IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

WIDEBAND PATCH ANTENNA ARRAY FOR GNSS APPLICATIONS

[1]Dr.S.Aruna, [2]G.Greeshma, [3]P.Navya Sri, [4]L.Gnanamrutha, [5]P.Sravani, [6]V.Sumanjali,

[1] Head of the department, [2,3,4,5,6] UG Students

Electronics And Communication Engineering (ECE)

Andhra University College of Engineering for Women (AUCEW), Visakhapatnam, Andhra Pradesh, India

Abstract: Signals from the Global Navigation Satellite System (GNSS) are susceptible to manipulation since they are relatively weak once they reach the earth's surface. As a result, signal jamming and spoofing have an impact on fixed site sites such as military bases, government buildings, and other areas. Due to its ability to counter possible jamming and spoofing, Global Navigation Satellite System (GNSS) anti-jamming systems have recently received a lot of attention.

So, a compact, wideband, antenna Array that has high isolation and low mutual coupling is needed for GNSS antijamming applications. Five identical Right Hand Circularly Polarized (RHCP) single feed rectangular patch antennas make up the array. The proposed antenna array is designed in CST STUDIO SUITE. The proposed array maintains an excellent mutual coupling performance of < -25dB while offering a wide frequency bandwidth of 250MHZ (1.5-1.75GHZ). A return loss of -32.7274dB is achieved which provides good impedance matching.

***Index Terms* - GNSS services, anti-jamming, RHCP, compact antenna, low mutual coupling.**

I. INTRODUCTION

GNSS technology is currently advancing quickly. GNSS is essential to the smooth operation of vital infrastructure, including military operations, financial systems, land surveys, and communication networks. Due to the fact that GNSS signals are fragile and readily jammed, it is not very difficult to interfere with or jam them. A jammer can use other RF frequencies to overwhelm considerably weaker GNSS signals, preventing the GNSS receiver from functioning. Location and timing services can still function even when under assault because of GNSS anti jamming system's ability to discriminate between actual signals and jammers. Anti-jam systems for the Global Navigation Satellite System (GNSS) have drawn a lot of attention, mostly because of their capacity to counter possible spoofing, interference, and jamming.

RHCP antennas are used by GNSS systems because they have a number of benefits, including resistance to Faraday's rotation and reduced multipath propagation losses. In contrast to linearly polarized antennas, circularly polarized antennas are unaffected by transmitter or receiver orientation and are less susceptible to the effects of propagation. The circularly polarized antenna reduces signal issues such as phase shifts, multipath effects, fading, and distortions as the signal reaches the ionosphere. Circular polarization features are used by the majority of radar systems, communication systems, navigation systems, global positioning systems, and mobile applications. This project aims for a wideband patch antenna array with circular polarization properties for GNSS applications.

The conciseness of the GNSS antenna array is veritably critical for movable platforms and mobile outstations. The main challenge in designing a compact GNSS anti-jam antenna array system is the demand of maintaining a wide impedance bandwidth and at the same time keeping the collective coupling between different antenna rudiments to a minimal position.

II. SINGLE ANTENNA ELEMENT

Figure 1 depicts the proposed single antenna's configuration. The dielectric substrate Rogers TMM10i with the following properties: (ε_r = 9.8, tanδ = 0.002) is deployed . For attaining the necessary bandwidth, a standard thickness of 5.08 mm is considered. The size of each patch antenna element is 32 × 32 × 5.08 mm^3, and the patch element is square in shape with truncated opposite corners as illustrated in Figure 1 to achieve the right circular polarization. Finally, coaxial feeding methods are used to feed the antennas.

Using a probe, microstrip antennas may also be supplied from bottom. The coaxial cable's centre conductor is stretched up to the patch antenna, while the outside conductor is attached to the ground plane.

To modify the input impedance, the feed's location can be changed as in a similar fashion as the inset feed.

If the height of the substrate becomes significant (a considerable fraction of a wavelength), the coaxial feed adds an inductance into the feed that may need to be taken into consideration. The probe will also radiate, which might result in radiation coming from unfavourable angles.

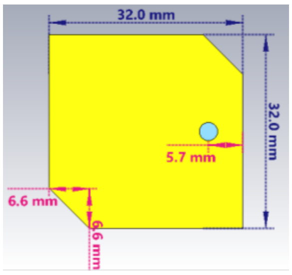

Figure 1. Design Geometry of Single Antenna Element

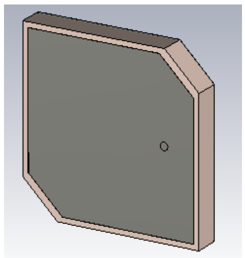

Figure 2. Top view of Single Antenna Element

III. ARRAY DESIGN

The sequentially rotated design is used in the proposed five-element antenna array. With linearly polarized antenna elements, circular polarization has been achieved in this design. Here, a ground plane composed of aluminum plate with a diameter of 123 mm and a thickness of 1.5 mm is employed. The ports are fed using coaxial feeding while the antenna components are successively rotated ($P_1=0^0$, $P_2=90^0$, $P_3=180^0$, $P_4=270^0$) in order to achieve RHCP gain antenna without any nulls. Mutual coupling is thereafter reduced. An MT-30 microwave absorber with a 123 mm diameter and 9.525 mm (H) thickness is included in order to further limit mutual coupling. Here, the MT-30 (ε_r = 15.79, tanδ = 1.944) absorber is chosen for incorporation due to its light weight and low cost as compared to other absorbers.

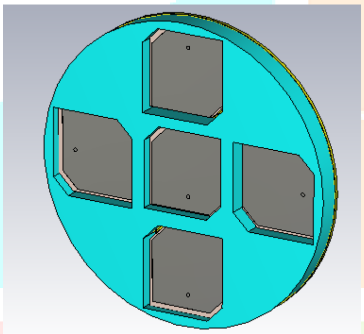

Figure 3. Top view of the proposed Antenna

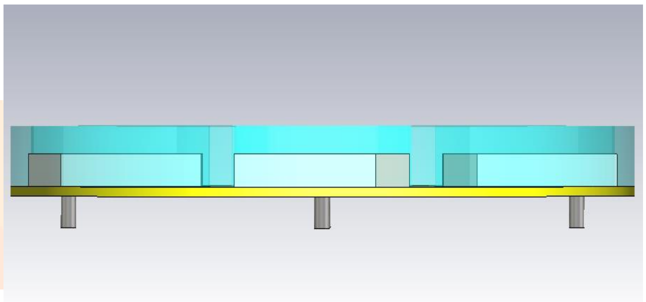

Figure 4. Bottom view of the proposed Antenna

3.1 DESIGN PARAMETERS

Parameter	Value (mm)
D	123
s1	32
g	1.5
d1	6.6
f	5.7
t	5.08
H	9.525
t1	1.5
Outer diameter	2.5
Inner diameter	1.5

D - Diameter of absorber
s1 - length and width of substrate
g - gap between the patch elements and the microwave absorber
d1 - length of the truncated corners
f - feed point
t - thickness of substrate
H - height of the microwave absorber
t1 - thickness of aluminum ground

IV. RESULTS AND DISCUSSION

4.1 SINGLE ANTENNA RESULTS:

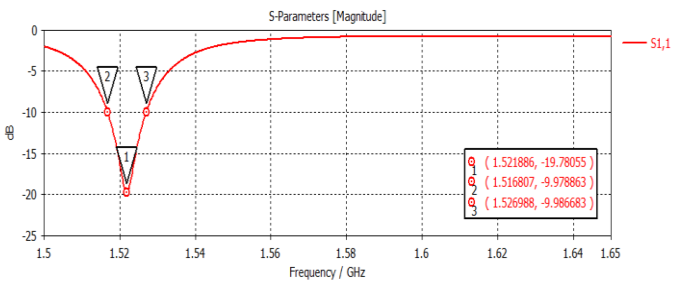

Figure 5: Return loss S_{11}

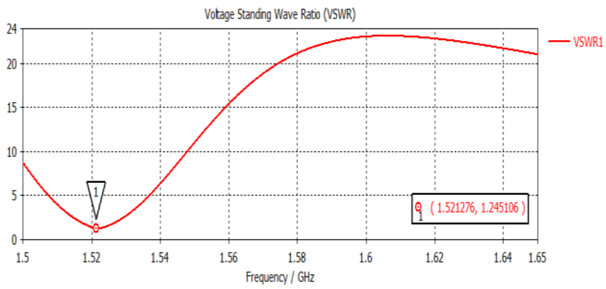

Figure 6: VSWR

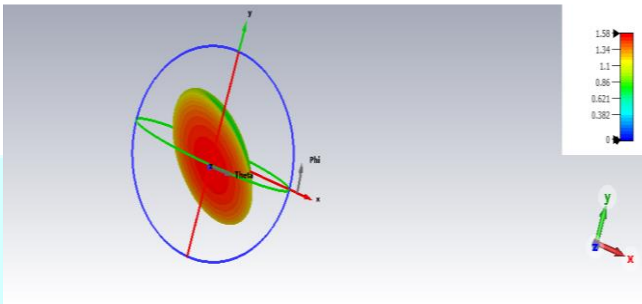

Figure 7: Gain obtained

4.2 PROPOSED ANTENNA ARRAY RESULTS :

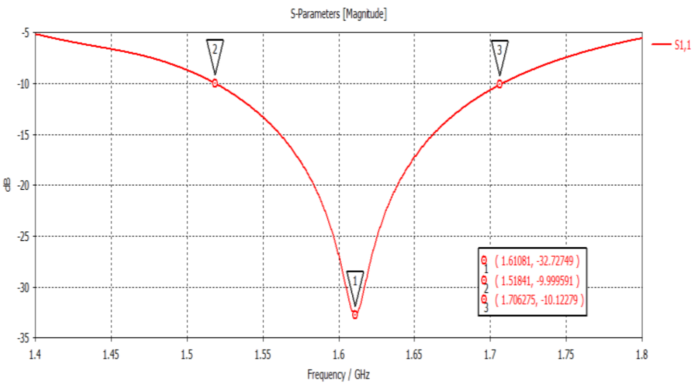

Figure 8: Return Loss S_{11}

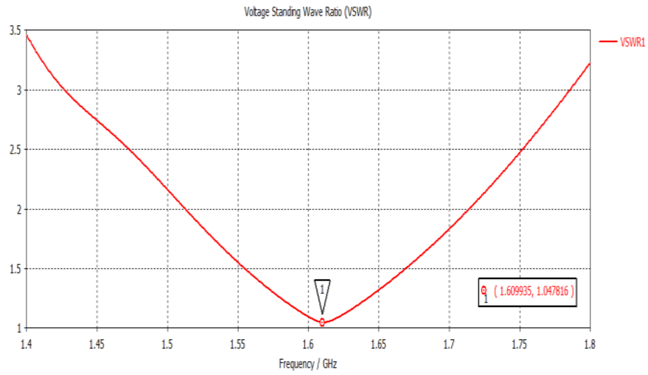

Figure 9: VSWR obtained

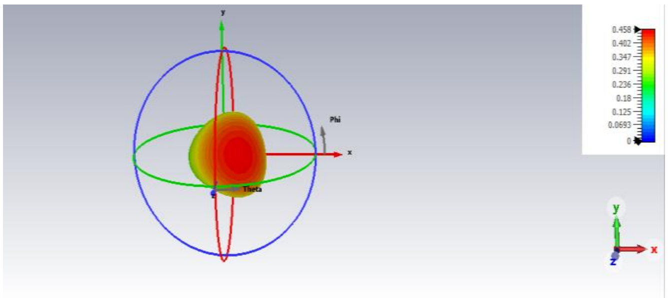

Figure 10: Gain obtained

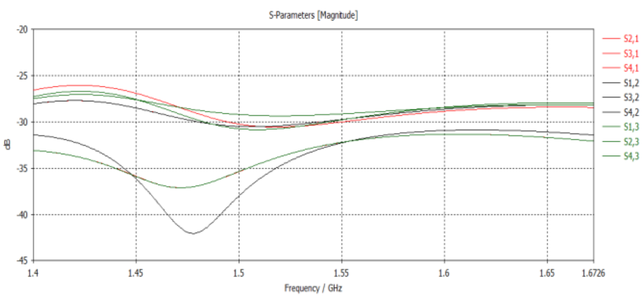

Figure 11: Mutual Coupling

Figure 8 depicts the proposed antenna's reflection factor or return loss [S11] in dB. The reflection factor at the feed point, where the microstrip patch antenna's input was applied, is provided in S11. It has to be lower than -10dB in order to operate properly. It demonstrates that the resonance frequency of the proposed antenna is 1.61 GHz.

At this resonant frequency, the reflection coefficient was measured to be -32.7274 dB. A good match is achieved since the obtained return loss is substantially lower than -10dB.

The gain and mutual coupling of the antenna tend to decrease as the thickness of the microwave absorber (H) increases.
Gain and mutual coupling rise with an increase in the gap (g) between the patch elements and the microwave absorber.
The proposed antenna's mutual coupling tends to be reduced as a result of the impact of the microwave absorber integrated into the design. It ultimately contributed to a mutual coupling of less than -25dB for the proposed antenna. The mutual coupling between the ports is seen in Figure 11. In addition, the microwave absorber aids in achieving a high degree of isolation between the antenna elements.
Reducing mutual coupling favors boosting the efficiency and performance of the antenna.
Figure 12 and Figure 13 illustrates the impact of gap between the patch elements and the microwave absorber (g) and height of the microwave absorber (H) on the return loss.

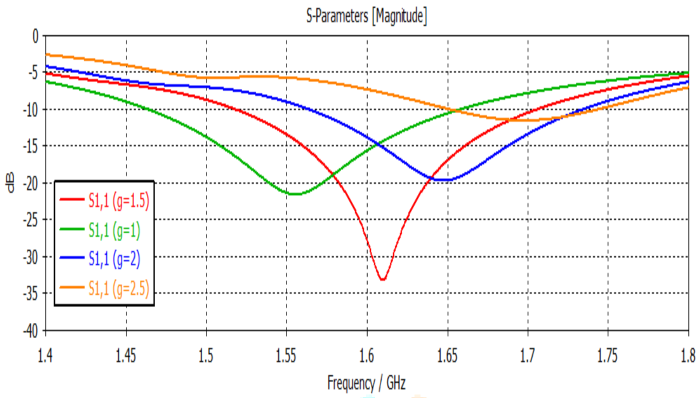

Figure 12. Impact of g on the return loss

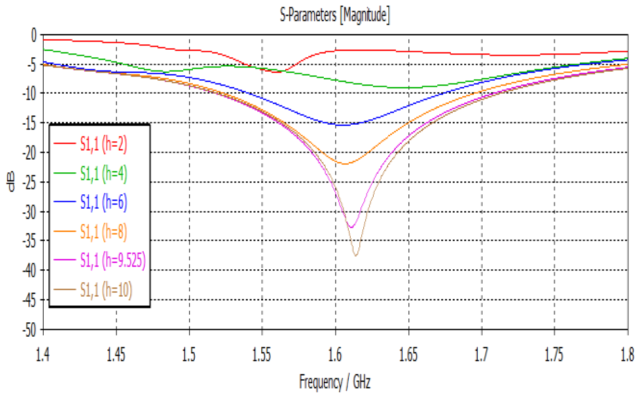

Figure 13. Impact of h on the return loss

4.3 COMPARISION TABLE:

	Return loss (dB)	VSWR	Gain (dB)	Mutual Coupling
Single Element	-19.78	1.245	1.577	_
Four Element	-22	1.175	1.355	< -15 dB
Five Element	-32.8	1.048	0.5575	< -25 dB

V. CONCLUSION

The proposed antenna features a 123mm diameter small size antenna array. Five identical 32mm sized antenna elements, each truncated in opposite corners, make up the antenna array, which is mounted on an aluminum ground plane. The MT-30 microwave absorber is deployed to achieve high isolation and further reduce mutual coupling. As a result, a wideband of 1.5–1.75 GHz is achieved with low mutual coupling of < -25dB.

VI. ACKNOWLEDGEMENT

We would like to sincerely thank our Head of the Department and Project guide, Dr. S. Aruna, for her support. We are pleased to take this opportunity to express our gratitude towards our project mentor, for all of her guidance, inspiration, and insightful talks that have helped us finish our project.
Their advice proved to be the most valuable in overcoming all obstacles in the completion of this major project **"WIDEBAND PATCH ANTENNA ARRAY FOR GNSS APPLICATIONS".**

REFERENCES

[1] GNSS Signal-Navipedia. Accessed: Sep. 9, 2021. [Online]. Available:https://gssc.esa.int/navipedia/index.php/GNSS_signal.

[2] M. Alibakhshikenari, F. Babaeian, B. S. Virdee, S. Aïssa, L. Azpilicueta, C. H. See, A. A. Althuwayb, I. Huynen, R. A. Abd-Alhameed, F. Falcone, and E. Limiti, ''A comprehensive survey on 'various decoupling mechanisms with focus on metamaterial and metasurface principles applicable to SAR and MIMO antenna systems,''' IEEE Access, vol. 8, pp. 192965–193004, 2020.

[3] M. Alibakhshikenari, B. S. Virdee, L. Azpilicueta, M. Naser-Moghadasi, M. O. Akinsolu, C. H. See, and B. Liu, ''A comprehensive survey of 'metamaterial transmission-line based antennas: Design, challenges, and applications,''' IEEE Access, vol. 8, pp. 144778–144808, 2020.

[4] M. M. B. Suwailam, O. F. Siddiqui, and O. M. Ramahi, ''Mutual coupling reduction between microstrip patch antennas using slotted-complementary split-ring resonators,'' IEEE Antennas Wireless Propag. Lett., vol. 9, pp. 876–878, 2010.

[5] K. Buell, H. Mosallaei, and K. Sarabandi, ''Metamaterial insulator enabled superdirective array,'' IEEE Trans. Antennas Propag., vol. 55, no. 4, pp. 1074–1085, Apr. 2007.

[6] A. Z. Narbudowicz, ''Advanced circularly polarised microstrip patch antennas,'' Ph.D. dissertation, Dublin Inst. Technol., Dublin, Ireland, 2013.

[7] E. Everett, A. Sahai, and A. Sabharwal, ''Passive self-interference suppression for full-duplex infrastructure nodes,'' IEEE Trans. Wireless Commun., vol. 13, no. 2, pp. 680–694, Jan. 2014.