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# A Comparative Review of Wideband Microstrip Antenna Designs for Modern Wireless Communication Systems

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*Abstract:* Many modern wireless systems need antennas that work across many frequencies. GPS needs 1.15 GHz to 1.6 GHz. WiFi and WiMax need 2.3 GHz to 6 GHz. Normal microstrip patch antennas are small and cheap but they work only on a narrow band. This review paper looks at two different ways to make microstrip antennas wideband. The first method uses a square patch with cut corners and capacitive feeding [1]. It gives circular polarization from 1.15 to 1.6 GHz. The second method uses a circular patch with a CPW feed line [2]. It gives linear polarization from 2.3 to 6 GHz. Both designs use FR4 board. This paper compares their shape, feeding, polarization, bandwidth, gain, and radiation. The final conclusion is simple: use the first design for GPS and satellite. Use the second design for WiFi and WiMax.

***Keywords:*** Wideband antenna, microstrip patch, circular polarization, capacitive feed, CPW feed, GPS, WiFi, WiMax

## I. INTRODAUCTION

Wireless communication is growing very fast. Many different systems now operate at different frequencies. GPS works near 1.2 GHz and 1.5 GHz. Galileo will use several bands from 1.1 GHz to 1.6 GHz. WiFi uses 2.4 GHz and 5.8 GHz. WiMax uses 2.3 GHz, 3.3 GHz, and 5.8 GHz [3]–[5]. A single narrowband antenna cannot serve all these.

Microstrip patch antennas have many good points. They are flat, light, and cheap to make [6]. But they have one big problem. Their bandwidth is only 1% to 5% [7]. That is too small for modern needs. So researchers have tried many tricks to increase bandwidth. Some use an air gap under the patch. Some use special feeding methods. Some use stacked patches or aperture coupling [8]–[10].

This review focuses on two specific designs from conference papers. The first one is by Murugan and Rajamani [1]. They made a circularly polarized antenna for GPS. The second one is by Kurniawan and Mukhlishin [2]. They made a linearly polarized wideband antenna for WiFi and WiMax. We will compare both designs. No new experiments are done here. This is only a summary and comparison.

## II. MICROSTRIP ANTENNAS HAVE NARROW BANDWIDTH

A normal microstrip patch antenna has a patch on top of a substrate and a ground plane below [11]. The patch size decides the resonance frequency. But the Q factor is high. High Q means narrow bandwidth. Thin substrates and high dielectric constant make it worse [12].

To fix this, engineers use an air gap between substrate and ground plane [13]. Air has low dielectric constant. This lowers the effective Q and increases bandwidth. Another trick is capacitive feeding. A small feed patch is placed very close to the main patch. This cancels the inductance of the probe pin [14].

CPW feeding is different. Here the feed line and ground are on the same side of the board [15]. This reduces unwanted effects. Truncation means cutting corners or edges of the patch. This creates extra resonance modes. If tuned properly, these modes merge and give wideband response [16]. Both designs we review use one or more of these techniques.

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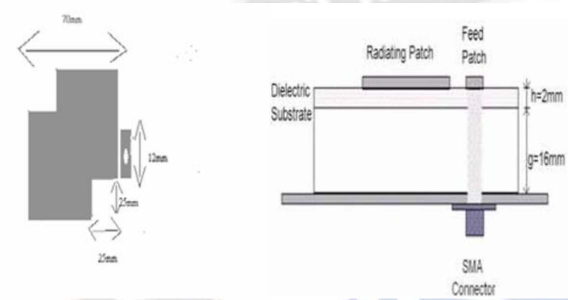
## III. First Design: Capacitive Fed Square Patch with Truncated Corners

### A. *Shape and Size*

This antenna [1] is designed for 1.375 GHz center frequency. The patch is a square of 70 mm × 70 mm. Two opposite corners are cut. Each cut removes a 25 mm × 25 mm square. A small feed strip of 12 mm × 2.4 mm is placed 0.5 mm away from the patch. The patch is suspended 16 mm above the ground plane. The substrate is FR4 with thickness 2 mm and dielectric constant 4.4. A coaxial probe feeds the strip, and energy jumps to the patch through coupling.




Fig,1, Top and side view of the capacitive fed antenna [1]

### B. *How It Works*

A normal square patch gives linear polarization. Cutting two opposite corners disturbs the two main modes. Their frequencies split. When the split is just right, they become 90° out of phase. This creates circular polarization [17]. The small gap between feed strip and patch gives a large capacitance. This cancels probe inductance [18]. The air gap lowers the effective dielectric constant and widens the bandwidth.

### C. *Results from Simulation*

The authors used HFSS software. Here are the main results [1]:

- Return loss below –10 dB from 1.15 GHz to 1.6 GHz. That is 32% bandwidth.
- Axial ratio below 3 dB from 1.26 GHz to 1.49 GHz. That is 16% bandwidth.
- At 1.375 GHz, axial ratio is only 0.031 dB. Very good circular polarization.
- Gain is 2.1 dB.
- Radiation pattern is hemispherical. No side lobes.

### D. *Changing the Truncation Size*

The authors tried three truncation sizes: 20 mm, 25 mm, and 30 mm. Table 1 shows what happened [1].

Table I. Effect of Truncation Size [1]

| Truncation (mm) | Resonance (GHz) | Impedance BW (GHz) | Gain (dB) | Min Axial Ratio (dB) |
|---|---|---|---|---|
| 20 | 1.26 | 1.10 – 1.76 | 2.9 | 4.2 |
| 25 | 1.375 | 1.15 – 1.60 | 2.1 | 0.031 |
| 30 | 1.43 | 1.25 – 1.62 | 0.8 | 3.6 |

Larger truncation moves resonance upward. It also reduces bandwidth and gain. The best axial ratio happens at 25 mm.

## IV. Second Design: Circular Patch with CPW Feed

### A. *Shape and Size*

This antenna [2] covers 2.3 GHz to 6 GHz. The patch is circular with diameter 32 mm. It has a small truncation of 5.6 mm. The feed is a CPW line. The center strip is 2.4 mm wide. Two square ground patches (16.1 mm × 15 mm) sit on both sides. The gap between strip and ground is 0.3 mm. The whole thing is printed on FR4 of thickness 0.8 mm and dielectric constant 4.3. No air gap is used. So the antenna is compact.

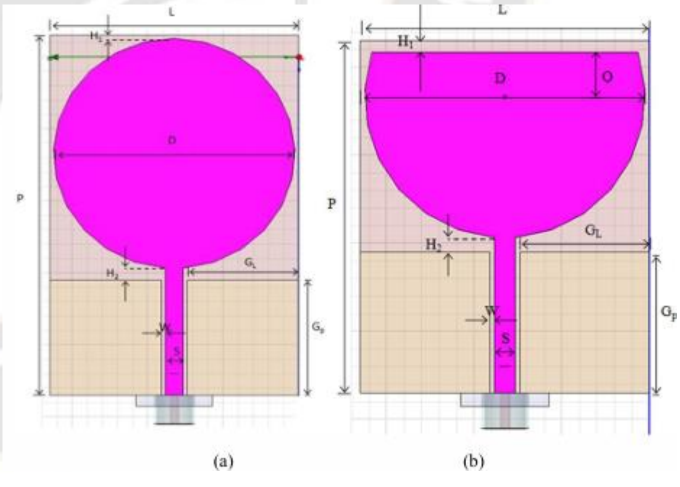



Fig.2. Top view of CPW-fed circular patch antenna [2].

### B. *How It Works*

CPW feeding has low loss and is easy to integrate [19]. A simple circular patch gives narrow band. But truncation creates extra current paths. This makes extra resonance modes [20]. By choosing the right truncation and gaps, these modes merge. The result is a continuous wideband from 2.3 to 6 GHz.

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### *C. Simulated and Measured Results*

The antenna was built and tested. Simulation and measurement matched well [2].

- Measured return loss is better than –9.54 dB (VSWR < 2) from 2.3 GHz to beyond 6 GHz.
- Simulated gain goes from 0 dB at 2.3 GHz up to 4.5 dB at 6 GHz. Measured gain is slightly lower but follows the same curve.
- Radiation pattern is bidirectional in x-y plane and circular in x-z plane. Good for indoor access points.

### *D. Parameters Change*

The authors changed several parameters [2]. Making the CPW gap smaller improved matching above 3.5 GHz. Increasing the gap between patch and ground patches improved return loss but shifted resonance higher. Another gap, if increased, made return loss worse and shifted resonance lower. Truncation mainly affects frequencies above 3.5 GHz.

## V. COMPARING BOTH DESIGNS

Table II. Comparison of Two Designs [1][2]

| **Truncation (mm)** | **Resonance (GHz)** | **Impedance BW (GHz)** |
|---|---|---|
| Patch shape | Square, truncated corners | Circular, truncated |
| Feeding | Capacitive strip | CPW |
| Substrate | FR4, 2 mm thick | FR4, 0.8 mm thick |
| Frequency range | 1.15 – 1.6 GHz | 2.3 – 6 GHz |
| Best for | GPS, satellite | WiFi, WiMax |
| Best for | GPS, satellite | WiFi, WiMax |

Design one is better when circular polarization is a must. That is true for GPS because the receiver orientation can change. Design two gives wider bandwidth and higher gain but only linear polarization. That works for WiFi and WiMax base stations.

## VI. CONCLUSION

This review looked at two wideband microstrip antennas from the literature [1][2]. The first design uses a suspended square patch, corner truncation, and capacitive feeding. It gives circular polarization from 1.15 to 1.6 GHz. Bandwidth is 32% for return loss and 16% for axial ratio. Gain is 2.1 dB. This antenna is good for GPS and Galileo.

The second design uses a truncated circular patch and CPW feeding. It gives linear polarization from 2.3 to 6 GHz. Gain goes from 0 to 4.5 dB. This antenna is good for WiFi and WiMax.

Both use cheap FR4 boards and are easy to make. Choose design one for satellite navigation. Choose design two for terrestrial wireless. This comparison should help antenna designers pick the right approach for their application.

## VII. REFERENCES

[1] S. Murugan and V. Rajamani, "Design of Wideband Circularly Polarized Capacitive fed Microstrip Antenna," International Conference on Communication Technology and System Design, 2011.

[2] A. Kurniawan and S. Mukhlishin, "Wideband Antenna Design and Fabrication for Modern Wireless Communications Systems," 4th International Conference on Electrical Engineering and Informatics (ICEEI), pp. 348–353, 2013.

[3] N. Padros, J. L. Ortsou, and J. Baker, "Comparative study of high performance GPS receiving antenna designs," IEEE Trans. Antennas Propag., vol. 45, no. 4, pp. 698–706, 1997.

[4] J. M. Tranquilla and S. R. Best, "A study of Quadrafilar Helix antenna for Global Position systems Applications," IEEE Trans. Antennas Propag., vol. 38, no. 10, pp. 1545–1550, 1990.

[5] L. Boccia, G. Amendola, and G. D. Mossa, "A shorted elliptical patch antenna for GPS applications," IEEE Antennas Wireless Propag. Lett., vol. 2, no. 1, pp. 6–8, 2003.

[6] L. Boccia, "A Dual frequency Microstrip antenna for high precision GPS applications," IEEE Antennas Wireless Propag. Lett., vol. 3, no. 1, pp. 157–160, 2004.

[7] Y. S. Wang and S. J. Chung, "A Miniature Quadrafilar Helix antenna for Global Positioning Satellite reception," IEEE Trans. Antennas Propag., vol. 57, no. 12, pp. 3746–3751, 2009.

[8] A. A. Serra, P. Nepa, and R. Massini, "A Low profile Linearly Polarised 3D PIFA for handheld GPS terminals," IEEE Trans. Antennas Propag., vol. 58, no. 4, pp. 1060–1066, 2010.

[9] F. Scire-Scappuzzo and S. N. Markov, "A Low profile Multipath Wideband GPS antenna with Cutoff

or Noncutoff Corrugated ground planes," IEEE Trans. Antennas Propag., vol. 57, no. 1, pp. 33–46, 2009.

[10] K. R. Carver and J. W. Mink, "Microstrip Antenna Technology," IEEE Trans. Antennas Propag., vol. 29, no. 1, pp. 2–24, 1981.

[11] V. G. Kasabegoudar and K. J. Vinoy, "Coplanar capacitively fed Microstrip antenna for wideband applications," IEEE Trans. Antennas Propag., vol. 58, no. 10, pp. 3131–3138, 2010.

[12] R. Maksch, K. Usha Kiran, and K. J. Vinoy, "Broadband design of a Triangular Microstrip antenna with a capacitive Feed," J. Microw. Optoelectron. Electromagn. Appl., vol. 7, no. 8, pp. 44–53, 2008.

[13] V. G. Kasabegowdar and K. J. Vinoy, "A wideband Microstrip antenna with symmetric radiation pattern," Microw. Opt. Technol. Lett., vol. 50, no. 8, pp. 1991–1995, 2008.

[14] V. G. Kasabegoudar and K. J. Vinoy, "A Broadband Suspended Microstrip Antenna for Circular Polarisation," Prog. Electromagn. Res., vol. 90, pp. 353–368, 2009.

[15] S. Sainkar and A. Jeyalumar, "Design Analysis of Broadband circularly polarized compact Microstrip antenna for wireless applications," Int. J. Electron. Commun. Technol., vol. 2, no. 2, pp. 135–139, 2011.

[16] R. L. Li, J. Laskar, and M. M. Tentzeris, "Wideband probe-fed circularly polarized circular loop antenna," Electron. Lett., vol. 41, no. 18, pp. 997–999, 2005.

[17] M. I. Sulaiman and S. K. Khamas, "A Single fed Rectangular resonator antenna with a wideband circular polarization," IEEE Antennas Wireless Propag. Lett., vol. 9, pp. 615–618, 2010.

[18] I. J. Bahl and P. Bhartia, Microstrip Antennas. Norwood, MA: Artech House, 1980.

[19] D. Liu and B. Gaucher, "A branched inverted-F antenna for dual band WLAN applications," Proc. IEEE Antennas Propag. Soc. Int. Symp., Monterey, CA, vol. 3, pp. 2623–2626, 2004.

[20] R. K. Raj, M. Joseph, C. K. Anandan, K. Vasudevan, and P. Mohanan, "A new compact microstrip-fed dual-band coplanar antenna for WLAN applications," IEEE Trans. Antennas Propag., vol. 54, no. 12, pp. 3755–3762, 2006.W. Hong et al., "Millimeter-wave 5G antennas and systems," Proceedings of the IEEE, vol. 105, no. 7, 2017.