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Improving Radiation Efficiency Using Metamaterial in Pyramidal Horn Antenna

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Abstract : The proposed metamaterial design help to increase the radiation efficiency at 2.9 GHz by reducing the side and back lobes by making the phase difference of the waves emerging from the phase center of the horn antenna same after passing through metamaterial array. The unit cell of the metamaterial is having concentric ring structure made of copper of 0.035 mm thickness on both sides of FR4 sheet. The inner ring diameter is kept as 3 mm, and the outer ring diameters are changed according to the path and tramission phase difference of the unit cell from the phase center of the antenna in both the horizontal and vertical direction, i.e., in x- and y-axis. In this case, the ring radius varies from 3.19 mm to 6.99 mm with the respective S21 phase difference of -62.25° to -124.64°. The total phase difference can be calculated by adding the path difference of the respective unit cell in the array to the phase difference of S21. Taking one of the unit cell as the reference, the total phase difference between the reference unit cell and other cells must be integer multiple of 360°. The variation of transmission coefficient S21 with the ring radius is greater than -6 dB. The array having 5 x 5 unit cell is kept inside the pyramidal horn antenna (L X B X H = 295.451 x 384.233 x 298.66 mm3) at a distance of 36.68 mm from the waveguide throat. There is an improvement in side lobe level in E-plane by 14.6 dB when the array is used. The front to back lobe ration is increased by 1 dB by using the array. The proposed antenna with metamaterial array can be used in beam shaping for wireless power transfer applications.

Keywords : metamaterial, side lobe level, front to back ratio, beam forming
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