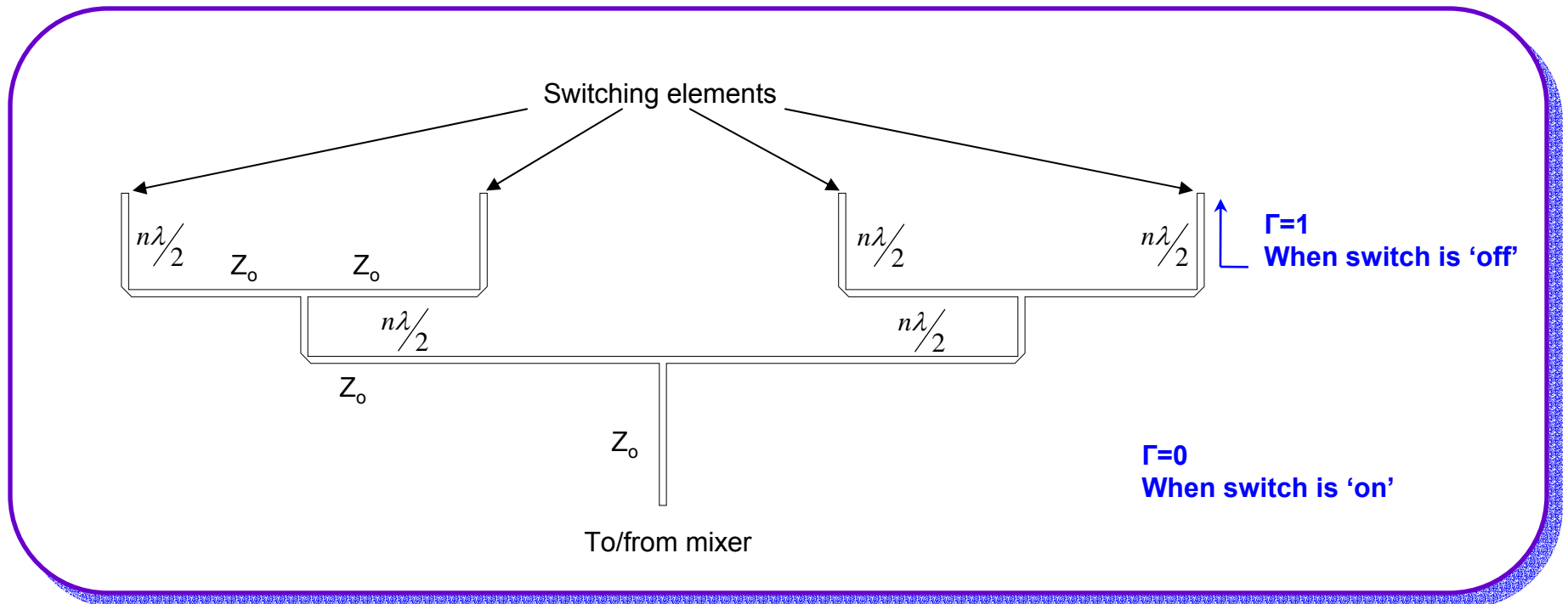
Switched Antenna Retrodirective Concept

- Switching element at each antenna
- **Single** LO and phase conjugating mixer!
- Eliminates inter-channel imbalances



Switching Feed Network

- Symmetric unconventional feed network – Z_0 @ all T-Junctions
- Always matched to a single antenna
- Relies on open circuit approximation of switch in “off” state

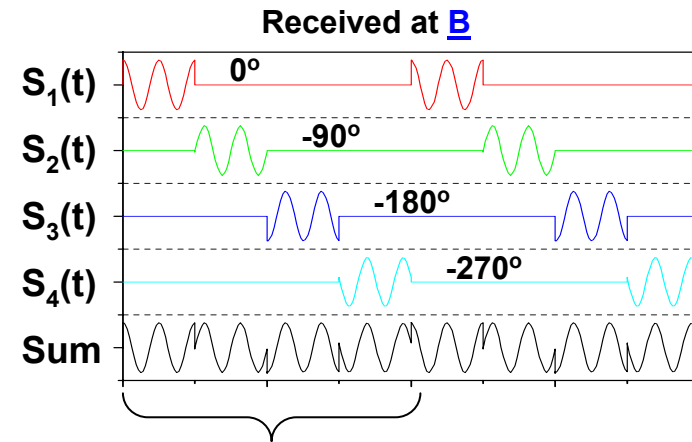
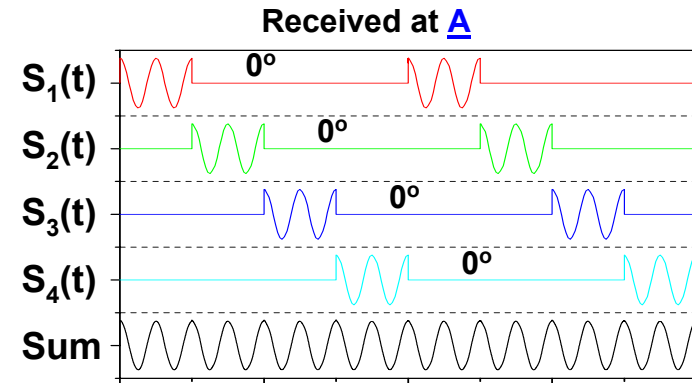
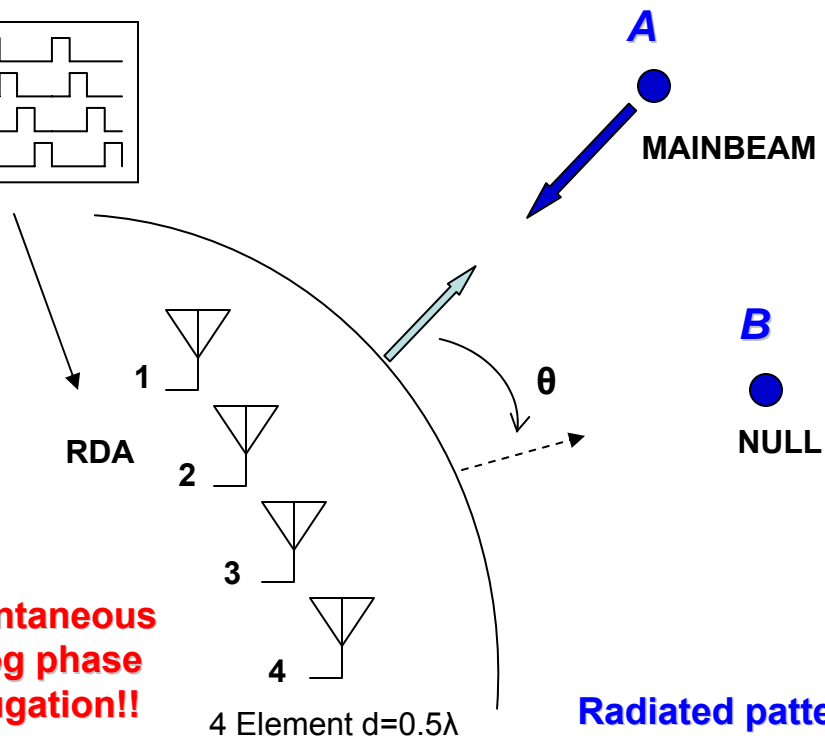
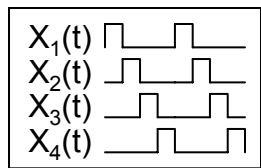


System Operation

Phase-conjugated retransmitted signal at each channel:

$$S_n(t) = x_n(t) \cdot \frac{1}{2} V_{RF} \cdot V_{LO} \cdot [\cos(\omega_{IF}t - \theta_{RFn})]$$

Conventional phase-conjugated signal



Complete switching period

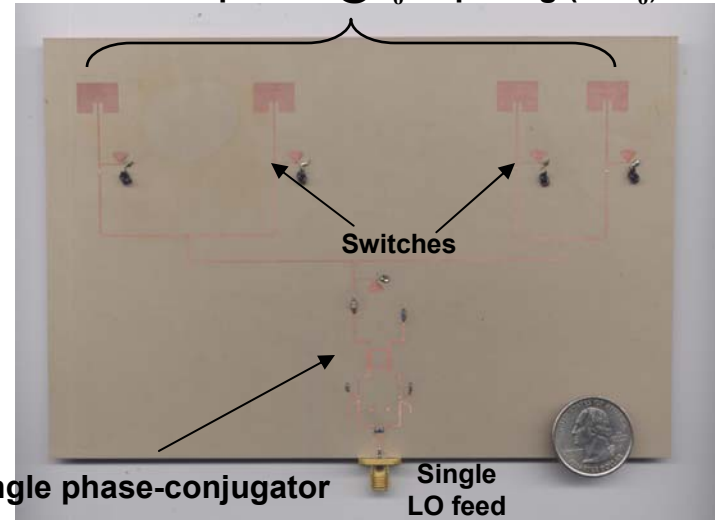


Switching Scheme Integrated with Sparse Array

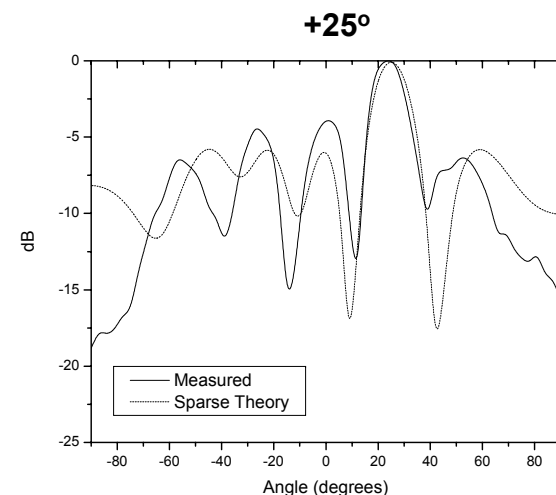
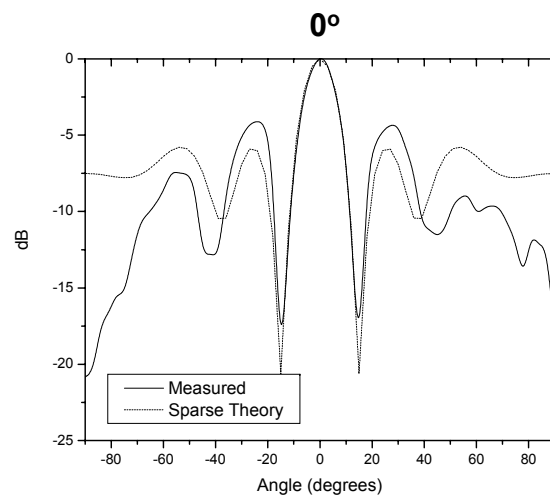
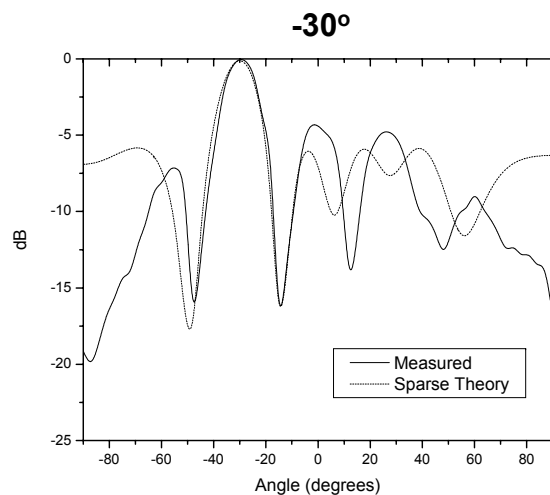
Further hardware reduction with sparse architecture!

* A conventional retrodirective array with same aperture typically would require 6 radiators and 6 mixers.

6-element aperture @ $\lambda_0/2$ spacing ($2.5\lambda_0$)



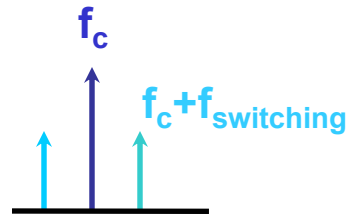
Measured Bistatic Patterns:



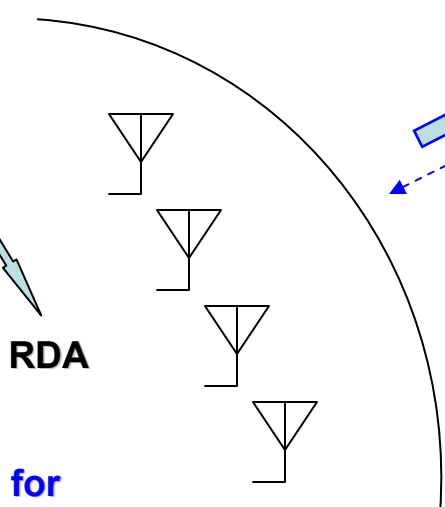
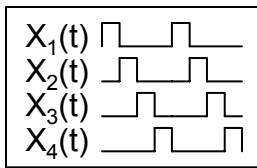
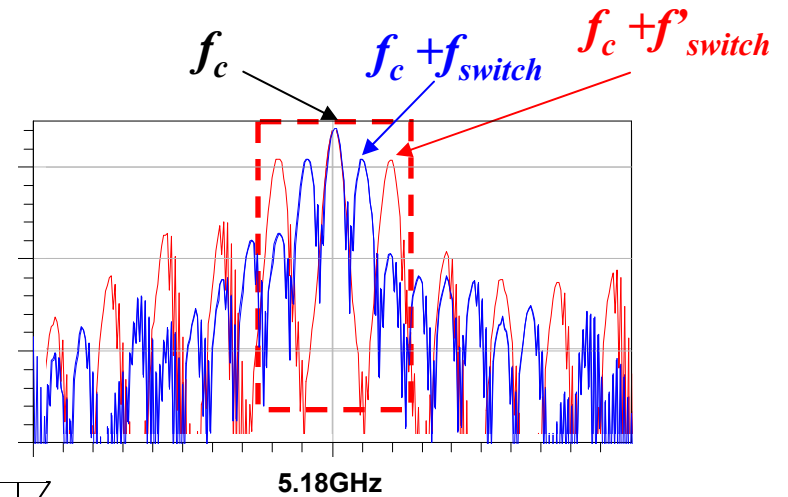
Built-in Modulation Scheme

Retransmitted signal will contain sidebands based on the switching frequency

Switching waveform controls modulation index



Received spectrum at interrogator

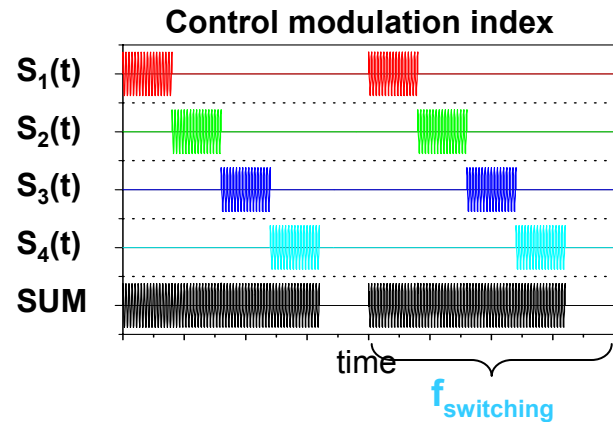


RDA

Change $f_{switching}$ for simple data transfer

Interrogator

f_c



Summary

- Switching scheme offers an **N to 1 hardware reduction**
- Maintaining **directive transmission** response based on array theory
- Flexible scheme allows for integration of **amplification** and **external LO elimination**

