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A Novel J Slot Antenna for UWB WiMedia

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Abstract

A novel J shaped slot antenna for ultra-wide band (UWB) WiMedia is presented. The proposed antenna is designed using a microstrip to slot line cross transition on FR4 substrate with permittivity 4.4. Return loss of the antenna is from 2.8- 13 GHz and occupies just $28 \times 10 \text{ mm}^2$ on the PCB. Radiation patterns are stable and omni-directional. Antenna transfer function and impulse response are analyzed to study the pulse handling capability of the antenna.

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1. Introduction

Compared to traditional carrier based systems, Ultra Wide Band (UWB), the carrier less way of communication, jointly uses excess bandwidth and very low transmitted power to provide a reliable radio link. Large bandwidth enables very fine time-space resolution for accurate location of the UWB nodes as well as high data rate communication, use of very short pulses aid in combating multipath fading and use of low power density leads to low probability of signal detection as well as coexistence with existing narrow band systems.

In the emerging UWB application known as WiMedia, compact, radiation efficient printed antennas are desired. The present paper discusses the design and performance of a slot antenna intended for WiMedia systems. In slot antennas, the transverse electric field constricted between a short ended slotline is transformed to free waves at the open end. Typically, a microstrip-to-slot line cross transition is used to excite the antenna. Bandwidth limitation of the crossjunction transition results mainly from the frequency dependance of the slot reactance and microstrip reactance¹. In², a tapered slot antenna with such an arrangement is proposed that operates in the lower UWB. In this design, the microstrip feed extends beyond the slotline to create a virtual short to minimize internal reflections in the transmission

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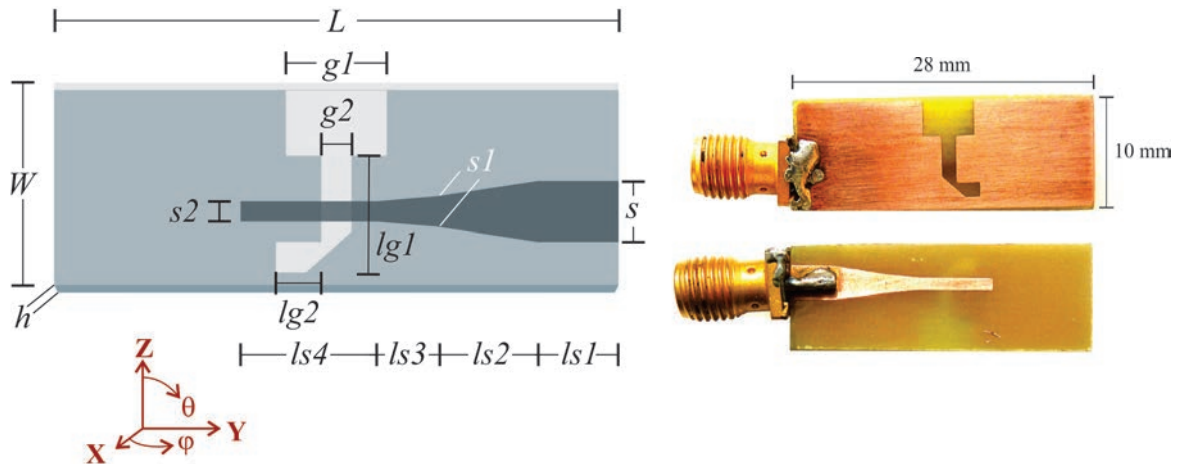


Fig. 1: Configuration of the proposed antenna.

line. Alternately, the microstrip line can be terminated in a stub as in³ to realize ultra-wide bandwidth. The tapered slot antenna proposed in⁴ has a novel design idea that combines electric and magnetic resonances in the geometry to realize operation in the full UWB. Novel design techniques to realize ultra wide bandwidth in slot antennas by modifying the microstrip feed at the cross-junction is proposed in⁵ and⁶. These antennas, in addition, have compact dimension and omni directional radiation that aid their use in commercial handheld devices. In this work, we have attempted to reduce the overall PCB area still further, without making any compromise on the radiation characteristics of the antenna. The antenna operates in the 3.1-10.6 GHz UWB with omni directional radiation that is constant throughout the entire UWB.

2. Evolution of the proposed antenna

The design idea of the antenna proposed in this paper is from^{5,6} where microstrip to slotline cross transitions are suitable designed to minimize internal reflections in the antenna geometry and result in UWB. It is also observed that small element antennas are good candidates for UWB as their radiation patterns remain almost omni-directional even at higher frequencies. In these antennas, surface currents at different parts of the geometry are in phase and generate constant radiation patterns. In the present work, the authors have combined these aspects and designed an ultra-wide band antenna that occupies very small area in the printed circuit board, with constant radiation pattern over the entire bandwidth. Design of the antenna is shown in Fig. 1.

It is evolved from a simple microstrip to slot line transition as shown in Fig. 2(a). To achieve a broad band impedance matching better than -10dB, the microstrip feed is first tapered at the transition region (Fig. 2(b)). An additional step cut introduced at the end of the open slot further transforms the guide impedance to free space impedance as shown in Fig. 2(c). Size of the antenna can further be minimized by folding the shorted end of the slot line as indicated in Fig. 2(d). Impedance mismatches resulting from the folding is minimized by meandering the slot line as in Fig. 2(e). Simulations indicate that the resulting impedance bandwidth of the antenna is from 2.8 13 GHz.

3. Antenna design and performance

Geometrical parameters of the antenna (in mm) when designed on FR4 glass epoxy with relative permittivity $\epsilon_r = 4.4$ and height $h = 1.6$ mm are: $s = 3$, $s_1 = 1.5$, $s_2 = 1$, $g_1 = 5$, $l_{s1} = 4$, $l_{s2} = 5$, $l_{s3} = 5$, $l_{s4} = 4$, $g_2 = 1.5$, $l_{g1} = 5.75$, $l_{g2} = 2.25$, $L = 28$, $W = 10$. Measured return loss of the antenna shows close correspondence with simulation as indicated in Fig. 3.

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