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CIRCULARLY POLARIZED ANTENNA FOR SATELLITE RECEPTION

SHORT TECHNICAL PAPER

This short paper illustrates simulation and design of circularly polarized antenna for GPS applications [1]. The general requirements for such an antenna are: wide frequency bandwidth, wide radiation pattern to cover the sky and good circular polarization (CP) performance. In this design, center operating frequency of 1.5 GHz (L1 GNSS band) was chosen. The proposed generic structure is based on [2-4] and consists of thick dipoles with offset feeding as shown in Fig. 1.

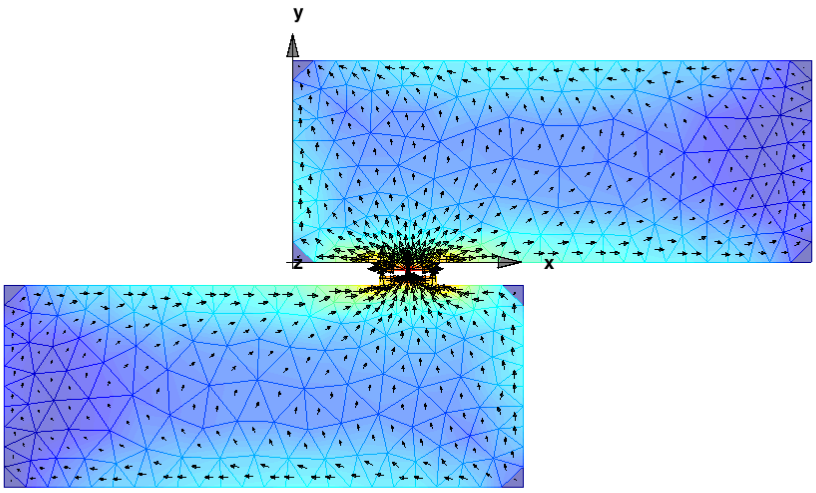

Fig. 1. A generic version of the circularly polarized antenna, the surface current density at 1.5GHz as calculated by the AToM [5] package is shown.

The relative frequency bandwidth for RL<10 dB is around 70% as seen from Fig. 2.

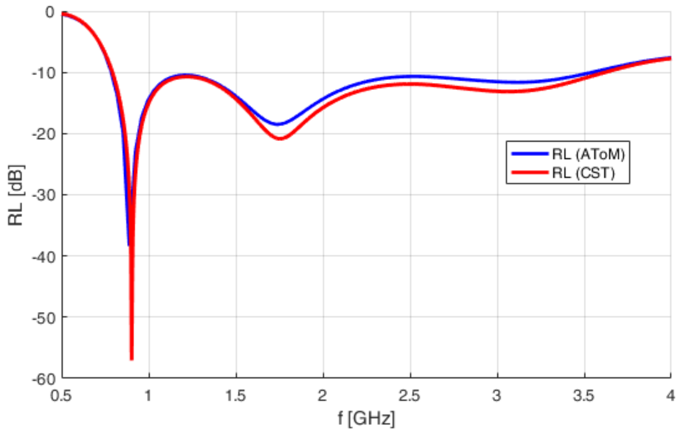

Fig. 2. The return loss of the generic structure, calculated both by the AToM frequency domain solver and CST [6] time domain solver. The agreement is very good despite different approaches used.

The Characteristic Mode theory (CM) [7] provides us with additional insight into antenna operation. We used both the AToM and CST to perform the modal decomposition, see Fig. 3.

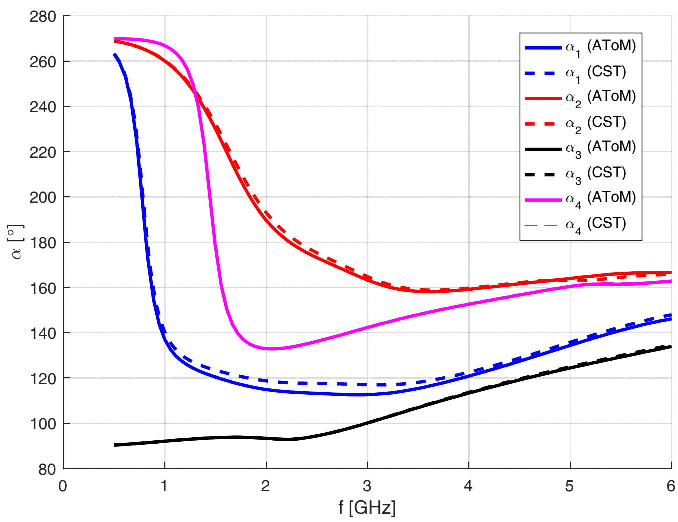

Fig. 3. Characteristic angles of first four modes as calculated by the AToM and CST software (note that slightly different meshes were used).

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Peaks in return loss (see Fig. 2) at ~0.9 and ~1.7 GHz are obviously caused by resonance (characteristic angle is crossing 180 degrees) of modes 1 and 4 respectively, while mode 2 is responsible for matching the rest of the band. Matching deteriorate above ~3 GHz due to inductive mode 3.

In order to have the radiation only into the upper hemisphere, ground plane and proper feeding structure should be added to the above generic structure. In this design, the antenna is fed by a coaxial cable followed by a microstrip line forming a „hook" probe, see Fig. 4. The probe is supported by a plastic holder, shown in blue. Simulated results are shown in Figs 5-6.

The frequency matching and CP performance do not completely overlap, however, in result, the good CP performance (AR<3 dB) is attained within the fractional bandwidth of nearly 50%.

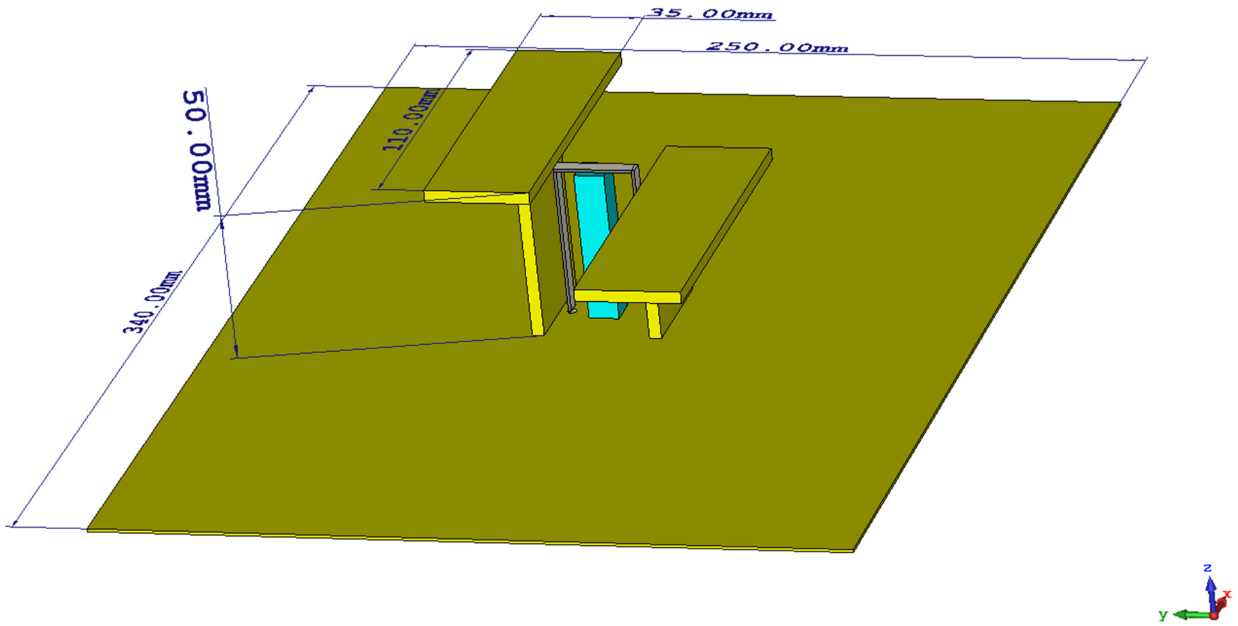

Fig. 4. Layout and dimensions of the proposed circularly polarized antenna

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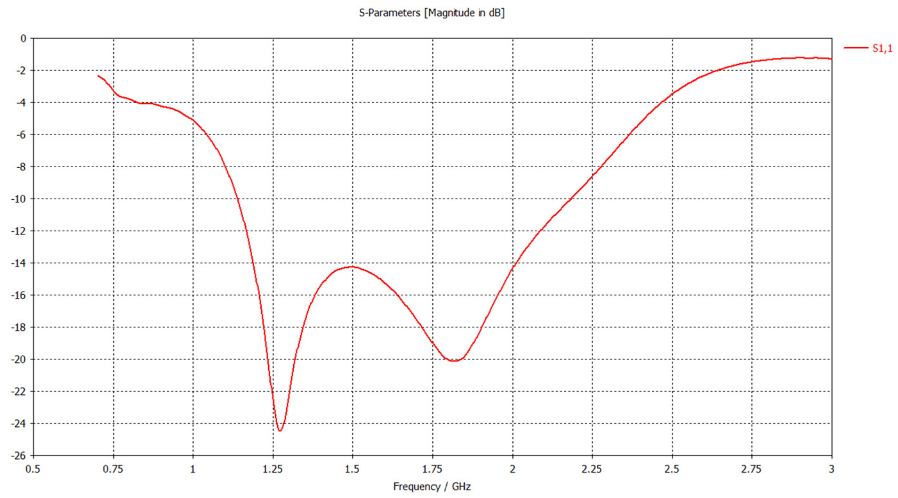

Fig. 5. Simulated S_{11} for the antenna from Fig. 4. The fractional frequency bandwidth is 62%.

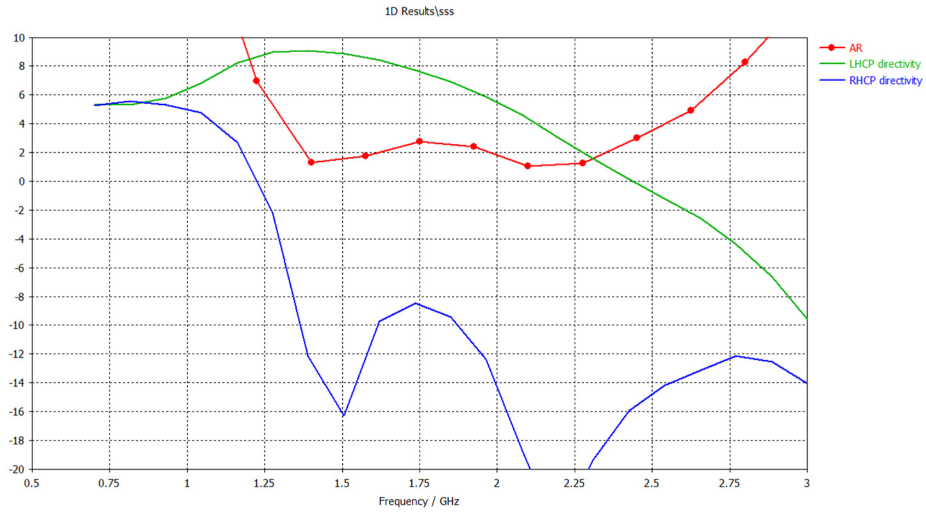

Fig. 6. Boresight AR and LHCP/RHCP directivities. The fractional AR bandwidth is 47%

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The radiation patterns are quite stable within the band, see cuts for three frequencies in Fig. 7. The 3dB beamwidth ranges from 66 degrees (@ 1.5 GHz) to 120 degrees (@ 2 GHz).

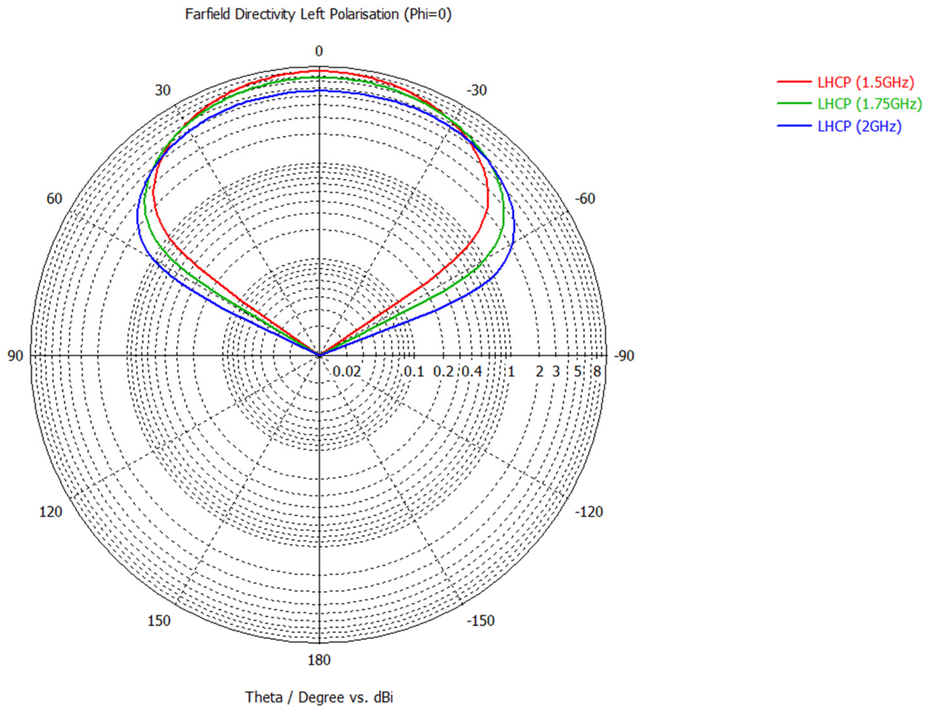

Fig. 7. Radiation pattern cuts at frequencies of 1.5, 1.75 and 2 GHz showing wide beam

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