Effects of a shorting post on the impedance characteristic of TCDA antenna

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To have a wideband and low-profile array antenna, tightly coupled dipole arrays (TCDA) have been widely used (Munk, Ben A. Finite antenna arrays and FSS. John Wiley & Sons, 2003). However, it has a limitation for impedance matching at extremely low frequency band when it is on the ground plane. Because the input impedance of a unit cell of TCDA is very capacitive and has a small resistance at extremely low frequency band, it is hard to match the impedance.

In order to match the impedance at extremely low frequency band, we use shorting posts and analyze these. A shorting post has been used for rejecting the common mode generation (Holland, Steven S., and Marinos N. Vouvakis. The planar ultrawideband modular antenna (PUMA) array IEEE Transactions on Antennas and Propagation 60.1 (2012): 130-140). But it can also be used for matching the low frequency band as shown in Figure 1 where the frequency selective surface and the 150Ω discrete port have been used. Figure 2 shows the modified equivalent circuit of the unit cell. The shunt inductor which represents the shorting posts is added to conventional equivalent circuit. Figure 3 shows the smith chart to compare impedance properties where the impedance is normalized to 150Ω. Blue locus corresponds to the unit cell with shorting posts and yellow locus corresponds to the unit cell without shorting posts. Without shorting posts, the impedance matching is poor at 0.58GHz and the impedance matching is good from 0.72GHz. On the other hand, with shorting posts, the impedance is well matched from 0.58GHz.

As a result, the impedance bandwidth without and with shorting posts are 0.72-4.8(6.67:1) and 0.58-4.7(8.10:1), respectively. The heights of the antenna including the FSS are $0.104\lambda_{low}$ and $0.084\lambda_{low}$ at the lowest operating frequency.

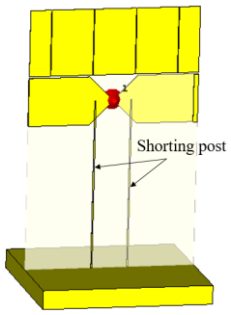

Figure 1. Proposed unit cell configuration.

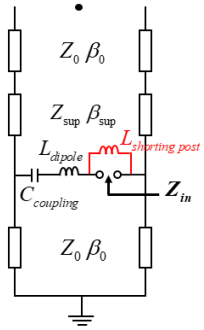

Figure 2. Equivalent circuit of the proposed unit cell.

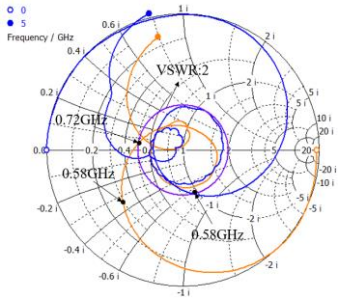

Figure 3. Smith chart to compare impedance properties

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