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Centre d'Investigació en Metamaterials per a la Innovació en Tecnologies Electrònica i de Comunicacions

3D-Printed Microwave Encorders based on Embedded and Buried Dielectric Inclusions

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URSI-GASS 2020, Rome (Italy)

URSI GASS 2020

UAB Research Park

Universitat Autònoma de Barcelona

tecnio catalonia

ACCIÓ Generalitat de Catalunya

Outline

1. Motivation & Objectives
2. Previous work
3. Proposed Chipless RFID system
4. Fabrication and measurement
5. Conclusions

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1. **Motivation & Objectives**
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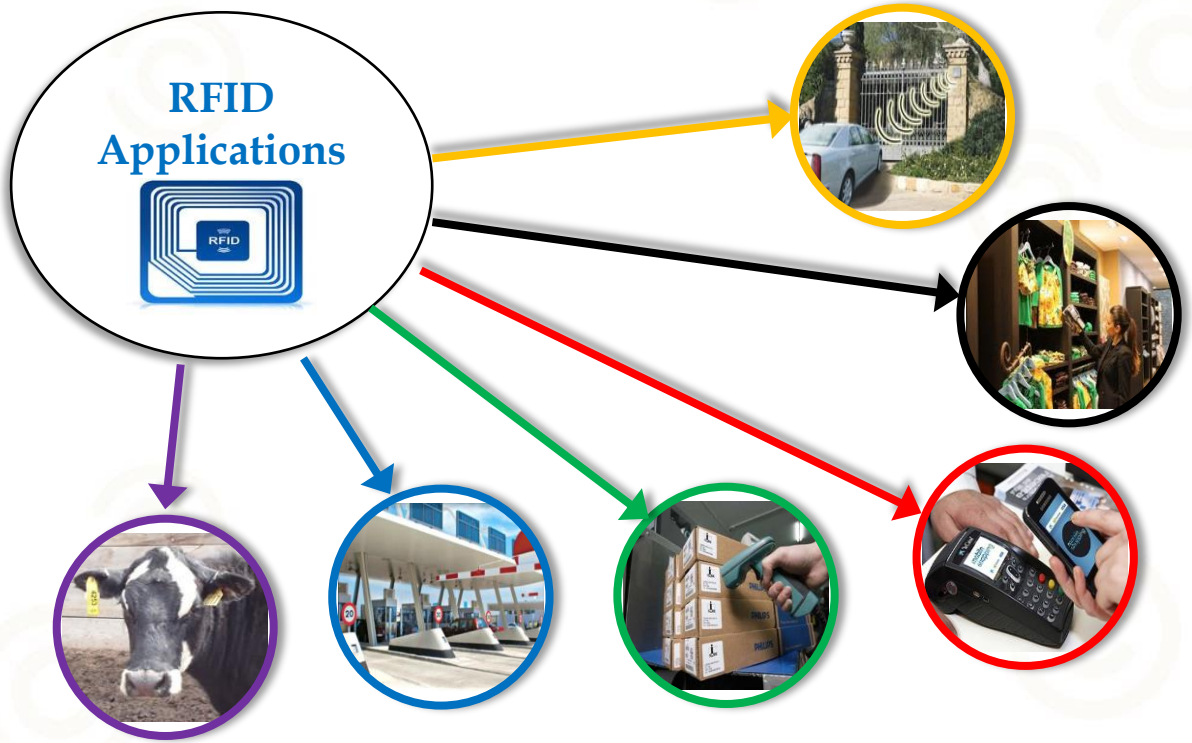
1. Motivation & Objectives

- RFID: a major technology in the field of identification.
- More than 3000 applications (Logistics, Item and pallet tracking, fare collection, pharmacy, ...)



1. Motivation & Objectives

- RFID: a major technology in the field of identification.
- More than 3000 applications (Logistics, Item and pallet tracking, fare collection, pharmacy, ...)
- Barcode vs RFID passive Tags

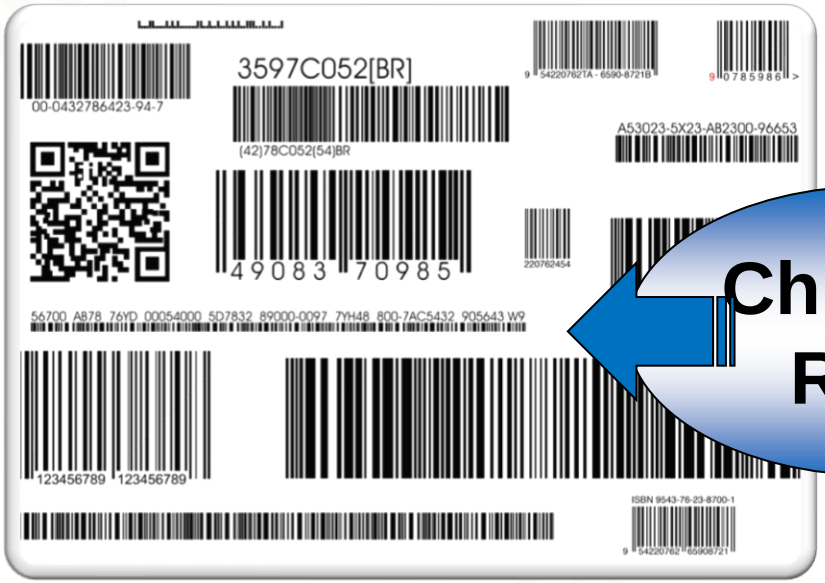
Read Range	Few centimeters	Up to 15 m (passive)
Capacity	43 bits (EAN 13)	EPC 96 bits
Multireading		
Reprogrammable		
Security		
Direct Line of sight		
Durability		

Cost < 0.01 €

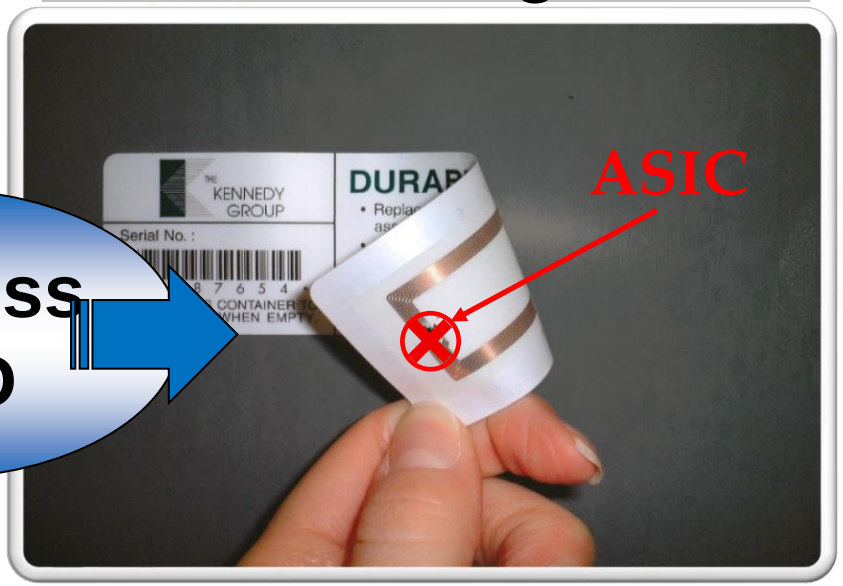
Cost ≈ 0.10 €

1. Motivation & Objectives

Optical barcodes



RFID tags



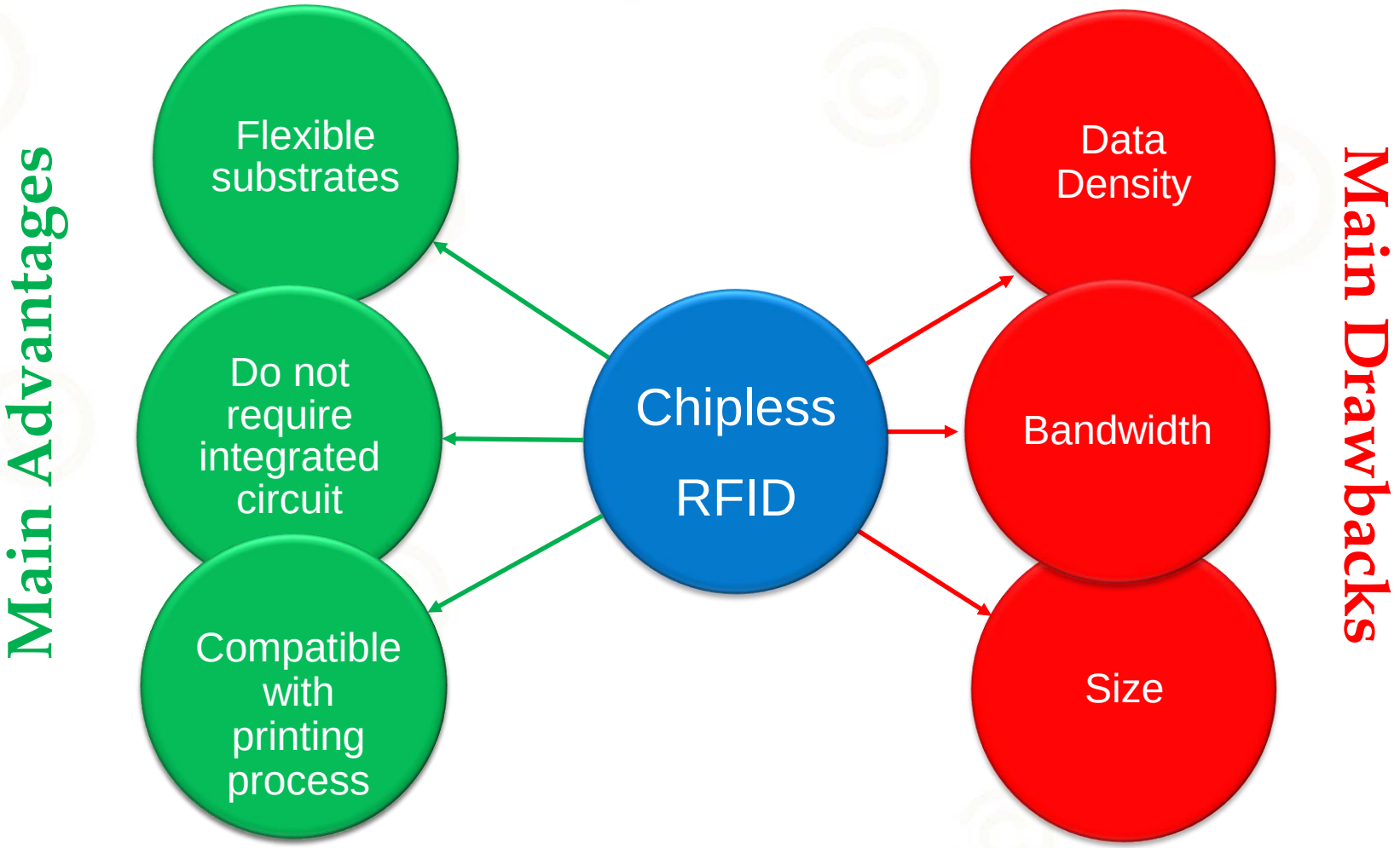
Chipless RFID

Cost < 0.01 €

Cost ≈ 0.10

1. Motivation & Objectives

The ASIC (chip) is replaced with a printed encoder in chipless RFID



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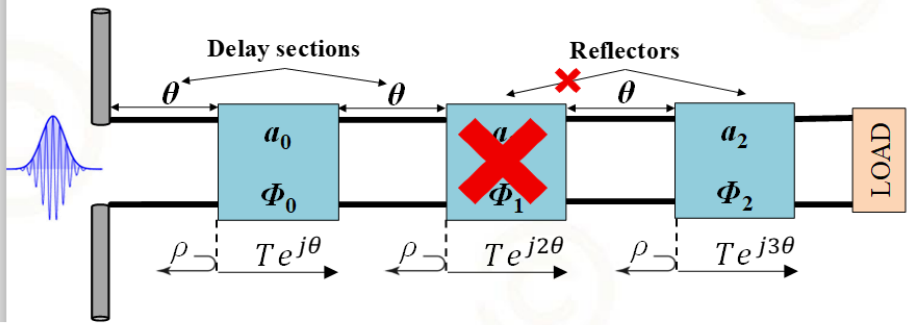
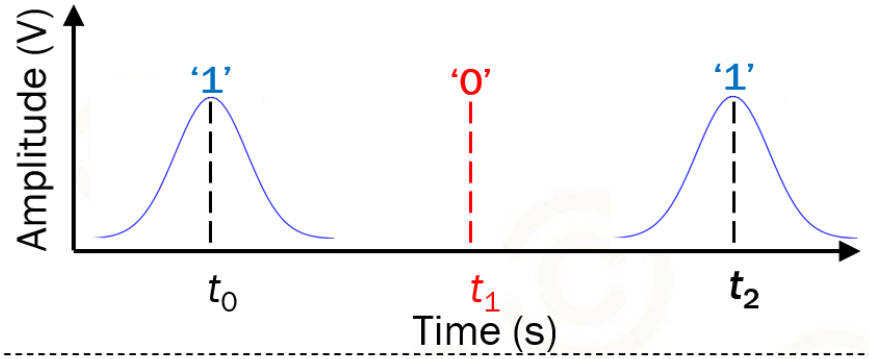
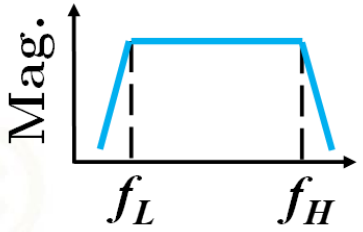
2. Previous work

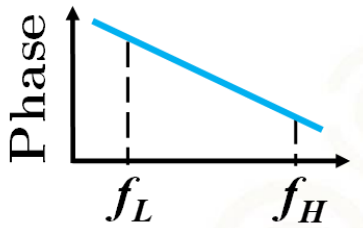
Time-domain

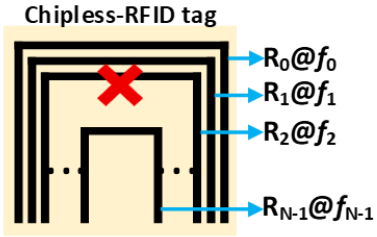


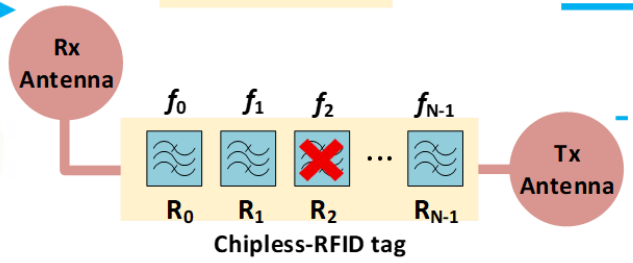


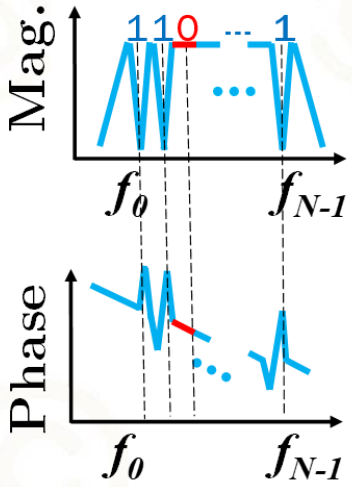
Frequency-domain





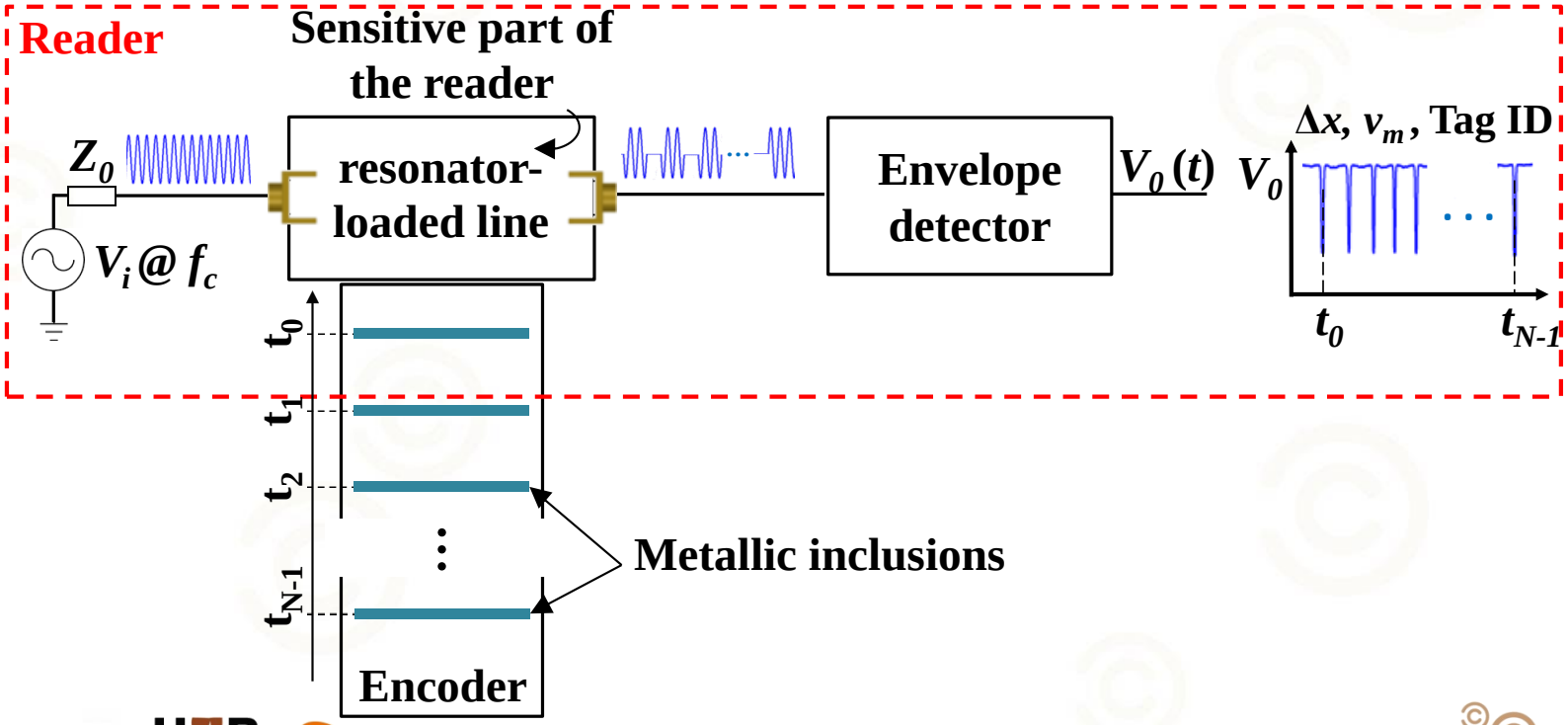






2. Previous work

- Time-domain near-field chipless-RFID system with sequential bit reading.
- The chipless RFID tag consists of a set of identical resonators.
- The presence/absence of resonant elements in the chain is used for coding purposes.



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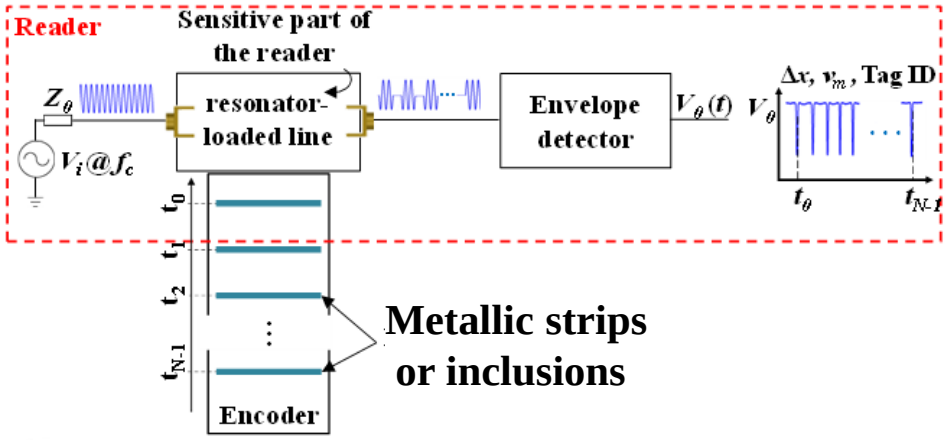
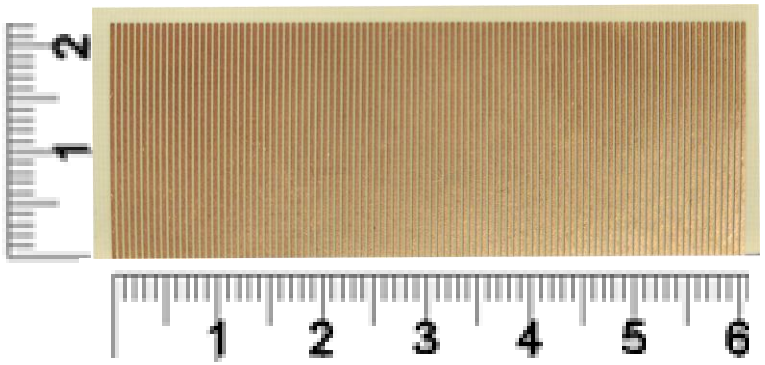
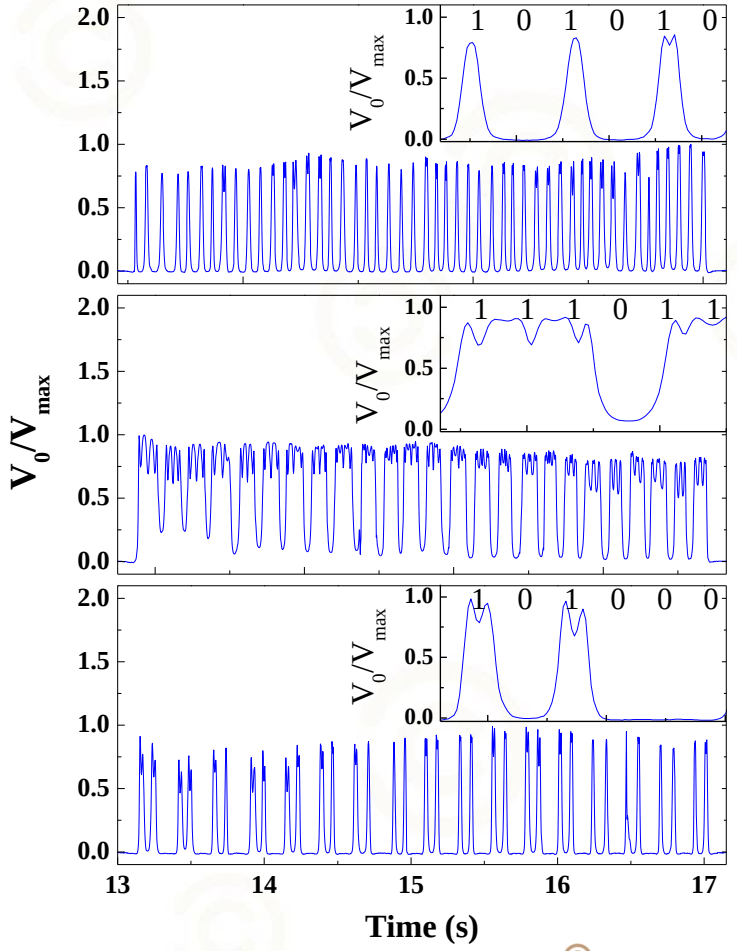
Time-domain near-field chipless-RFID system with sequential bit reading.







Outline

1. Motivation & Objectives
2. Previous work
3. **Proposed Chipless RFID system**
4. Fabrication and measurement
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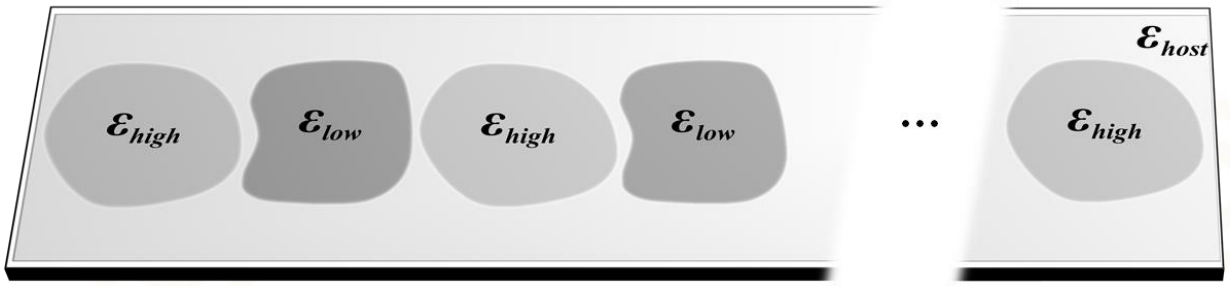
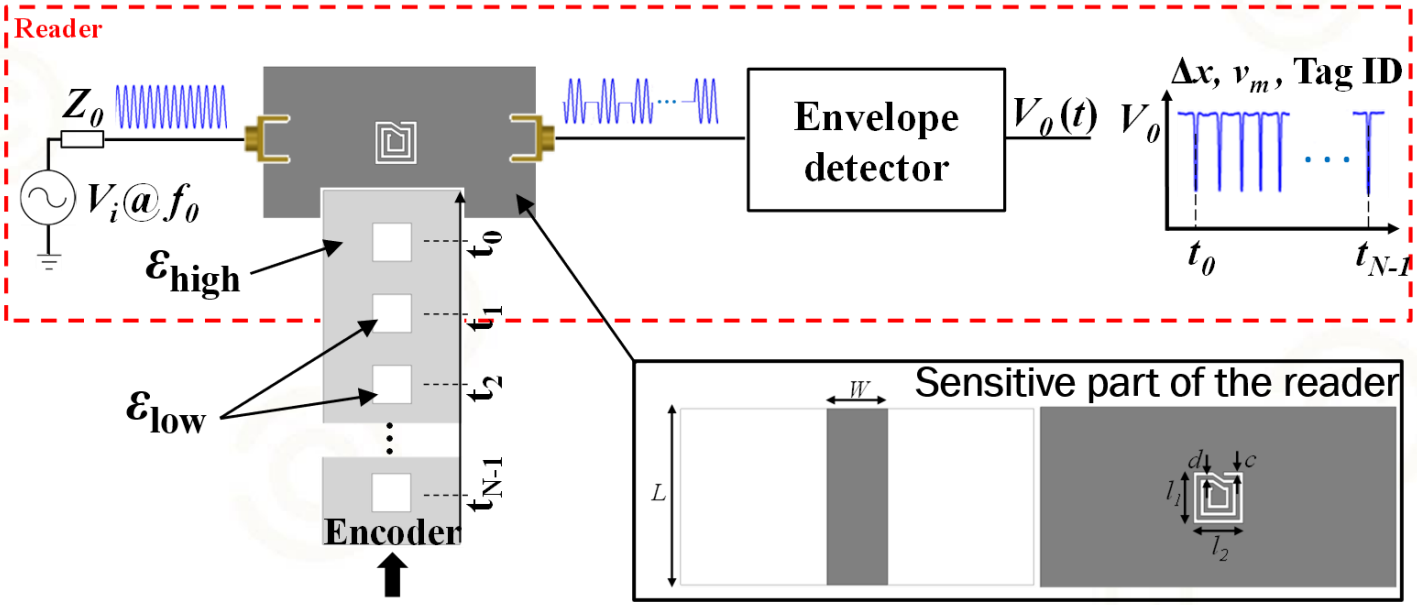
3. Proposed Chipless RFID System

- A time-domain near-field chipless-RFID system with sequential bit reading.
- The encoder consists of a chain of dielectric elements embedded in a host substrate, exhibiting either ε_{high} or ε_{low} .
- The presence/absence of these dielectric embedded inclusions in the chain is used for coding purposes.



3. Proposed Chipless RFID System

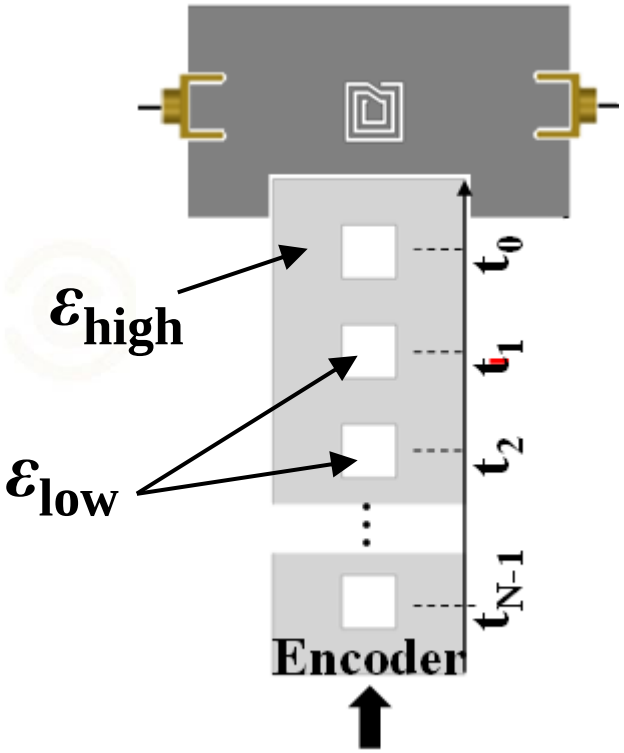
- The working principle of the proposed all-dielectric encoders is permittivity contrast.
- Advantages with regard to previous work:
  - Lower cost (etching or printing processes are not needed).
  - Major robustness against mechanical wearing and aging effects.

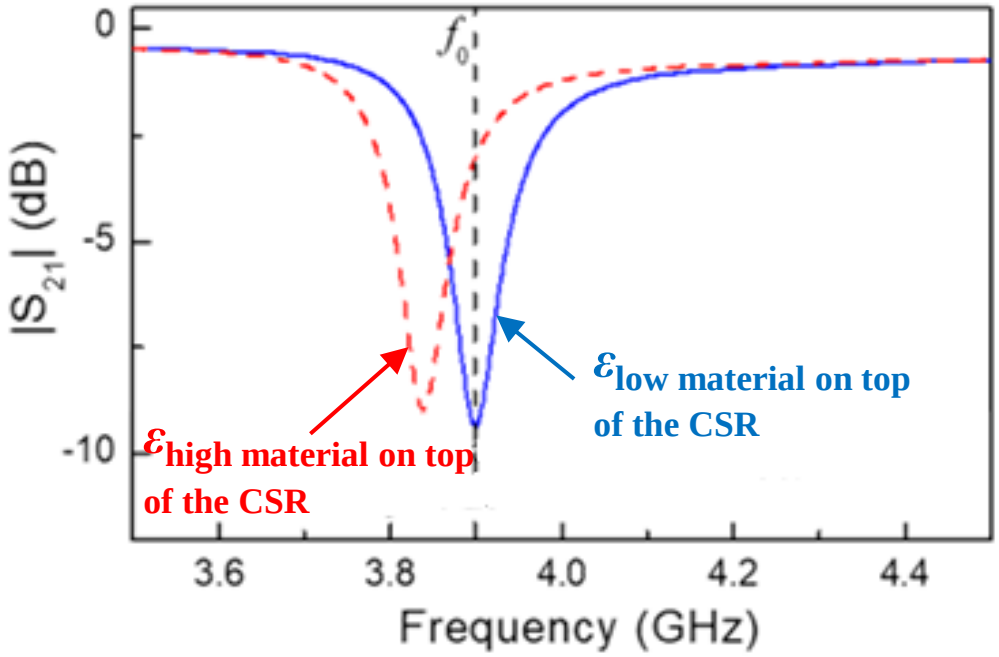


3. Proposed Chipless RFID System

CSR high Q factor and electrically small

System works @ 3.9 GHz





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3. Proposed Chipless RFID system
4. **Fabrication and measurement**
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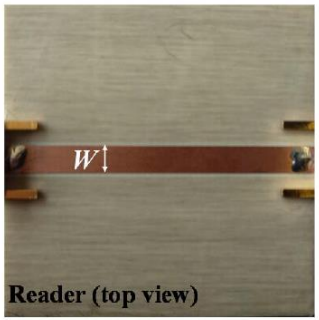
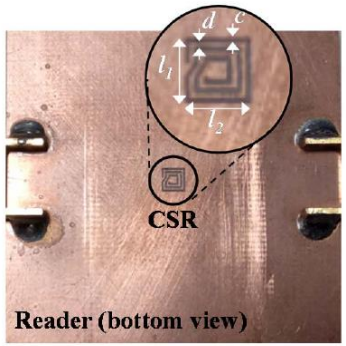
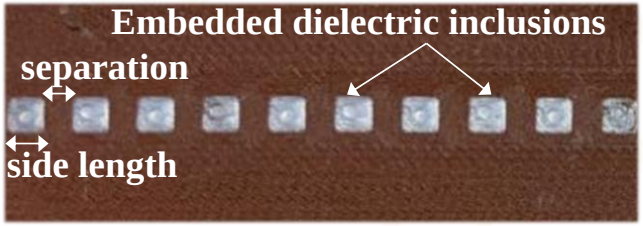
4. Fabrication & Measurement

- Material with high dielectric constant: RS Pro MT-Copper inclusions, $\varepsilon_r = 7,6$
- Material with low dielectric constant: PLA Polylactic acid , $\varepsilon_r = 3$

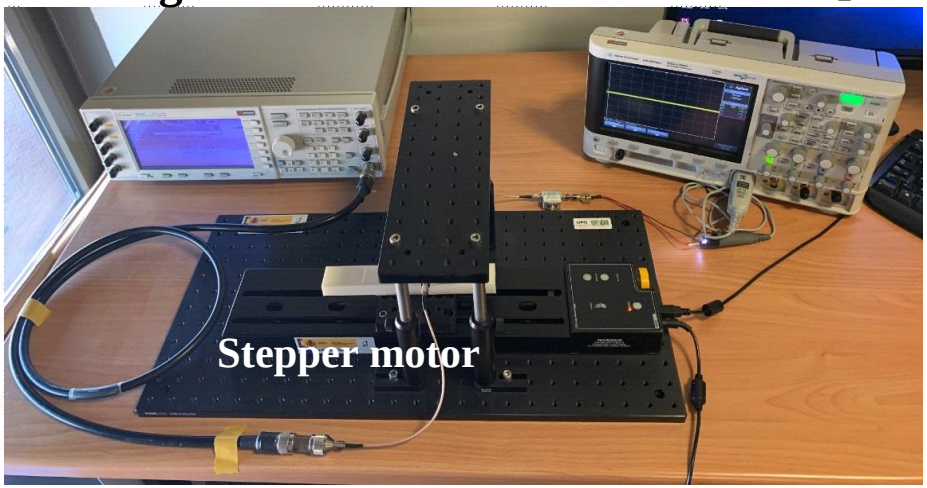






Sign. Generator

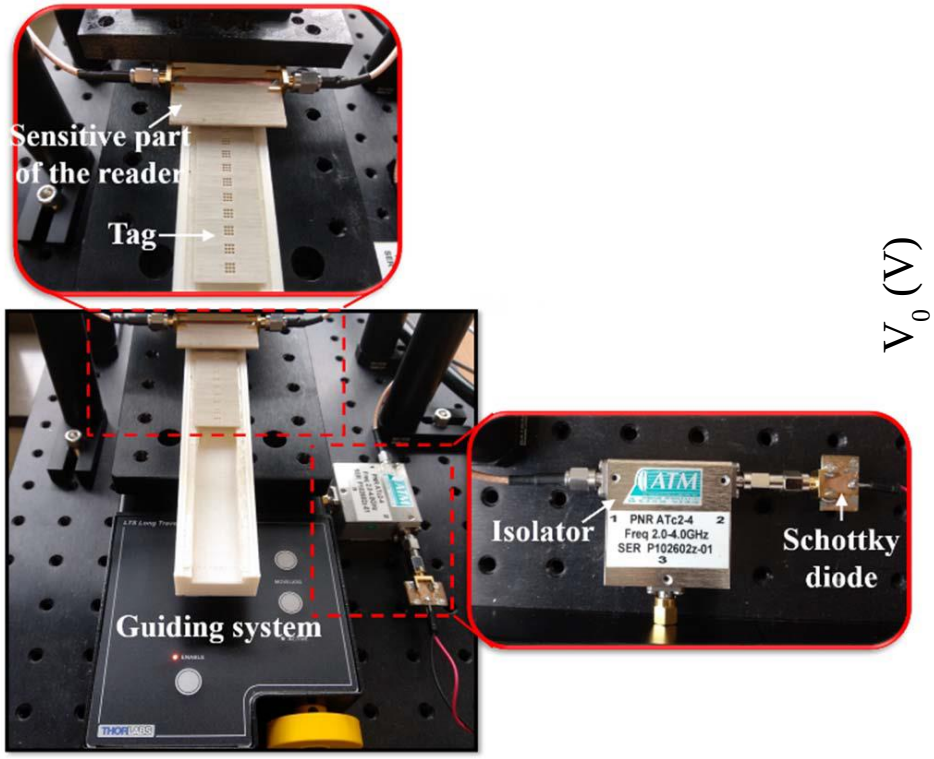
Osciloscope

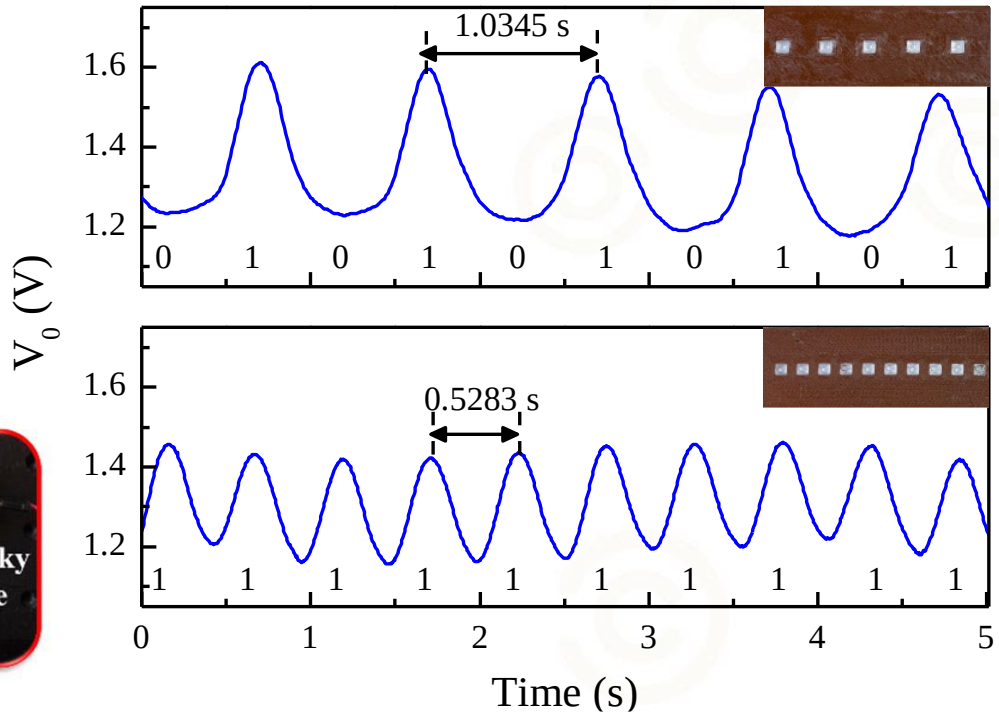


4. Fabrication & Measurement

Encoders based on **embedded dielectric inclusions**

System @ 3.9 GHz

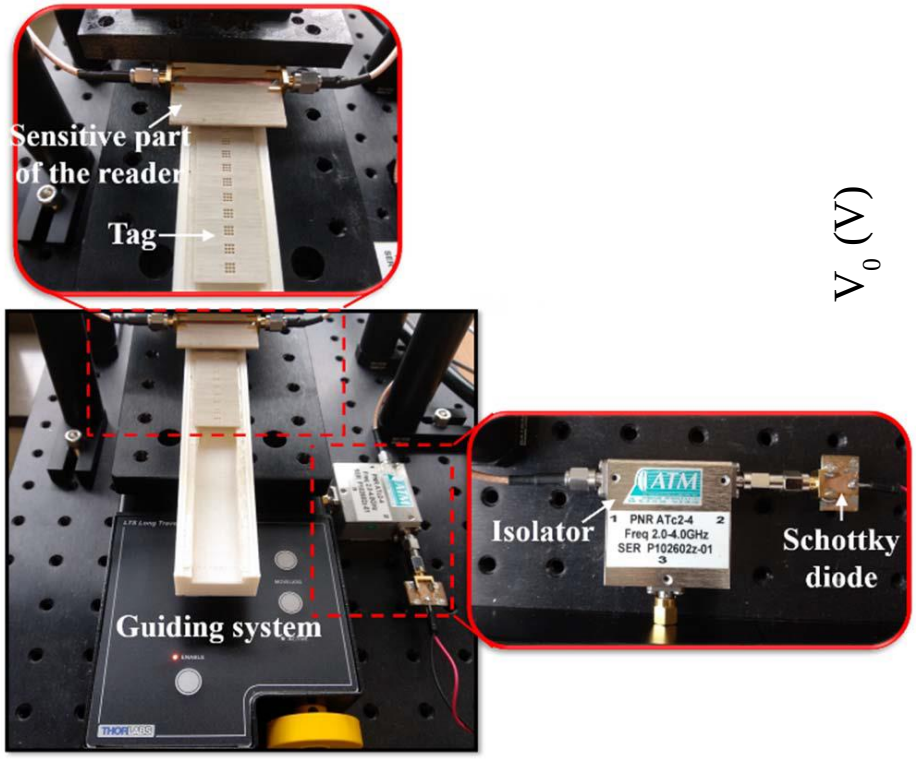


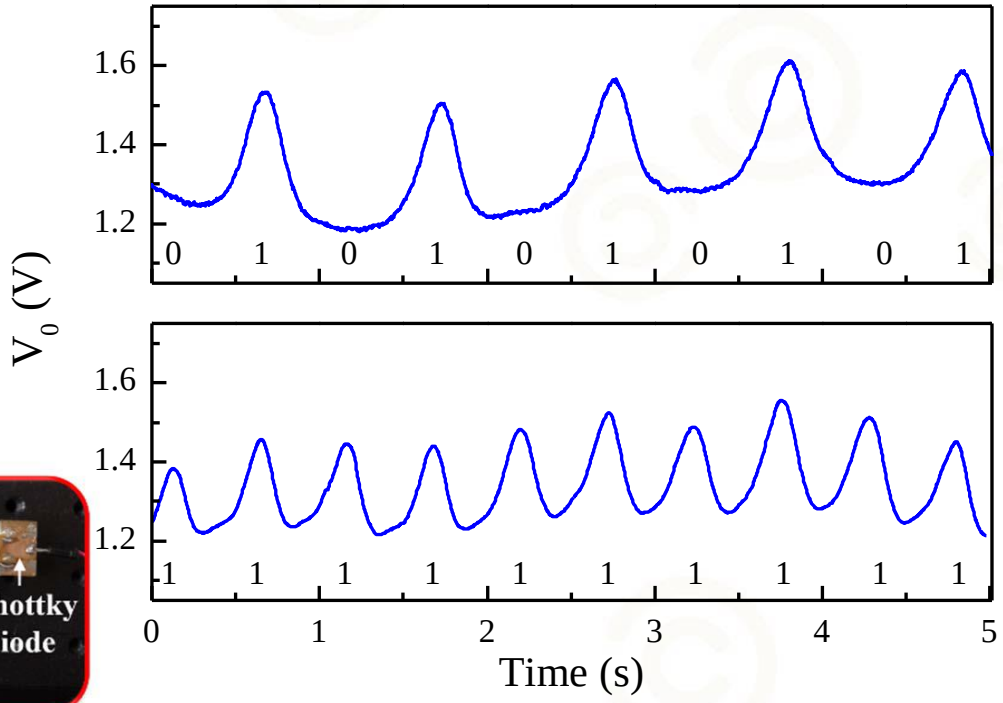


4. Fabrication & Measurement

Encoders based on **buried dielectric inclusions**

System @ 3.9 GHz





Outline

1. Motivation & Objectives
2. Proposed chipless RFID system
3. Tag and reader
4. Reader System & tag reading operation
5. **Conclusions**

5. Conclusions

- An **approach** for the implementation of **chipless RFID systems**, working in time domain and read through **near-field coupling**, has been proposed.

- The **encoders can be used** for **chipless-RFID** tags or as **displacement/velocity measurements**. In both cases, encoder reading is based on **permittivity contrast**.

- The experimental validation, carried out by reading three 10-bit encoders, has revealed that **avoiding the use of metallic resonant elements** in the encoder may represent a **cost reduction in chipless-RFID applications.**

- The **encoders based on buried inclusions offer** high levels of **confidence against copying or spying**, as far as the **inclusions are not visible.**

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Thank you

for your attention

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