International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 11 | Nov - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Designing A Cross-Dipole Antenna Using CST Studio Tool- A Review

Bhargavi Vijendra Sangam
Assistant Professor, ECE,
KSSEM, Bangalore.
bhargavivs@kssem.edu.in

V Harshitha
Student, ECE,
KSSEM, Bangalore.
harshithav@kssem.edu.in

V Pavani
Student,ECE,
KSSEM,Bangalore.
pavaniv@kssem.edu.in

Venishree S
Student,ECE,
KSSEM,Bangalore
venishree@kssem.edu.in

Yesa Lakshmi B
Student,ECE
KSSEM, Bangalore
lakshmibyesa@kssem.edu.in

Abstract:-

The cross-dipole antenna, has another name known as turnstile antenna. It consists of two dipole antennas set up at right angles (90 degrees) to each other. The cross-dipole antenna is typically fed with a 90-degree phase shift to produce circular polarization. It is widely used radio antenna in applications for circular polarization and omnidirectional radiation patterns in the horizontal plane. The antenna is made to work in the UHF frequency range, centred around 435 MHz, and the design was done using CST Studio Suite (a simulation tool). This project focuses on designing and testing a cross-dipole antenna, which helps improve signal reception and transmission especially useful in satellite communications, aerospace systems, and telemetry, where the signal direction can constantly change. The paper looks into how the antenna is designed, how it sends out signals (its radiation pattern), how it behaves with electrical signals (impedance), and how it can be used in real-world scenarios. Both computer simulations and actual tests were done to show how well it works across different frequencies. The project looked at important performance factors like return loss, gain, radiation pattern and polarization. This cross-dipole antenna gives equal signal in all directions in horizontal plane. We fed with signals that are 90 degrees out of phase as this set up helps for circular polarization, which is useful in communicating with satellites that keep changing their position and angle.

Keywords: CST Studio Suite, antenna design, cross-dipole antenna, electromagnetic simulation, UHF band, circular polarization, polarization matching, gain, return loss, satellite communication, remote sensing, telemetry, omnidirectional radiation.

Introduction

In modern wireless communication systems, antennas play a critical role in determining the efficiency of signal transmission, reception, reliability and performance. The cross-dipole antenna is known as Turnstile antenna, consists of two dipole antennas placed perpendicular to each other(in a cross shape) and fed with signals of 90 degree out of phase. It has the ability to produce circular polarization and its omnidirectional radiation pattern in the horizontal plane. These qualities make it highly suitable for applications where the orientation of either transmitter or receiver varies. This antenna is used in wider area of network in satellite communication, wirelesss communication, radar system, remote sensing and telemetry.

The CST Studio Suite tool is used to design cross-dipole antenna. Instead of making real models first, CST lets us test them virtually. It shows how devices behave at different frequencies. The cross-

dipole antenna has of two identical dipoles mounted perpendicular and typically fed with a 90-degree phase shift for circular polarization. This polarization ensures that signal degradation due to mismatched polarization is minimized, which is crucial for maintaining communication links with rotating or tumbling satellites. The use of circular polarization also enhances multipath resistance, further improving signal quality.

In this study, a cross-dipole antenna operates in the UHF band (around 435 MHz) is designed and analysed using CST Studio Suite, it is a powerful 3D electromagnetic simulation tool. The antenna is optimised to achieve stable radiation patterns, good axial ratio performance and low return loss, across the desired frequency band. The design process includes parametric analysis and performance evaluation based on key antenna characteristics such as gain, VSWR, radiation efficiency, and polarization.

LITERATURE REVIEW

[1] Authors- G. Gopal & Aathmanesan Thangakalai(2020)

Title- Cross Dipole Antenna for 4G and Sub-6GHz 5g Base

Description- The antenna is fabricated using a low cost FR4 substrate material. The design is validated by both simulation and measurement.

[2] Authors- Kyei Anim, Bonghyuk Park and Hui Dong Lee(2021)

Title- Simple Printed Cross-dipole Antenna with Modified Feeding Structure and Dual-Layer Printed Reflecter for Direction Finding Systems

Description- The radiating structure consists of two interlocking printed dipoles, mounted orthogonally over a dual-layer printed reflector. A novel feeding/signal interconnection method is used instead of the conventional co-axial bead through the reflector.

[3] Authors- A. Perez-Miguel and Flores-leal(2019)

Title- Comparison of Four High Performance Dual Polar Antennas for Base Stations

Description- The four types compared are: Dipoles with sloping-cut arms, dipoles with flooded arms, dipoles with a helical shape, helical dipoles with inverted branches.

[4] Authors- Huy Hung Tran, Nguyen Truong Khang(2018)

Title- A Very Wideband Circularly Polarized Crossed Straight Dipole Antenna with Cavity Reflector and Single Parasitic Element

Description- The paper says widen the Axial Ratio(AR) bandwidth. The design includes a cavity reflector plus a single parasitic element to introduce additional resonances and extend the operating range.

[5] Authors- Song Yuan Xu, Jiwon Heo and Won Seok Choi(2025)

Title- Simulation-Based Design of A Low-Cost Board Band Cross-Dipole Antenna for Multi-Global

Description- The design is done via CST studio suite simulations in single stages: first modelling a

single dipole, then the cross-dipole, ten combining with feed network and the full structure.

[6] Authors- Guirong Feng, Lei Chen and Na Li(2019)

Title- Boardband Crossed-Stepped-Dipole Antenna Incorporating A Crossed Slotted Square Patch

Description- The radiating structure uses crossed-dipoles where each dipole has two stepped sections connected by cacant-quarter rings.

[7] Authors- Yejun He, Wei He, and Hang Wong

Title- Wideband Circularly Polarized Cross-Dipole Antenna

Description- The wideband circularly polarized cross-dipole antenna was designed and shared their work in the IEEE Antennas and Wireless Propagation Letters. In their paper, they explained how the antenna was designed and showed both simulation and real measurement results. The antenna showed strong circular polarization (CP) performance across a wide frequency range, making it a solid option for applications needing reliable wideband communication.

[8] Authors- Anshul Agarwal, P. K. Singhal, and V. V. Thakare

Title- Wideband Crossed Dipole Antenna for Base Station Antenna

Description- They wrote a chapter called "Wideband Crossed Dipole Antenna for Base Station Antenna" in a book on Intelligent Computing. Their work focuses on using crossed-dipole antennas for base stations, aiming for wideband performance. They combined design techniques with simulations done in CST Studio Suite to study and improve the antenna's behaviour for practical base station use.Without vision it can be challenging for a visually impaired person to navigate without bumping into obstacles. With the traditional stick it can be sometimes inconvenient, uncomfortable and perhaps inaccurate in avoiding obstacles.

To overcome this, the proposed paper uses many ultrasonic sensors fixed with Arduino Mega board to detect obstacles without touching them.

Conclusion

Using CST Studio Suite in this work, the antenna was simulated to work well in the UHF frequency range. The results showed good impedance matching, low return loss (S11 less than –10 dB), and a strong circular polarization performance, with the axial ratio staying below 3 dB across the desired frequency range. The antenna setup, made of two dipoles placed at right angles and fed with a 90-degree phase difference, successfully produced right-hand circular polarization (RHCP) and showed stable radiation performance. We designed and studied a cross-dipole antenna that creates circular polarization and sends signals evenly all around. This makes it a great fit for things like satellite communication, telemetry, and CubeSat projects. Overall, the cross-dipole antenna proves to be a strong and compact choice for circularly polarized communication. In the future, work can focus on making it even smaller, boosting its bandwidth, and building physical prototypes to test it out in real-world setups like satellites or drones. The antenna's radiation pattern showed it sends

signals evenly all around horizontally, with a decent gain that works well for both space and ground communication.

References

[1] Geetharamani Gopal and Aathmanesan Thangakalai, "Cross Dipole Antenna for 4G and Sub-6Ghz Base Station Applications", ACES Journal, Vol. 35, No. 1, January 2020 Pages: 16–22

[2] Kyei Anim, Bonghyuk Park and Hui Dong Lee(2021), "Simple Printed Cross-dipole Antenna with Modified Feeding Structure and Dual-Layer Printed Reflector for Direction Finding Systems", Sensors(Basel) Journal,Vol.21, Issue 17, article 5966, 2021, Doi 10.3390/s21175966

[3] Perez-Miguel. A, Jardon-Aguilar H, Gomez-Villanueva R, and Flores-Leal R,(2019), Comparison of Four High Performance Dual Polar Antennas for Base Stations Wireless Personal Communications,110(4), 1707-1728. Doi 10.1007/s11277-019-06808-X

[4] Tran, H. H., Doan, M.T., Bui, C.D., and Nguyen, T. K.(2018), A Very Wideband Circularly Polarised Crossed Straight Dipole Antenna with Cavity Reflector and Single Parasitic Element. REV Journal on Electronics and Communications, Vol.8, No.1-2, Jan-Jun 2018, Doi 10.21553/rev-jec.193

[5] Song Yuan Xu, Jiwon Heo and Won Seok Choi(2024), Simulation-Based Design of A Low-Cost Board Band Cross-Dipole Antenna for Multi-Global Navigational Satellite System Positioning, Sensors, 25(15), 4665, Doi 10.3390/s25154665

[6] Feng, g., Chen, L., and Li, N., et al.(2019). Broadband CP crossed-stepped-dipole antenna incorporating a cross slotted square patch. IET Microwaves, Antennas and Propagation, Vol. 13, Issue 3, pp. 340-345, Doi 10.1049/iet-map.2018.5254

[7] He, Y., He, W., and Wong, H.(2014). A Wideband Circularly Polarised Cross Dipole Antenna, IEE Antennas and Wireless Propagation Letters, Vol.13, pp.67-70

[8] Agarwal, A., Singhal, P.K., and Thakare, V. V.(2020), Wideband Crossed Dipole Antenna for Base Station Antenna, In: Pandit, M., Srivastava, L., Rao, R. V.(eds) Intelligent Computing Applications for Sustainable Real-World Systems. ICSISCET 2019, Proceedings in Adaptation, Learning and Optimization, Vol 13. Springer, Cham, pp. 261-270. Doi 10.1007/978-3-030-44758-8-23