



## ANTENNA DESIGN IN AMBIENT BACKSCATTER COMMUNICATIONS FOR IOT APPLICATIONS

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### Abstract

Internet of Things (IoT) is an attractive topic for academia and industries as it can provide a connection network with devices at anytime and anywhere. However, the energy limitation and the cost of implementation and maintenance are considerable challenges in IoT. Ambient Backscatter Communications (AmBC) is a newly emerged paradigm, that is a promising technology to power the IoT devices and transmit information, utilizing the inexpensive and ubiquitous RF signals; consequently, AmBC supports sustainable and independent communication systems.

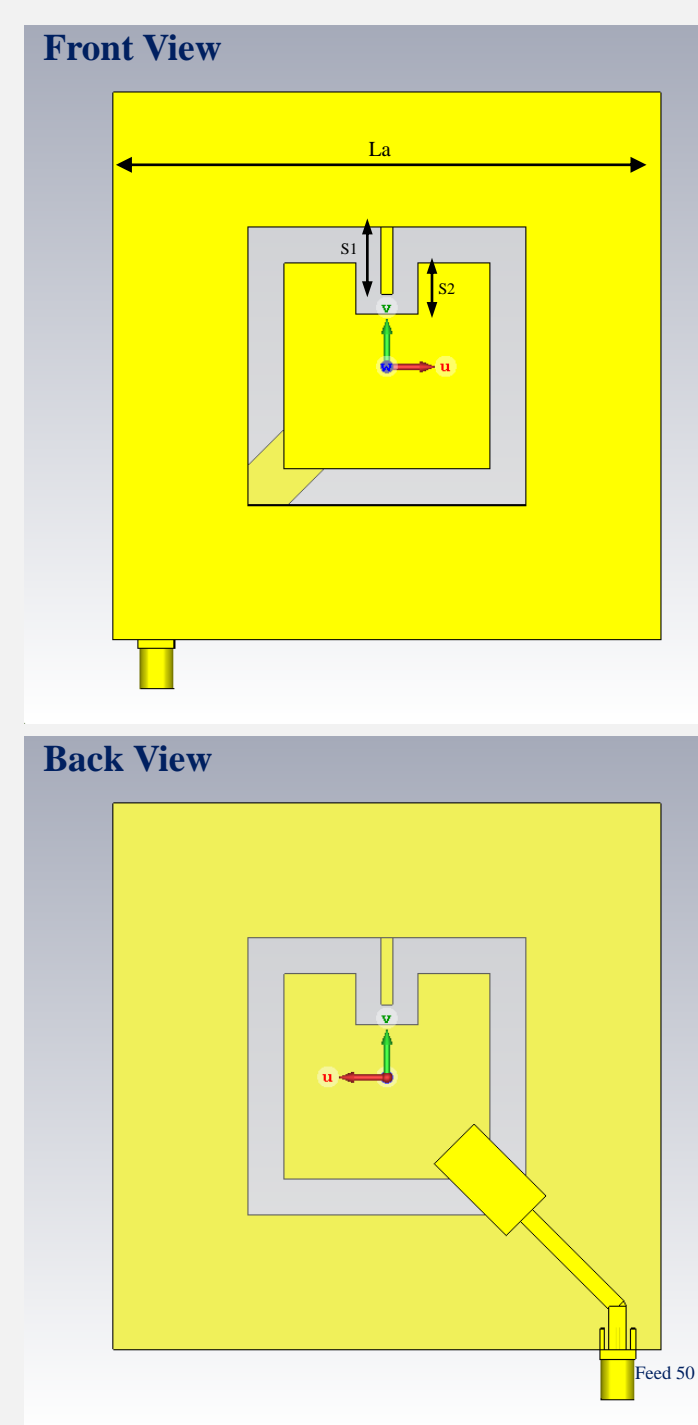
### Ambient Backscatter Configuration

- Ambient Source → TV Tower, Cellular Tower, Wi-Fi Access Point
- Backscatter Transmitter → Battery-Free Tag
- Backscatter Receiver → Battery-Free Tag or Reader

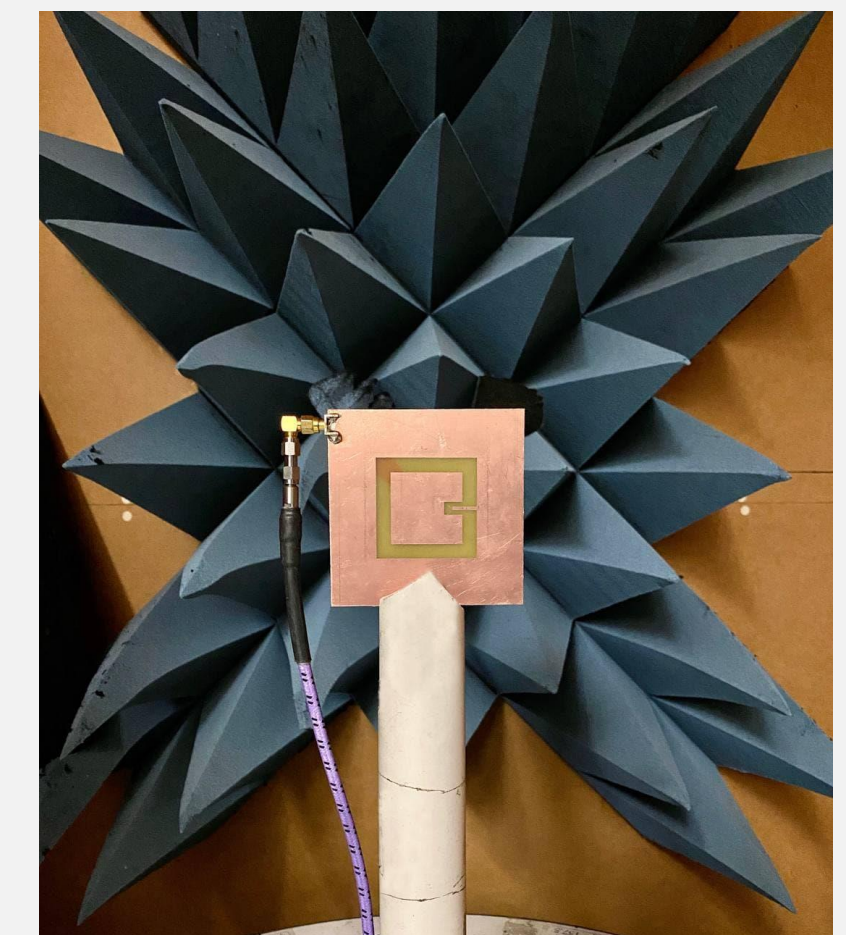


### Antenna Design for Energy Harvesting and Transmitting Purposes

- Circularly polarized antenna
- Operating from 2.40 to 2.63 GHz



	CP Square Ring Slot
Impedance Bandwidth (IBW)	230 MHz
ARBW% over IBW	61.97%
Realized Gain at 2.45 GHz	4.49 dBi
Total Size Antenna (mm <sup>3</sup> )	95.33 × 95.33 × 1.614



### Basic Principles of Ambient Backscatter Communications

The battery-free device:

1. harvests energy from the ambient wireless signals to activate the backscatter transmitter and transmit the information;
2. maps a sequence of digital symbols onto the RF backscattered waveforms at the antenna, by tuning its effective load impedance.

### Modulation and Demodulation

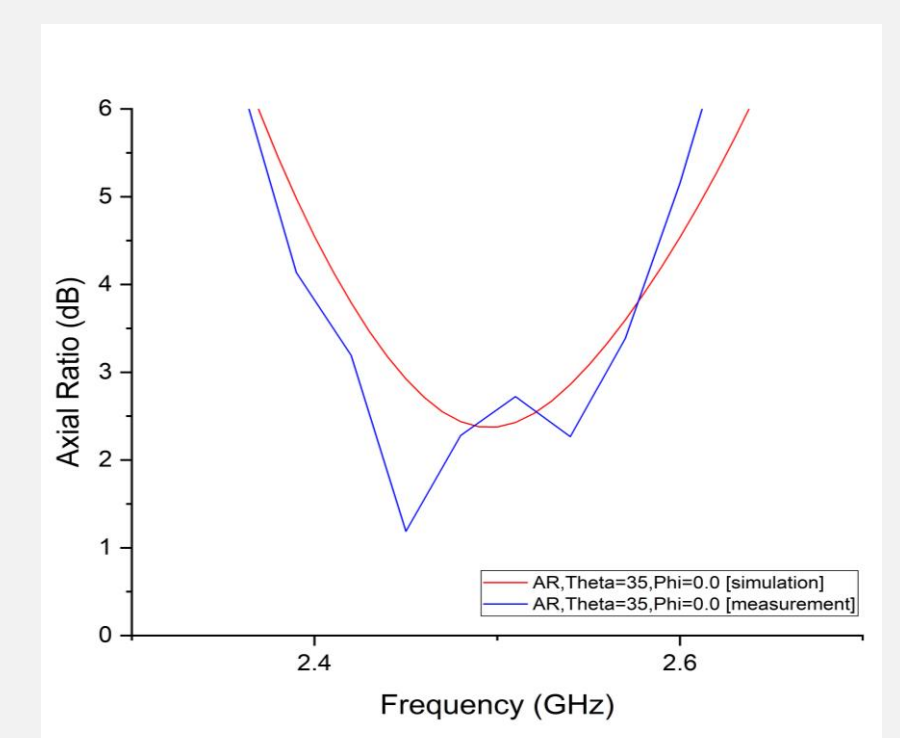
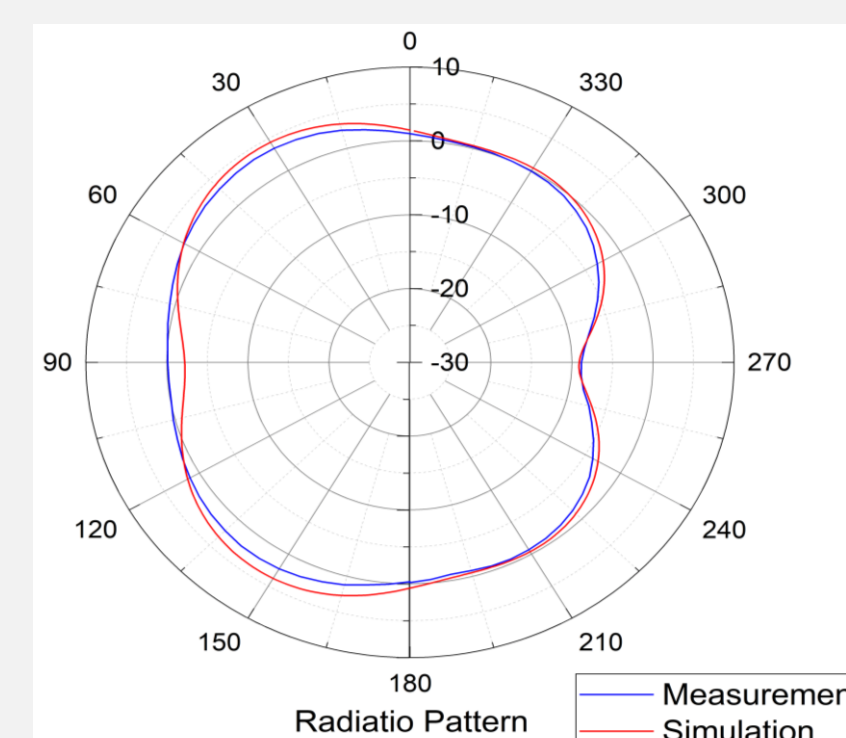
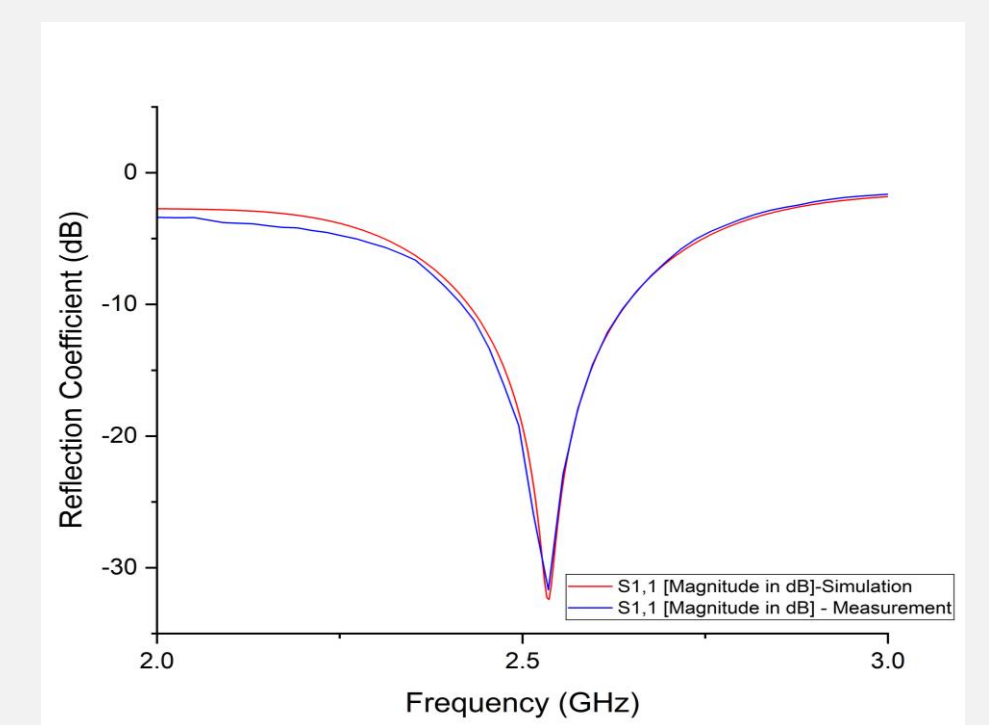
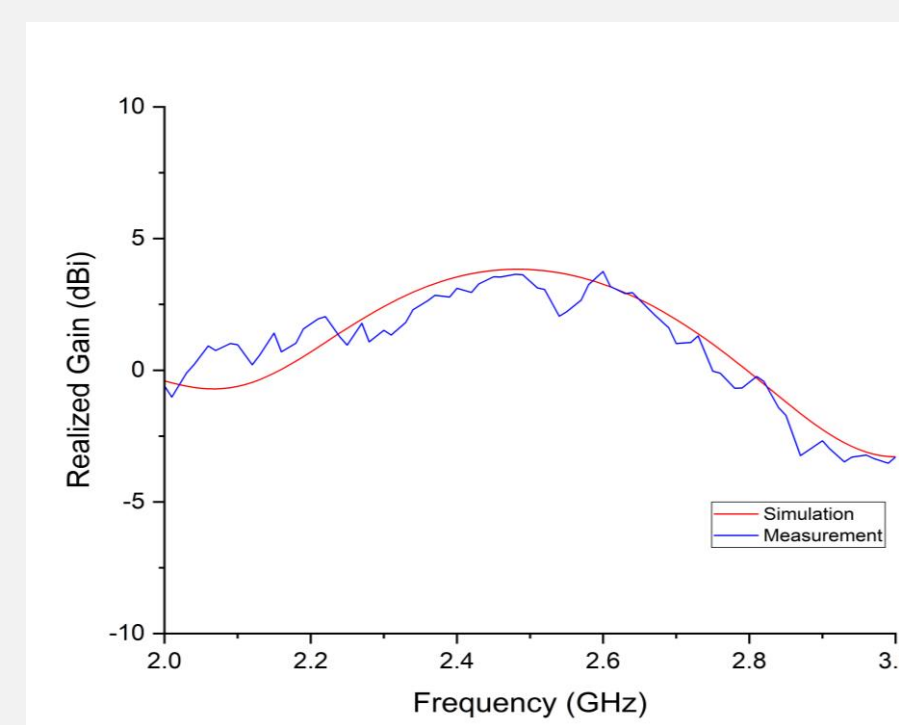
- **Backscatter transmitter** modulates information on the phase or amplitude of the backscattered signal.
- **Backscatter receiver** determines the amplitude or phase variation by applying appropriate demodulation technique.

### Desired Frequency Range for Antenna Design

Ambient backscatter system does not require dedicated spectrum resources to operate, however, the most common desirable frequency bands, used in IoT networks, are:

- 2.45, 5.2, 5.4, and 5.8 GHz from WLAN resources;
- 900 MHz and 1.8, 2.1, 2.6 GHz from cellular resources.

### Simulation and Measurement Results



### References

- [1] Liu, A. Parks, V. Talla, S. Gollakota, D. Wetherall, and J. R. Smith, "Ambient backscatter: wireless communication out of thin air," in *Proceedings of the ACM SIGCOMM 2013 conference*, p. 39, Hong Kong, China, August 2013.
- [2] K. L. Wong, C. C. Huang and W. S. Chen, "Printed ring slot antenna for circular polarization", *IEEE Trans. Antennas Propag.*, vol. 50, pp. 75-77, Jan. 2002.