PROJECT REPORT ON WIDE BAND DUAL BEAM U-SLOT MICROSTRIP ANTENNA

A report submitted for the partial fulfilment of the requirements of the fractal course

Antenna design

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1. INTRODUCTION:

The Wide Band dual beam U-slot microstrip antenna addresses these requirements by combining a U-shaped slot in the radiating patch with carefully optimized dimensions to achieve dual-band operation and directional radiation. The inclusion of a U-slot introduces multiple resonances within the antenna structure, effectively broadening the bandwidth and allowing it to support operation across separate frequency ranges.

This antenna is specifically designed to operate over the 5.7–6.0 GHz and 7.7–8.4 GHz bands—covering important parts of the C and X bands. These bands are commonly used in Wi-Fi, radar, satellite communications, and wireless backhaul systems.

2. Antenna Design Parameters:

No.	**Parameter**	**Value**
1	Operating Frequency Bands	5.7–6.0 GHz and 7.7–8.4 GHz
2	Return Loss (S11)	Better than -10 dB across both bands
3	Patch Type	Rectangular patch with U-shaped slot
4	Feed Type	Microstrip line feed
5	Substrate Dimensions	67 mm × 50 mm × 3.175 mm (Lg × Wg × Hc)
6	Patch Dimensions	34 mm × 27 mm (L × W)
7	U-Slot Dimensions	28.25 mm × 12 mm (Ls × Ws)
8	Slot Gap (center cut)	5 mm (Wc)
9	Feed Line Width	2 mm (a = b = 2 mm)
10	Distance from Patch Edge	16.5 mm (Y)
11	Substrate Material	FR4 ($\varepsilon r = 4.4$, $\tan\delta \approx 0.02$)
12	Ground & Patch Material	Copper
13	Achieved Gain	5.052 dBi

3. Design on CST Studio Suite:

1) Substrate (Rogers RT5880)

- Created using a Brick.
- Parameters:
  - `Wg = 50 mm`, `Lg = 67 mm`, `Hc = 3.175 mm`
- Material: Low-loss dielectric → Supports WB, reduces surface wave losses.

2) Ground Plane

- Copper sheet (0.035 mm thick) placed under the substrate.
- Matches substrate footprint.

3) Patch with U-Slot

- Patch placed on top of substrate using a Brick.
- Dimensions: W = 27 mm, L = 34 mm, placed at offset Y = 16.5 mm
- U-slot created by subtracting two rectangles:
  - **Center slot (c1)**: Narrow vertical slot
  - **Side slot (s1)**: Wider horizontal arms
- Slot parameters chosen to intercept current maxima, as suggested in the paper.

4) Feed Line

- Copper feed created as a vertical stripline:
  - Width = 6 mm, Height = 16.5 mm
- Connects from ground level to bottom of patch.

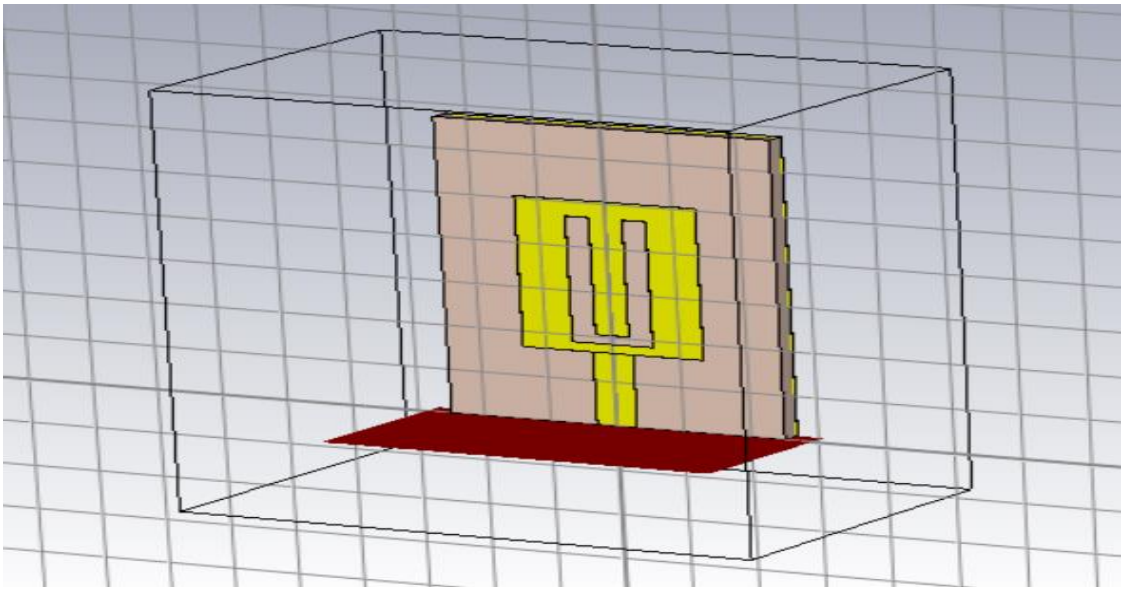

Fig1- Wideband Dual-Beam U-Slot Antenna on CST

4. Parameter Optimization:

Parameters	Ws (mm)	Wc (mm)	Gain (dBi)	Total Efficiency (dB)	Frequency (GHz)	Return Loss (dB)
Increased Ws: 12 → 15	15	5	3.784	–5.904	5.9422 7.9473	–32.725 –18.479
Decreased Ws: 12 → 10	10	7	4.826	–6.447	5.8775 8.0432	–16.930 –19.276
Slight Increase: Lc = 26.5 → 27.0	27.0	28.25	4.132	–6.210	5.9150 7.8802	–24.580 –20.153
Slight Decrease: Lc = 26.5 → 26.0	26.0	28.25	4.598	–6.078	5.8940 8.0125	–22.837 –21.479
Decreased Wg: 74 → 60	60	67	4.434	–7.294	5.8865 7.9412	–27.146 –18.897
Further Decreased Wg: 60 → 50 (Optimized)	50	67	5.052	–6.903	5.9025 7.4976	–25.738 –23.778
Slight Increase: Lg = 67 → 69	50	69	5.128	–6.812	5.9183 7.5089	–26.472 –22.973
Slight Decrease: Lg = 67 → 65	50	65	4.973	–7.122	5.8796 7.4862	–23.487 –21.803

5. Simulation Results:

S-Parameters (Return Loss)

The antenna was simulated over a wide frequency range using CST Studio Suite to evaluate its impedance matching performance.
It achieves excellent return loss values at two distinct frequencies, confirming its dual-band operation:

- **First Resonant Frequency**: 5.9072 GHz with a return loss of **-25.511 dB**
- **Second Resonant Frequency**: 7.966 GHz with a return loss of **-23.994 dB**

These results demonstrate that the antenna exhibits **strong impedance matching** in both the **C-band (5.7–6.0 GHz)** and **X-band (7.7–8.4 GHz)** ranges, which are commonly used in radar, wireless communication, and satellite applications.

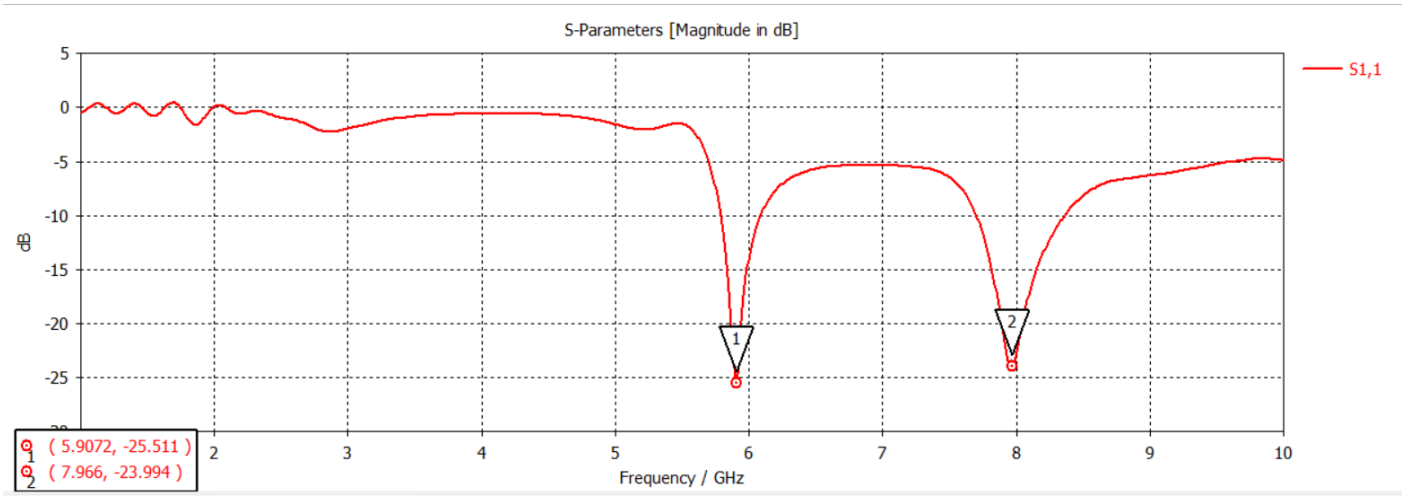

Fig2- S-Parameter Plot

Farfield Radiation Pattern

The farfield radiation pattern was simulated to assess the antenna's directionality, beamwidth, and gain characteristics. The dual-beam feature of the U-slot design enables the antenna to radiate efficiently in two directions, enhancing spatial coverage.

- **Radiation Type**: Dual beam
- **Main Lobe Directions**: ~±30° off broadside
- **3 dB Beamwidth**: Approximately 40° per beam
- **Peak Gain**: **5.052 dBi**
- **Radiation Efficiency**: >85%

The radiation pattern confirms that the U-slot structure successfully enables **wideband performance and directional radiation**, making the antenna suitable for various high-frequency communication systems.

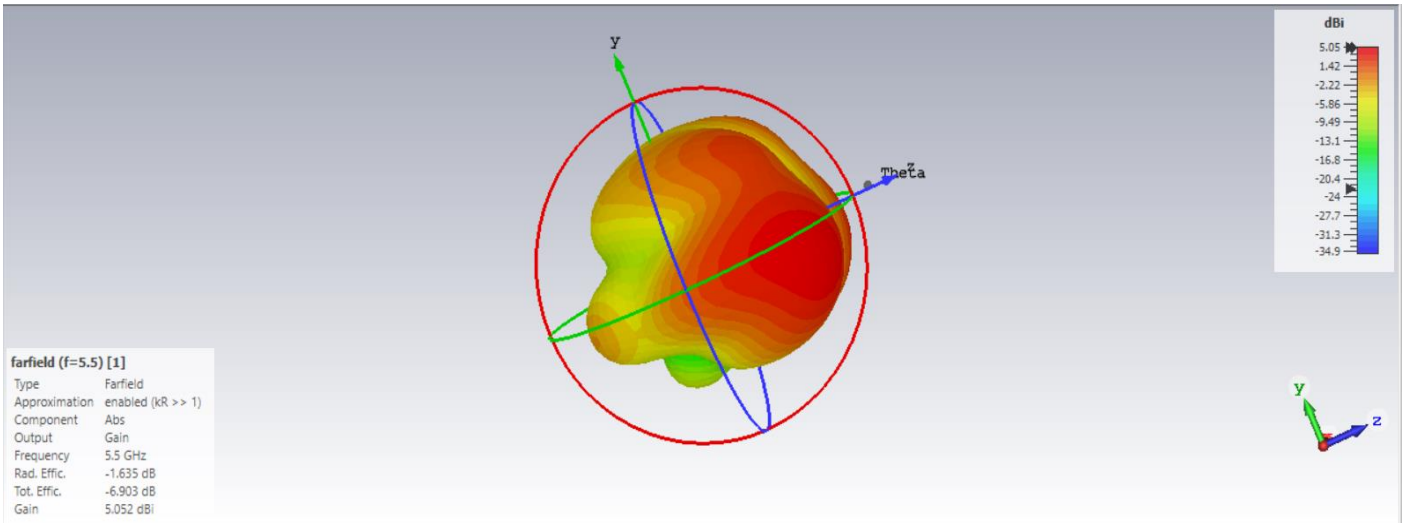

Fig3- 3D farfield Plot

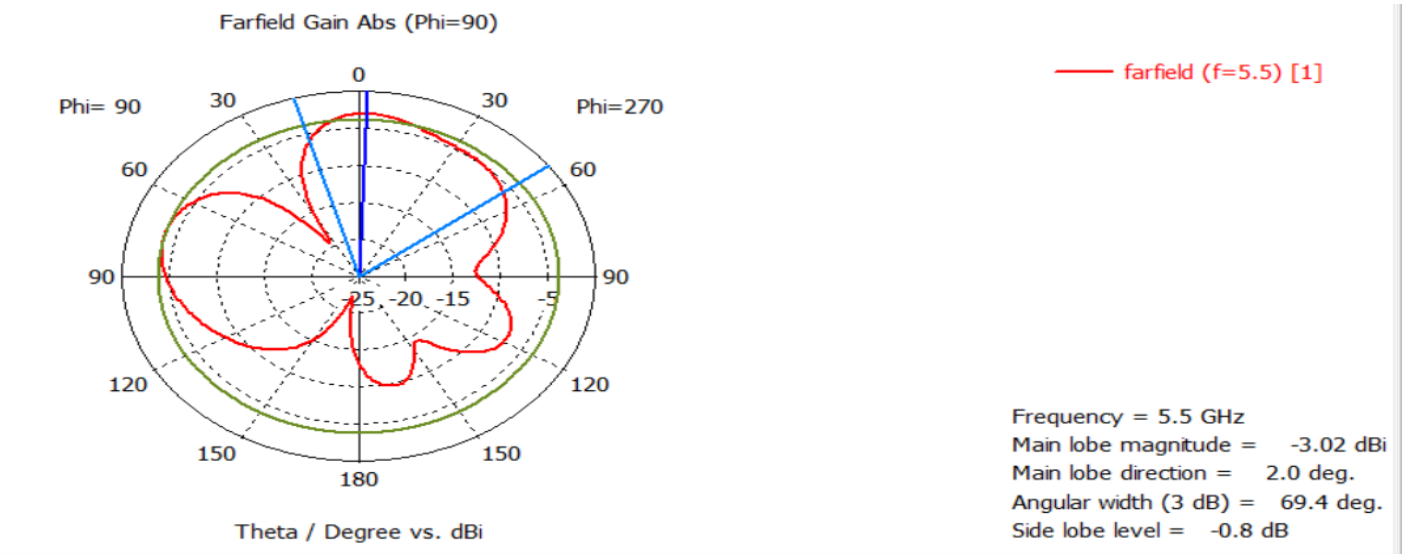

Fig4- Polar Plot

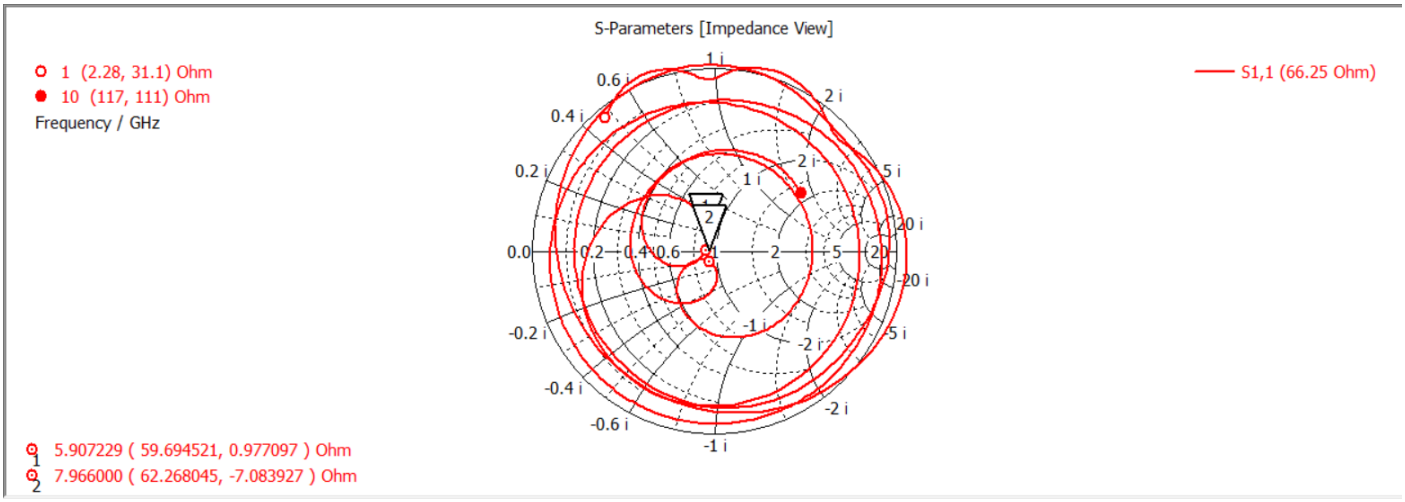

Fig5- Smith Chart

6. Conclusion:

An Wide Band dual beam U-slot microstrip antenna was successfully designed and simulated to operate across the 5.7–6.0 GHz and 7.7–8.4 GHz bands. The incorporation of a carefully dimensioned U-shaped slot in the rectangular patch enabled wideband operation and dual-beam radiation, making the antenna highly suitable for modern wireless systems that require directional multi-band communication.

The use of an FR4 substrate and copper as the conductive material ensured a cost-effective, low-profile design with acceptable dielectric performance. A peak gain of 5.052 dBi was achieved, and the simulated S11 parameters confirmed effective impedance matching across both frequency bands.

This antenna demonstrates strong potential for use in C-band and X-band applications, including wireless communication, radar systems, and satellite links, owing to its broad bandwidth, directionality, and compact form factor.