# Miniaturized Circular Polarized Antenna with Optimized Multipath Suppression for Indoor Positioning Systems

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The development of Indoor Positioning Systems (IPS) promises an extension of satellite navigation to indoor scenarios with significantly better spatial and temporal resolution [1]. We have developed a time difference of arrival (TDoA) based IPS approach operating at 5.8 GHz ISM band featuring Frequency Division Multiplexing (FDM) principals with minimized channel offsets of the up to eight base stations placed around the monitoring space. Mobile devices analyze these signals for the position estimation. Due to the high number of scattering objects in indoor scenarios, one major challenge here is the multipath propagation superimposing line of sight signals and thus disturbing the extraction of the TDoA information. Using circular polarized RF signals aims at minimizing this interference by switching the polarization after reflection. This article introduces the antenna developed for the receiving mobile devices. For applications as human motion analysis, the mobile devices have to be small, lightweight and should favor a central reference position to make the device symmetrically rotatable around its center of reception. A circularly polarized annular ring patch antenna fulfills these requirements [2]. The chosen design realizes a matched right-hand circular polarized (RHCP) antenna. Employing a ceramic ($Y_20_3$ partially stabilized Zirconia) with high permittivity ($\varepsilon_r = 29$) leads to considerable minimal dimensions (Fig. 1a) in comparison to monopole and other patch antennas [3]. We made use of the EMPro software tool from Keysight to optimize the antenna dimensions and performance by simulation.

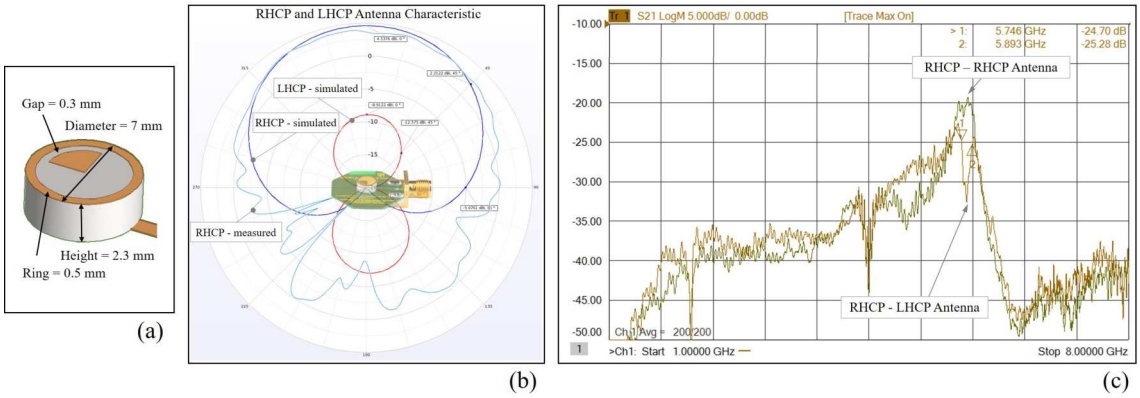


**Figure 1.** (a) Antenna dimensions; (b) RHCP and LHCP simulated and RHCP measured antenna characteristics; (c) measured characteristics for different antenna combinations

The measurements of the prototype assembled on a test PCB with the final layer stack-up, carried out in an anechoic chamber in combination with conical logarithmic spiral antennas (CLSA 0110R and CLSA 0110R, Schwarzbeck) show an antenna gain of 3 dB and the expected radiation characteristic (Fig. 1b). The measured bandwidth of 150 MHz at 5.8 GHz is sufficient for the narrowband target application. Moreover, when employing two antennas with opposing polarization a 13 dB attenuation of the opposing polarization is confirmed (Fig. 1c). This result represents a significant suppression of multipath effects. The achieved characteristics of the designed antenna are promising in performance and the form factor allows for miniaturization of the mobile devices. Further investigations will validate the impact on system-level regarding a multipath disturbance and help to improve the method for the high-yield assembly of the optimized antenna.

1. R. Xiong, S. van Waasen, C. Rheinlander, and N. Wehn, “Development of a Novel Indoor Positioning System With mm-Range Precision Based on RF Sensors Network,” IEEE Sensors Letters, 2017.
2. Y.-F. Lin, H.-M. Chen, and S.-C. Lin, “A New Coupling Mechanism for Circularly Polarized Annular-Ring Patch Antenna,” IEEE Transactions on Antennas and Propagation, vol. 56, no. 1, pp. 11–16, 2008.
3. M. Matsunaga, “A dual-band single-feed circularly polarized microstrip patch antenna with a cross slot,” in 2016 IEEE APWC, Cairns, Australia, pp. 91–92, 2016.