

Design of Corporate Feed Radial Line Curl Array Antenna for Wideband Operation

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Radial line slot antennas (RLSA) are easy to design with large aperture structures, making them suitable for various applications such as BS broadcasting reception antennas, satellite-mounted antennas, and wireless power transfer (WPT), due to their high gain characteristics. However, as the number of elements in the antenna array increases, a challenge arises where the bandwidth narrows due to the properties of the slot pairs and the long-line effects. The goal of our research is to develop an antenna using radial lines that can simultaneously meet the required bandwidth and gain specified by the system. In our previous research, we achieved wideband coupling by using curl radiation elements, which can be implemented on PCB, instead of the conventional slot pairs used in traditional radial line slot antennas (G. Nakayama, T. Tomura, “Design of PCB-based Spiral Radiation Elements for Radial Line Slot Antenna”, 2024 *IEEE Int. Symp. Antennas Propag.*, Incheon, Korea, pp. 142-143). This is because, while the slot pairs behave resonantly, the curl radiation elements are excited as a traveling wave. Additionally, by using corporate feed multi-layer structures with a corporate feed ring slot that adjusts the power flow both inside and outside the radial line, we reduced the long line effects (G. Nakayama, T. Tomura, “Feeding Circuit Design for Full-Corporate Feed Radial Line Slot Antennas”, 2024 *IEEE Int. Symp. Antennas Propag. and UNCS-URSI Radio Science Meeting (AP-S/URSI)*, Florence, Italy, pp. 2795)

This paper presents the full antenna structure analysis results obtained by combining these technologies. The center frequency is 19.5 GHz. A radial line fed by a coaxial cable is designed with two layers using a ring slot, and circularly polarized radiation is achieved using curl radiation elements. We designed a radial line curl array antenna with 10 laps of radiating elements in a single layer of radial line, and a radial line curl array antenna with 8 laps of radiating elements in a two-layer radial line. Figure 1 shows the frequency characteristics of the antenna efficiency obtained through HFSS electromagnetic field analysis. The radial line curl array antenna with 10 laps of radiating elements in a single layer of the radial line had a realized gain of 31.6 dBi, antenna efficiency of 76.2 %, and a 3 dB gain bandwidth of 7.6 %. The radial line curl array antenna with 8 laps of radiating elements in a two-layer radial line had a realized gain of 29.3 dBi, antenna efficiency of 62.8 %, and a 3 dB gain bandwidth of 12.8 %.

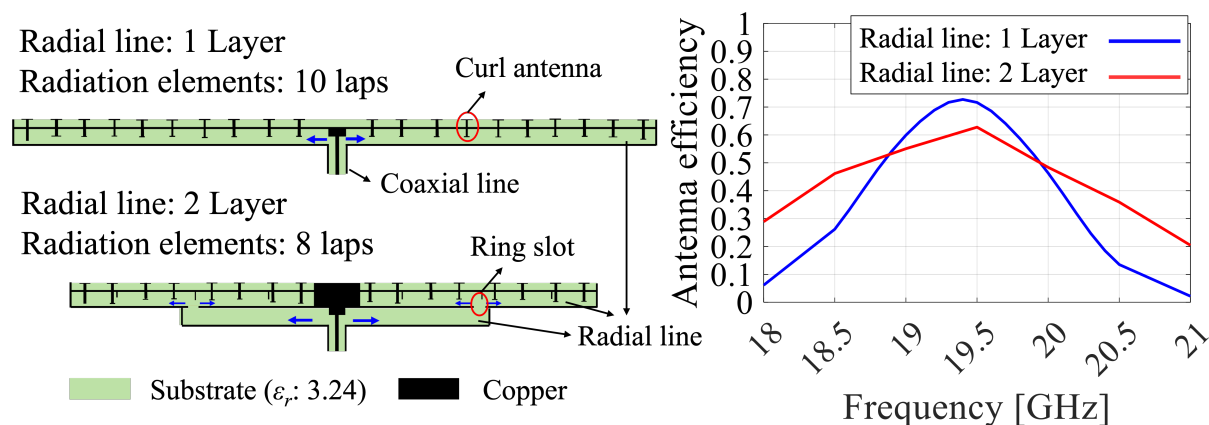


Figure 1. Cross section of single layer and two-layer radial line curl array antennas (left) and the antenna efficiency (right: Blue line is single layer radial line and Red line is two-layer radial line).