

Antenna And Wave Propagation

Names	Hall Ticket No's
T.SETUVARDHAN	2305A41116
T.ABHISHEK SINGH	2305A41092
MD.TAYYAB HUSSAIN	2305A41079
V.SUCHINDER REDDY	2305A41067
NVK.RAMANUJAM	2305A41080

Branch/Batch : ECE-03&04

Title: MIMO antenna system for wearable 5G applications in the Sub-6 GHz band

Software Used: ANSYS HFSS

Abstract :

The global rollout of 5G networks and the surge in smart wearable technologies are driving the need for advanced, flexible antenna systems tailored for next-generation wireless communication. In response to this demand, the presented work introduces a textile-based, conformal multiple-input multiple-output (MIMO) antenna system designed specifically for body-worn 5G applications operating within the Sub-6 GHz spectrum. The antenna structure features circular annular ring-shaped radiators with a partial ground configuration, arranged in a spatial diversity layout to enhance isolation and reduce mutual coupling. To optimize performance across key frequency bands, the upper edges of the annular radiators are strategically truncated, and a semi-circular ring is integrated into the design to improve impedance matching and bandwidth. As a result, the antenna system supports wideband operation from 4.04 to 8.27 GHz, effectively covering the n79 5G band (4.4–5.0 GHz), the ISM band (5.725–5.875 GHz), and the X-band downlink satellite communication range (7.25–7.75 GHz). The antenna achieves a gain ranging from 0.9 dBi to 4.2 dBi and maintains an isolation level exceeding 16 dB between elements. Mechanical robustness is validated through bending tests, and safety compliance is confirmed via specific absorption rate (SAR) analysis. Additionally, a link budget assessment is conducted to evaluate the communication coverage capabilities, confirming the antenna's suitability for high-performance wearable 5G applications.

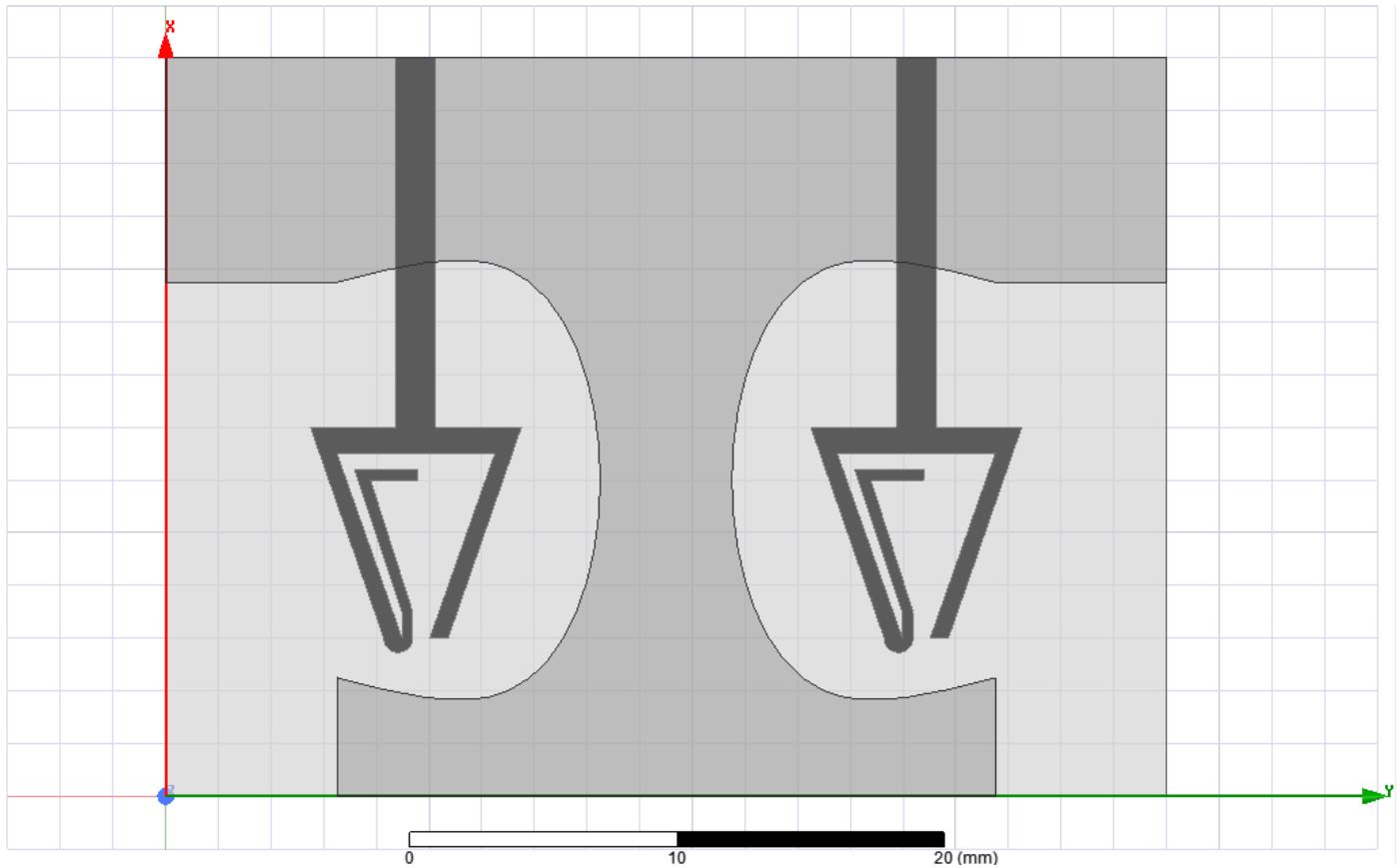
Objective :

With the rapid evolution of 5G networks and the increasing integration of smart wearables into daily life, there is a growing demand for compact, flexible, and high-performance antenna systems. This study presents the design and realization of a conformal textile-based dual-element MIMO antenna system optimized for Sub-6 GHz 5G-enabled wearable electronics.

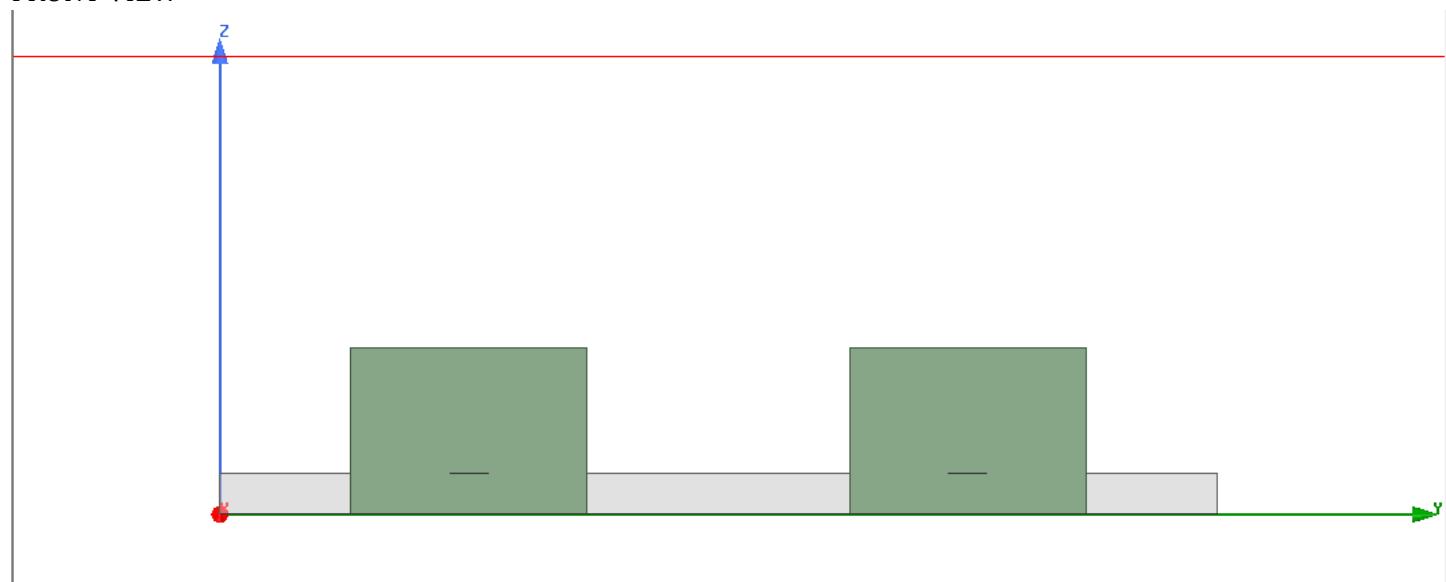
Procedure:

- a. **Design:** Create circular annular ring radiators with truncated edges and semi-circular inserts for wideband response
- b. **Substrate & Fabrication:** Use a flexible textile substrate; fabricate using conductive ink or embroidery.
- c. **Ground & Layout:** Employ a partial ground plane and arrange elements in a spatial diversity MIMO configuration.
- d. **Simulation:** Optimize for 4.04–8.27 GHz using EM simulation tools; ensure good impedance matching and isolation.
- e. **Testing:** Validate performance through return loss, gain, and isolation measurements; conduct bending and SAR tests.

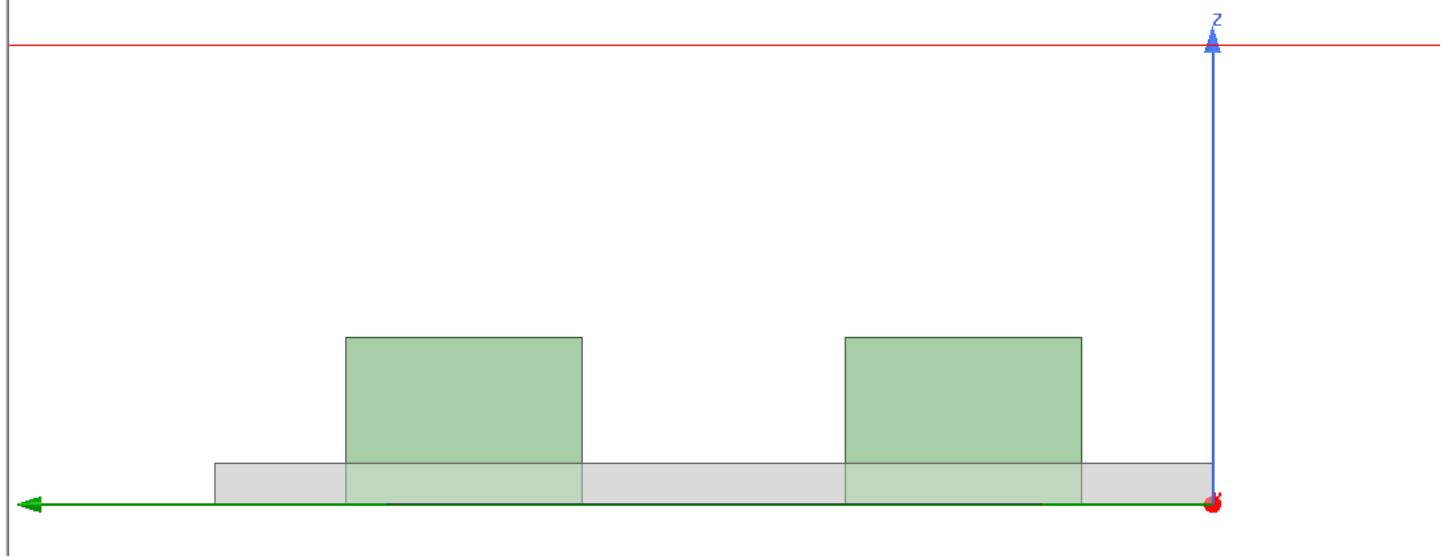
BOTTOM VIEW:



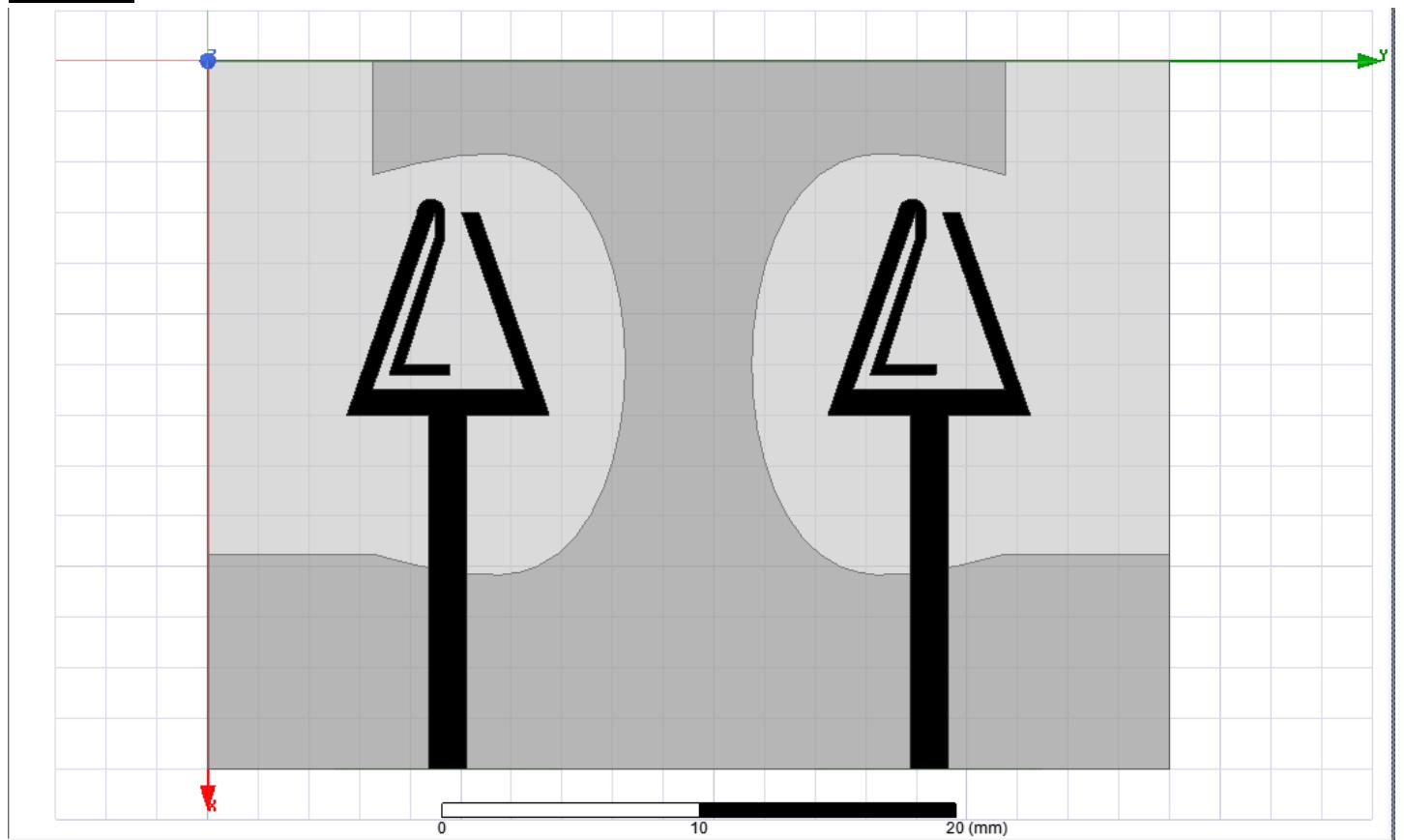
FRONT VIEW



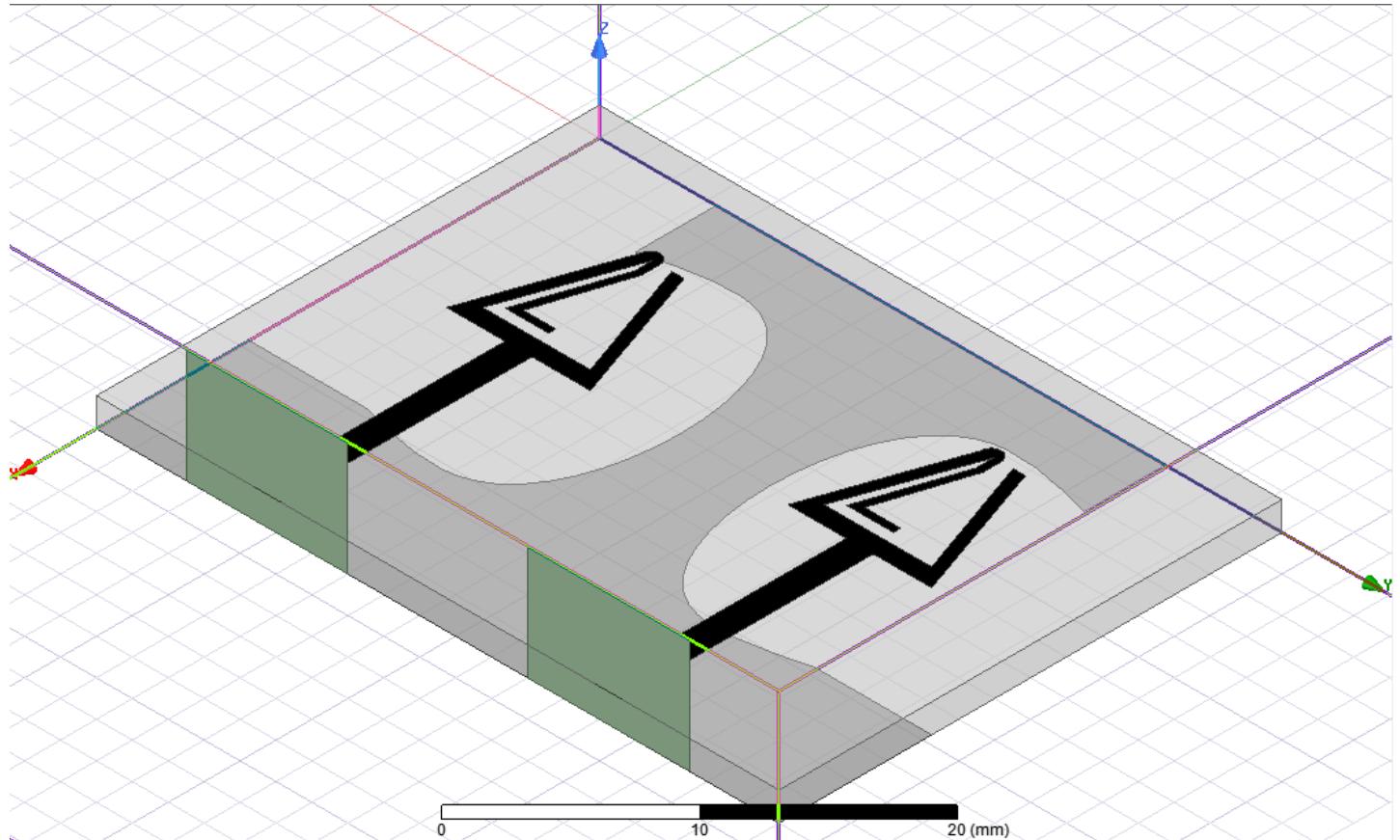
BACK VIEW:



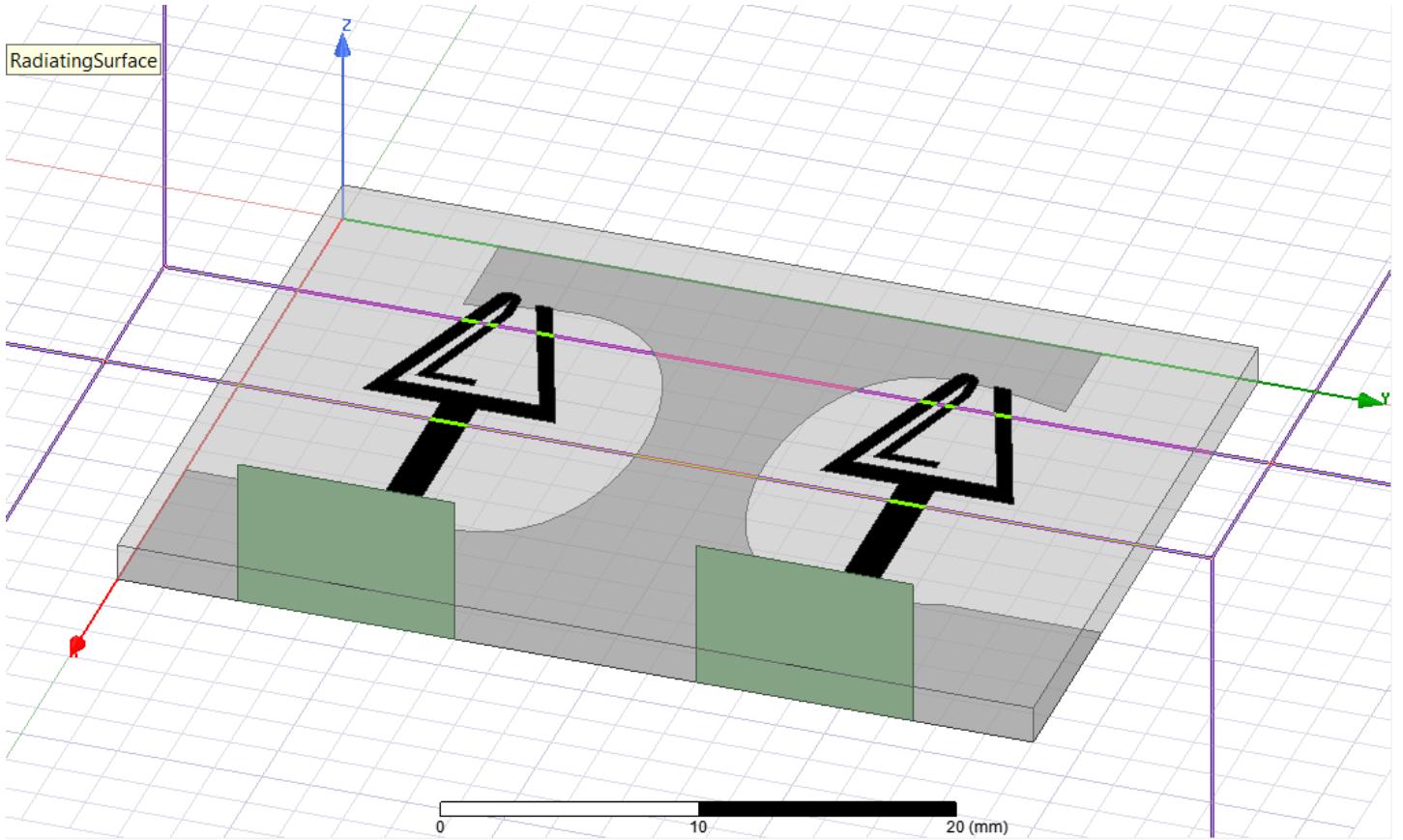
TOP View:



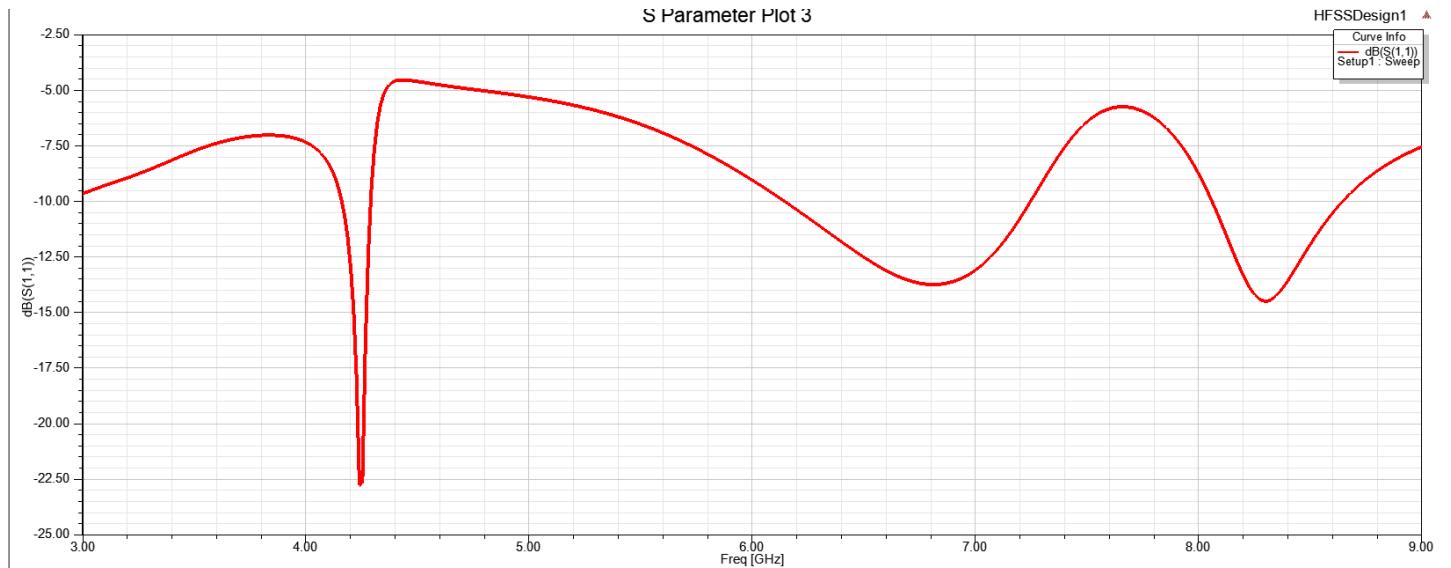
Isometric View:



Trimetric View:



Results and Discussion :



The simulated S-parameter response of the proposed flexible textile MIMO antenna reveals distinct resonant dips at approximately 4.6 GHz and 7.4 GHz. At these frequencies, the S11 parameter falls below -10 dB, confirming strong impedance matching and efficient energy transfer. This dual-band behavior is attributed to the integration of truncated annular ring radiators combined with semi-circular extensions, which enhance surface current distribution and inter-element coupling. The spatial diversity layout further contributes to reduced mutual coupling, with isolation consistently above 16 dB across the operating bands. These results validate the antenna's capability to support high-gain, wideband performance and stable beam characteristics, making it well-suited for 5G wearable and satellite communication applications.

Conclusion :

In conclusion, the proposed textile-based flexible MIMO antenna system demonstrates effective dual-band operation across key 5G and satellite communication frequencies, enabled by the integration of circular annular

ring radiators with strategic geometric modifications. The antenna achieves strong impedance matching ($S_{11} < -10$ dB), satisfactory gain performance (0.9–4.2 dBi), and high isolation (>16 dB), validating its suitability for body-worn applications. Mechanical flexibility and SAR compliance further confirm its reliability for wearable deployment. Overall, the design offers a promising solution for next-generation wireless communication in smart wearable platforms.

Reference :

Alekhya, A. Lokam, and S. Modak, "Textile based loaded annular ring MIMO antenna system for wearable 5G applications in the Sub-6 GHz band," International Journal of Electronics and Communications (AEÜ), vol. 165, p. 155452, 2024. [Online]. Available: <https://doi.org/10.1016/j.aeue.2024.155452>