Design of CPW-fed Star-Shaped Monopole Antenna for UWB Applications using Transmission Line Model

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Research Article

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Abstract

This article presents a structure of coplanar waveguide (CPW)-fed star-shaped monopole antenna (SSMA) with a pair of quarter-circular-slit (QCS) and partly-hexagonal-ring-slit (PHRS) defected ground structure. By inserting a pair of QCS and PHRS on the rectangular ground plane, an excellent impedance bandwidth is achieved i.e., 139 % (from 2.2–12.21 GHz). The dimension of the SSMA is about $0.286\lambda_l \times 0.216\lambda_l$ mm², where λ_l is the wavelength in free space at the lowest operating frequency i.e., 2.2 GHz. The transmission line model (TLM) of the SSMA is presented and it shows the antenna behavior based on the effect of each element. It is observed that the characteristics of the TLM model are close to the simulation result using the CST simulator. From the results, it is observed that the proposed ultra-wideband (UWB) antenna close to omnidirectional radiation patterns and suitable for UWB Applications.

Full Text

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Figures

Figure 1

Geometrical configuration of 9-point star-shaped (a) one-equilateral triangles, (b) two-equilateral triangles, (c) three-equilateral triangles, (d) four-equilateral triangles, (e) merge all triangles and (f) nine-point star

Figure 2

(a) Geometry of the proposed SSMA top view and (b) prototype

(a)

Figure 3

Evolution of the SSMA design (a) Antenna 1, Antenna 2, Antenna 3 (proposed) and their corresponding (b) S_{11}

Figure 4

Surface current density distribution of the SSMA at (a) 2.8 GHz, (b) 6.1 GHz and (c) 9.4 GHz

Figure 5

Simulated S_{11} performance of the SSMA as a function of (a) r_1 and (b) m_1

Figure 6

Equivalent transmission line model-RLC circuit elements of the proposed SSMA (a) basic patch antenna, (b) star-shaped step discontinuities, (c) all slit and gap structure and (d) simplified RLC circuit model

Figure 7

Simulated and equivalent transmission line circuit model response of the SSMA

Figure 8

Actual antenna measurement environment in an anechoic chamber

Figure 9

Measured and simulated S_{11} performance of the SSMA

Figure 10

Measured and simulated peak gain of the SSMA

Figure 11

Simulated and measured radiation patterns of E-plane (left) and H-plane (right) of the SSMA at (a) 2.8 GHz, (b) 6.1 GHz and (c) 9.4 GHz