INVESTIGATIONS ON DESIGN OF PLANAR ANTENNAS FOR ULTRA-WIDEBAND AND MULTIBAND APPLICATIONS

ABSTRACT

The performance of an antenna greatly influences the effectiveness of the wireless device. The features expected from an antenna are application specific. High data rate applications require an antenna to operate in broadband or ultra-wideband (UWB), whereas a multi-functional wireless product requires an antenna to operate in multiple band to reduce interference. The desire of having more compact, lightweight, handy equipment made the most optimum choice for an antenna as planar antenna. Hence, the present investigation pertains to the systematic study of few techniques for the design of antennas for UWB and multiband applications.

The first part of this research presents the design of planar antennas for UWB applications. Under this, the design of slot antenna for UWB applications is explored. It investigates microstrip parasitic fed hexagonal patch which is surrounded by slot followed by ground plane for achieving UWB. The subsequent research work presents the design of circular patch fed by Coplanar Waveguide (CPW) and applies the technique of ground plane reduction to increase bandwidth. Further, the Complementary Split Ring Resonator (CSRR) metamaterial (MTM) slot was designed and engraved on circular patch to provide notch band at 5 GHz band where WLAN devices operate to circumvent the interference problem.

The second part of the research focuses on the design of planar antennas for multiband operation. A rectangular patch antenna fed with conductor backed CPW was designed for multiband operation. The ground in CPW feed was connected to backed conductor for extending the area of ground plane. Its multiband operation has been improved by the inclusion of CSRR MTM on the extended ground plane.

Subsequently, the dual band antennas were designed by making use of novel MTM structures as radiating elements. Electric Inductive Capacitive otherwise Electric LC (ELC) MTM

and Closed Ring Resonator (CRR) MTM structures were used as radiating elements. This antenna was CPW fed and resonated at dual band. Successively, Square Split Ring Resonator (SSRR) and CRR were also used as radiating elements in the study of antenna. This was also CPW fed and dual band operation was observed. Further, the resonance characteristics were altered using truncation of ground plane to trapezoidal shape.

All necessary parametric studies were carried out to finalize the dimensions of the antenna. One of the unique features of this research work is that all proposed antennas have been designed and fabricated on FR4 substrate which is easily available and economical. For all the antennas, return loss and radiation pattern characteristics are plotted. The attribution of dual or multi band operation of the proposed antenna to its particular element is substantiated by using plot on surface current distribution. In addition to the above parameters, group delay plot has been drawn for UWB antennas. The characteristics of MTM were derived using suitable technique.

Experimental investigations were carried out to study the performance of the designed antennas. The return loss was measured using a vector network analyzer, far-field radiation pattern and gain were measured using an anechoic chamber with necessary measurement devices. The results of these measurements prove the suitability of the antennas under investigations. The measured results of return loss, radiation pattern and gain were in good agreement with the simulated results.

In brief, parasitic fed hexagonal patch surrounded by slot and ground was proposed for bandwidth increase. Reduction of ground plane on both sides of CPW feed was introduced for improving the bandwidth. Defected structure utilizing metamaterial was analyzed for achieving notch band which results in multiband operation of the antenna. The new class of MTM structures such as ELC metamaterial and Square Split Ring Resonator (SSRR) metamaterial in addition to CRR were used as radiating elements for the realization of dual band antenna.

Keywords: Dual Band, Metamaterial, Multiband, Reduced ground plane,
Slot antenna, Ultra-Wideband (UWB).