PriMera Scientific Engineering
Volume 1 Issue 3 December 2022
DOI: 10.56831/PSEN-01-018
ISSN: 2834-2550

# Ku band metamaterial absorber for stealth applications against Radar and Military Satcom

**Type:** Review Article
**Received:** November 11, 2022
**Published:** November 28, 2022

**Citation:**
Vani Sadadiwala., et al. "Ku band metamaterial absorber for stealth applications against Radar and Military Satcom". PriMera Scientific Engineering 1.3 (2022): 46-48.



**Vani Sadadiwala[1]*, Vimlesh Singh[2] and Devender Sharma[1]**

[1]*Department of Aeronautical Engineering, MRIIRS, Faridabad, India*

[2]*Department of Electronics and Communication Engineering, MRIRRS, Faridabad, India*

***Corresponding Author:** Vani Sadadiwala, Department of Aeronautical Engineering, MRIIRS, Faridabad, India.

## Abstract

This paper suggests a Ku band metamaterial absorber simulation using CST Microwave Studio Software at a frequency ranging from 12-18 GHz [2]. The work proposes a design which has a square based ground Metamaterial Absorber (MA). The overall measurement of the unit cell assembly is 5* 5 mm^2. This assembly covers the Ku band which gives a wideband of absorption [1]. The optimization of structure is achieved at 13.3 GHz and 14.9 GHz respectively. The designed metamaterial absorber serves in stealth technologies. The major applications also include airborne surveillance and military protection.

***Keywords:*** Metamaterial; absorber; stealth; aircrafts; surveillance

## Introduction

Metamaterials are the type of materials having the properties not seen in naturally occurring materials. Metamaterials help us in obtaining negative permittivity, permeability from the unit cell assembly [1]. Nowadays, metamaterials are in high demand due to their significant characteristics such as negative index of refraction, stealth technology, sensors, radar cross sections, cloaking techniques. Some of the metamaterials have unpreventable energy losses which influence the performance in a bad way [2]. Generally, there are 3 surfaces of metamaterial. The substrate allows the flow of current in a circulating manner which is magnetically excited. The properties of the assembly varies with the electromagnetic field concurrently. This change in properties affects the permittivity and permeability to be unity as some given frequencies [1]. Microwave band is achieved by absorbers which are used in stealth applications, military, decreasing noise intrusion in radars. The development of faultless metamaterial absorber is captivating at terahertz control where natural materials are not available for the security purpose, at airports, for imaging etc [2]. Due to their qualities of being ultrathin, quick and easy fabrication, ideal absorption makes them more valuable than the electromagnetic absorbers [4]. The metamaterial absorbers have electric resonators on one side and metal on the back side. This electric resonator helps in electric resonance and coupling between the upper and lower layers which produces magnetic resonance [5]. In stealth technologies, the metamaterial absorbers also known as radar absorbers are widely used to reduce the radar cross sectional area of the identifying object/structure. These structures have lossy substrate ground surface on one side and patch layer on the next side. As mentioned earlier, the functioning is based on the resonance but there are chances of narrow bandwidths but can be solved using optimisers. The main goal is to design a metamaterial radar absorber which is thin and wideband and easy to produce [6]. Although the thin absorbers can reach to the absorption of nearly unity but still are of narrow/shallow bandwidth as they are produced with the help of resonance. To intensify the bandwidth, an alternative can be used i.e amalgamating two or more resonant structures to build a whole new resonant structure which intensifies bandwidth. The drawback of this alternative is that the size of the structure becomes so large after amalgamation. Also, many other alternatives are used i.e layers can be fixed one on another but leads to increase in thickness, also fabrication issues arise looking into the lumped registers concept [1]. This paper presents a metamaterial absorber summed up using FR-4 lossy as a substrate and Copper pure as ground and the patch. The main goal of this paper is to achieve wide band, low cost and easy fabrication and to catch the frequencies of Ku band to fulfil the criteria of absorbing, stealth and protection at the odds with airborne military radar platform and ground-based platform.

***Design of the metamaterial absorber***

In this paper, a design is proposed which catches Ku band frequencies and ensure polarisation. The metamaterial structure consists of three layers (Ground, Substrate, Patch) having different materials. The ground and patch are made up of copper which is in pure form. Copper is used due to its high electrical resistivity, easy availability and low cost. FR-4 (lossy) is used to generate substrate. FR-4 (lossy) gives good response in humid and dry conditions. To intensify the band-width it becomes mandatory to used lossy materials. Multilayering the different materials gives good quality of power. Certain shapes like circles, rings and rectangles/squares give better enhanced results [2].

***The dimensions of the designed absorber are as under***

| ***Sr. No*** | ***Dimensions*** | ***Description*** |
|---|---|---|
| 1. | 10 mm | Length of substrate |
| 2. | 1.6 mm | Height of substrate |
| 3. | 0.038 mm | Thickness of ground |
| 4. | 4 * 3.5 mm | Rect 1,2 |
| 5. | 0.8 mm | Big circles |
| 6. | 0.6 mm | Small circles |

***Table 1:*** Dimensions of the designed absorber.

This structure becomes useful in obtaining negative permeability and permittivity. Two types of materials are combined in order to achieve the quality of a metamaterial which is not generally obtained naturally.

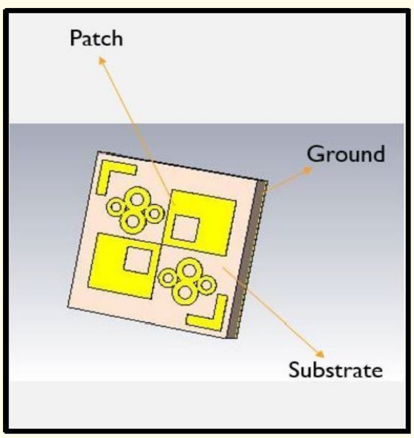


***Figure 1:*** Layers of the designed structure.

The design proposed is simulated using CST studio suite under the frequency range of 12-18 GHz. The following process includes extraction of S-parameters for the simulated and analysed model.

## Observations

On increasing the thickness, the absorptivity rate increases. The best thickness of the model observed is 1.6mm which gives the results at 13.3 GHz and 14.8 GHz respectively. The curve obtained is below -10 dB. The initial depth of the curve resembles the good percent of absorptivity rate.

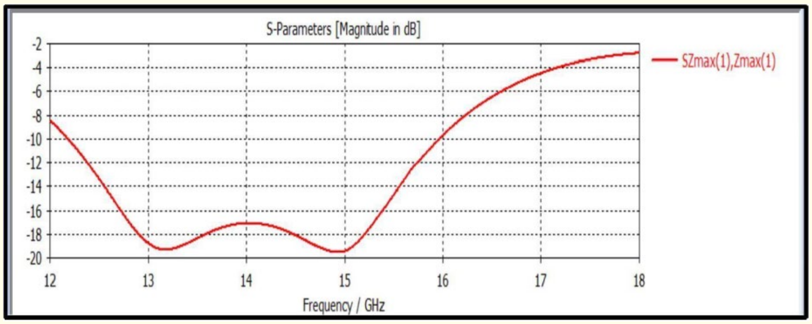


***Figure 2:*** S-parameters of the analysed model.

## Conclusion

We have proposed a design which works under 12-18 GHz frequency range. The main aim to achieve wide-band is achieved while extracting S-parameters. This type of model is useful for applications in military and defence. The metamaterial absorber of Ku and Ka band is also used in indoor radars, airborne surveillance and absorption. The designed structure is optimised at 13.3 GHz and 14.8 GHz frequencies lying under Ku band region. The materials used are of low cost which overall initiates a low cost fabrication process.

## References

1. Barde C, Choubey A and Sinha R. "Wide band metamaterial absorber for Ku and K band applications". Journal of Applied Physics 126 (2019): 175104.
2. Khaleed S. "Multi Band Metamaterials Absorber for Stealth Applications". Law, State and Telecommunications Review 11.1 (2019).
3. Sahai J and Tiwari G. "A metamaterial based I-shaped frequency selective surface for band pass and band stop applications". 2020 International Conference on Computer Communication and Informatics (ICCCI) (2020).
4. Sood D and Tripathi C. "A Compact Ultrathin Ultra-wideband Metamaterial Microwave Absorber". Journal of Microwaves, Opto-electronics and Electromagnetic Applications (2017).
5. Dhillon A, Mittal D and Bargota R. "Triple band ultrathin polarization insensitive metamaterial absorber for defense, explosive detection and airborne radar applications". Microwave and Optical Technology Letters 61.1 (2019).