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Design and Analysis of Microstrib-Fed Band Notch Uwb Antenna

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Abstract:

A compact printed microstrip-fed monopole ultra wideband antenna with multi notched bands is presented. The UWB slot antenna, covering 3.1–11 GHz A straight, open-ended quarter-wavelength slot is etched in the radiating patch to create the first notched band in 3.3–3.7 GHz for the WiMAX system. In addition, three semicircular half-wavelength slots are cut in the radiating patch to generate the second and third notched bands in 5.15–5.825 GHz for WLAN and 7.25–7.75 GHz for downlink of X -band satellite communication systems. Surface current distributions and transmission line models are used to analyze the effect of these slots.it produced broadband matched impedance and good omnidirectional radiation pattern. The designed antenna has a compact size of 25 x29 mm^2.

I. I.INTRODUCTION

In recent years, ultrawideband (UWB) systems, over the 3.1–10.6-GHz band, have attracted a lot of attention for the commercial applications. An important part of theUWB system is the antenna. For most of the applications, the antenna is required to have an omnidirectional and stable radiation pattern, high radiation efficiency, low group delay, and low profile.it is mainly used for high-data-rate wireless communication, high-accuracy radar, and imaging systems. support low output power and high data rate (110–200 Mb/s) applications over short ranges (4–10 m). Also,lower rate intelligent applications that provide accurate location-tracking capabilities over increased link range, i.e., over 30 m, are supported. The first successful UWBapplication is as a wireless universal serial bus (USB) enabler, where a PC or a laptop is wirelessly connected to a printer, hard drive, or other peripherals.Antenna Design of a Planar Ultrawideband With a New Band-Notch Structure,Chong-Yu Hong, Ching-Wei Ling, I-Young Tarn, and Shyh-Jong Chung, *Senior Member*, *IEEE*

A novel planar ultrawideband (UWB) antenna with band-notched function. The antenna consists of a radiation patch that has an arc-shaped edge and a partially modified ground plane.The antenna that makes it different from the traditional monopole antenna is the modification in the shape of ground plane, including two bevel slots on the upper edge and two semicircle slots on the bottom edge of the ground plane. These slots improve the input impedance bandwidth and the high frequency radiation performance. With this design, the return loss is lower than 10 dB in 3.1–10.6 GHz frequency range and the radiation pattern is highly similar to the monopole antenna. By embedding a pair of T-shaped stubs inside an elliptical slot cut in the radiation patch, a notch around 5.5 GHzWLANband is obtained. The average gain is lower than 18 dBi in the stopband, while the patterns and the gains at frequencies other than in the stopband are similar to that of the antenna without the band-notched function.

Band-Notched Design for UWB Antennas
The-Nan Chang and Min-Chi Wu

A method to form a notch band is presented.We etch complementary split-ring resonators in the T-stub region of a CPW-feed ultrawideband (UWB) antenna. Due to limited space in this region, we connect two resonators together so that they have a common slot edge. Compared with two separated CSSRs, this new design not only occupies less space but also yields high mismatch losses. It is found that high mismatch losses and deep suppression level can be obtained at the desired notch band.A Compact Ultrawideband Antenna With 3.4/5.5 GHz Dual Band-Notched Characteristics Qing-Xin Chu, *Member*, *IEEE*, and Ying-Ying YangWe propose a compact planar ultrawideband (UWB) antenna with 3.4/5.5 GHz dual band-notched characteristics. The antenna consists of a beveled rectangular metal patch and a 50 ohm coplanar waveguide (CPW) transmission line. By etching two nested C-shaped slots in the patch, band-rejected filtering properties in the WiMAX/WLAN bands are achieved.

The proposed antenna is successfully simulated, designed, and measured showing broadband matched impedance, stable radiation patterns and constant gain. An equivalent circuit model of the proposed antenna is presented to discuss the mechanism of the dual band-notched UWB antenna.Integrated Bluetooth and UWB Antenna-Bahadir S. Yildirim, Bedri A. Cetiner, *Member, IEEE*, Gemma Roqueta, *Student Member, IEEE*, and Luis Jofre, *Member, IEEE*

A small-sized, low-profile, and planar integratedBluetooth and ultrawideband (UWB) antenna is presented. The antenna exhibits a dual-band operation covering 2400–2484 MHz (Bluetooth) and 3100–10600 MHz (UWB) frequency bands. Itis fed by a microstrip line and built on a FR-4 substrate with 42X 46 mm^2 surface area. The impedance, radiation, phase linearity, and impulse response properties of the antenna are studied both theoretically and experimentally. The calculated and measured results agree well. The antenna shows acceptable gain flatness with stable omnidirectional radiation patterns across the integrated Bluetooth and UWB bands. The average group delay is approximately 0.2 ns across UWB frequencies.Bandwidth Enhancement of Novel Compact Single and Dual Band-Notched Printed Monopole Antenna With a Pair of L-Shaped Slots Reza Zaker, Changiz Ghobadi, and Javad Nourinia A dual band-notched printed ultrawideband monopole antenna is presented, with a modified ground plane. By using this modified element including a pair of variable L-shaped slots, cut in the ground plane, additional resonances are excited and hence the bandwidth is increased up to 130%. To generate single and dual band-notched characteristics, we use inverted U- and fork-shaped parasitic structures, respectively, instead of changing the patch or feedline shapes. By properly adjusting the dimensions of these capacitive-coupled elements, not only one or two controllable notch resonances are achieved, but also the lower-edge frequency of the band is decreased. The measured results show that the proposed dual band-notched monopole antenna offers a very wide bandwidth from 2.2 to 13.4 GHz (143%), defined by 10-dB return loss, with two notched bands, covering all the 5.2/5.8-GHz WLAN, 3.5/5.5-GHz WiMAX and 4-GHz C bands.

II. MICROSTRIP PATCH ANTENNAS

INTRODUCTION- In the past few years, the concept of creating microwave antennas using microstrip has gained much attention and possible designs are now emerging. Microstrip patch antennas have gained popularity in today’s world of wireless technology due to its many advantages such as low profile, conformability to both planar and non-planar surfaces, low cost, ease of integration with other components, mechanically robust and simple to fabricate. However the main drawback with microstrip antennas lies in its narrow bandwidthINPUT IMPEDANC STRUCTURE OF MICROSTRIP ANTENNA- Microstrip antenna consists of a very thin metallic strip (patch) ($t << \lambda o$) placed a small fraction of a wavelength above a ground plane ($h << \lambda o$, usually $0.003\lambda o \leq h \leq 0.05\lambda o$). The microstrip patch is designed so its pattern maximum is normal to the patch (broadside radiator). End-fire radiation can also be accomplished by proper choosing mode of excitation. For rectangular patch, the length L of the element is usually $\lambda o /3 \leq L \leq \lambda o /2$. The strip and the ground plane are separated by a dielectric substrate. The ones that are most desirable for antenna performance are thick substrates whose dielectric constant is low because they provide better efficiency, larger bandwidth, loosely bound fields for radiation into space, but at the expense of larger element size.

The radiating patch may be square, rectangular, thin strip (dipole), circular, elliptical, triangular or any other configuration. These and others are Square, rectangular, dipole, and circular are the most common because of ease of analysis and fabrication, and their attractive radiation characteristics. Arrays of microstrip elements, with single or multiple feeds may also be used to introduce scanning capabilities and achieve greater directivities.

III. FEEDING METHODS

There are many configurations that can be used to feed microstrip antennas. The most popular four feed methods are

MICROSTRIP FEEDING LINE- It is a conducting strip of much smaller width compared to the patch. It is easy to fabricate, simple to match by controlling the inset position and simple to model, However, as the substrate thickness increases, surface waves and spurious feed radiation increases, which for practical designs limits the bandwidth (typically 2-5%).

COAXIAL LINE FEED **-** The inner conductor of the coaxial line is attached to the patch while the outer conductor is connected to the ground plane, The coaxial probe feed is also easy to fabricate and match, and it has low spurious feed radiation. However, it also has narrow bandwidth and it is more difficult to model, especially for thick substrates ($h > 0.02\ \lambda o$).The previous two methods (microstrip feeding line and coaxial line feed) generate higher order modes, which produce cross-polarized radiation. To overcome some of these problems, the following two feed may be used.

APERTURE COUPLING **-** It is the most difficult of all four to fabricate and it also has narrow bandwidth. However, it is easier to model and has moderate spurious radiation. It consists of two substrates separated by a ground plane. On the bottom side of the lower substrate, there is a microstrip feed line whose energy is coupled to the patch through a slot on the ground plane separating the two substrates. This arrangement, allows independent optimization of the feed mechanism and the radiating element. Typically a high dielectric material is used for the bottom substrate, and thick, low dielectric constant material for the top substrate. The ground plane between the substrates also isolates the feed from the radiating element and minimizes interference of spurious radiation for pattern formation and polarization purity. *Matching is performed by controlling the width of the feed line and the length of the slot.*

PROXIMITY COUPLING **-** It has the largest bandwidth (as high as 13%), it is somewhat easy to model and has low spurious radiation. However, its fabrication is somewhat more difficult. *The length of the feeding stub and the width-to-line ratio of the patch can be used to control the match.*

FEEDS WITH MODIFICATION **-** There are different types of feed with modification, it are mainly depend on the previous four main feed with some modifications and can be classified as follows:

PROBE FEED **-**Narrow slot around the probe feed- For conventional Probe-fed microstrip antennas with thick substrate, the major problem associated with impedance matching is the large probe reactance owing to the required long probe pin in the thick substrate layer. To solve this problem, a variety of designs with modified probe feed has been reported. One design method is to cut an annular slot or narrow rectangular ring slot around the feed in the radiating patch. By choosing suitable dimension of the ring slot, the large probe reactance can be compensated, and good impedance matching over a wide bandwidth can be obtained.

CAPACITIVELY PROBE FEED **-** Miguel et al present a single microstrip patch arrays enclosed in metallic cavities and placed on thick substrates of very low permittivity materials with the application of the capacitive probe feeding in place of the direct junction probe-radiating patch, The goal is to obtain broad-band microstrip antennas on thick substrates without the limitations due to the generation of surface waves of the conventional microstrip antennas on infinite substrates.

IV. METHODS OF ANALYSIS

The most popular models for the analysis of Microstrip patch antennas are the transmission line model, cavity model, and full wave model (which include primarily integral equations/Moment Method). The transmission line model is the simplest of all and it gives good physical insight but it is less accurate. The cavity model is more accurate and gives good physical insight but is complex in nature. The full wave models are extremely accurate, versatile and can treat single elements, finite and infinite Microstrip patch with L-probe feed arrays, stacked elements, arbitrary shaped elements and coupling. These give less insight as compared to the two models mentioned above and are far more complex in nature.

RANSMISSION LINE MODEL**-** This model represents the microstrip antenna by two slots ofwidth W and height h, separated by a transmission line of length L. The microstrip is essentially a non-homogeneous line of two dielectrics, typically the substrate and air.most of the electric field lines reside in the substrate and parts of some lines in air. As a result, this transmission line cannot support pure transverse electro- magnetic (TEM) mode of transmission, since the phase velocities would be different in the air and the substrate. Instead, the dominant mode of propagation would be the quasi-TEM mode. Hence, an effective dielectric constant (ε_{reff}) must be obtained in order to account for the fringing and the wave propagation in the line. The value of ε_{reff} is slightly less then ε_r because the fringing fields around the periphery of the patch are not confined in the dielectric substrate but are also spread in the air In order to operate in the fundamental TM_{10} mode, the length of the patch must be slightly less than $\lambda/2$ where λ is the wavelength in the dielectric medium and is equal to $\lambda_o/\sqrt{\varepsilon_{reff}}$ where λ is the free space wavelength. The TM_{10} mode implies that the field varies one $\lambda/2$ cycle along the length, and there is no variation along the width of the patch. In the Fig.5.4 shown below, the microstrip patch antenna is represented by two slots, separated by a transmission line of length L and open circuited at both the ends. Along the width of the patch, the voltage is maximum and current is minimum due to the open ends. The fields at the edges can be resolved into normal and tangential components with respect to the ground plane.

It is seen from that the normal components of the electric field at the two edges along the width are in opposite directions and thus out of phase since the patch is $\lambda / 2$ long and hence they cancel each other in the broadside direction. The tangential components (seen in Fig.5.5), which are in phase, means that the resulting fields combine to give maximum radiated field normal to the surface of the structure. Hence the edges along the width can be represented as two radiating slots, which are $\lambda / 2$ apart and excited in phase and radiating in the half space above the ground plane.The dimensions of the patch along its length have now been extended on each end by a distance ΔL.

CAVITY MODEL- Although the transmission line model discussed in the previous section is easy to use, it has some inherent disadvantages. Specifically, it is useful for patches of rectangular design and it ignores field variations along the radiating edges. These disadvantages can be overcome by using the cavity model. A brief overview of this model is given below. In this model, the interior region of the dielectric substrate is modeled as a cavity bounded by electric walls on the top and bottom. The basis for this assumption is the following observations for thin substrates ($h << \lambda$)

Since the substrate is thin, the fields in the interior region do not vary much in the z direction, i.e. normal to the patch. The electric field is z directed only, and the magnetic field has only the transverse components H_x and H_y in the region bounded by the patch metallization and the ground plane. This observation provides for the electric walls at the top and the bottom. When the microstrip patch is provided power, a charge distribution is seen on the upper and lower surfaces of the patch and at the bottom of the ground plane. This charge distribution is controlled by two mechanisms-an attractive mechanism and a repulsive mechanism as discussed by Richards. The attractive mechanism is between the opposite charges on the bottom side of the patch and the ground plane, which helps in keeping the charge concentration intact at the bottom of the patch. The repulsive mechanism is between the like charges on the bottom surface of the patch, which causes pushing of some charges from the bottom, to the top of the patch. As a result of this charge movement, currents flow at the top and bottom surface of the patch. The cavity model assumes that the height to width ratio (i.e. height of substrate and width of the patch) is very small and as a result of this the attractive mechanism dominates and causes most of the charge concentration and the current to be below the patch surface. Much less current would flow on the top surface of the patch and as the height to width ratio further decreases, the current on the top surface of the patch would be almost equal to zero, which would not allow the creation of any tangential magnetic field components to the patch edges. Hence, the four sidewalls could be modeled as perfectly magnetic conducting surfaces. However, in practice, a finite width to height ratio would be there and this would not make the tangential magnetic fields to be completely zero, but they being very small, the side walls could be approximated to be perfectly magnetic conducting.Hence, in order to account for radiation and a loss mechanism, one must introduce a radiation resistance R_r and a loss resistance R_L. A lossy cavity would now represent an antenna and the loss is taken into account by the effective loss tangent δ_{eff} .

V .ANTENNA DIMENSIONS

- Length of the patch = 29mm
- Width of the patch = 25mm
- Substrate thickness = 0.8mm

VI. GEOMENTRY OF ANTENNA

Fig.1.Model of WiMAX rejection band

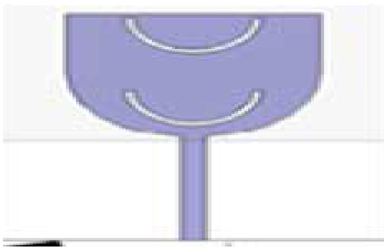

Fig.2.Model of X- band rejection

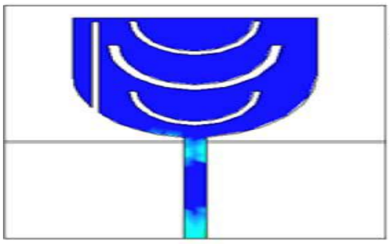

Fig.5.WiMAX,WiLAN and X –band satellite communication systems band rejection of antenna

VII.RESULTS

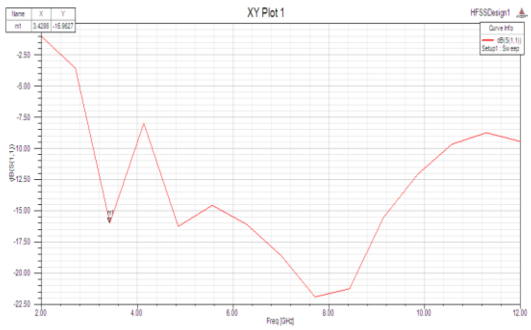

Fig.4. Output of WIMAX rejection band

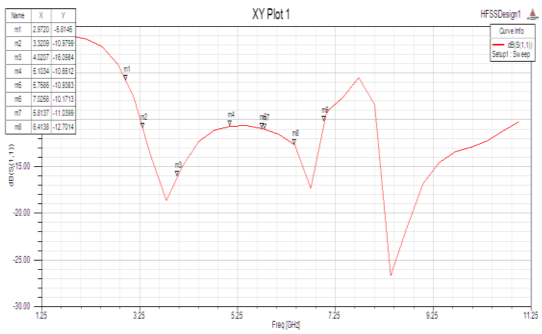

Fig.5. Output of X-band rejection

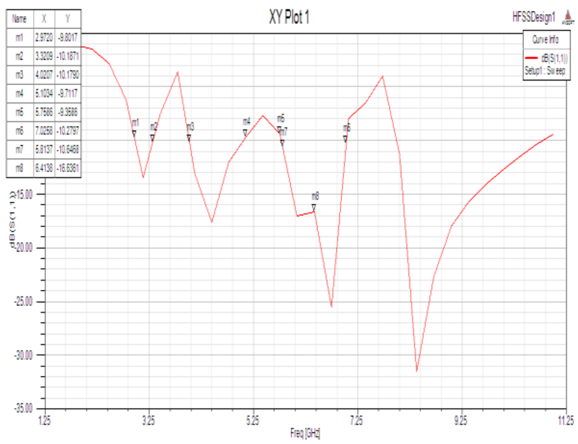

Fig.6.Output of 3 band rejection antenna

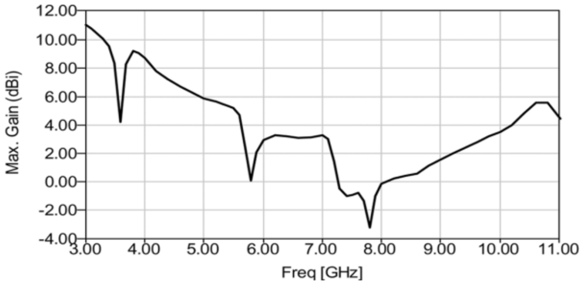

Fig.7. Calculated maximum gain of the antenna

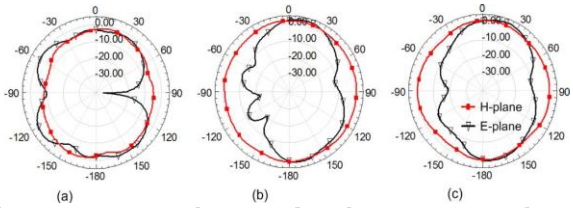

Fig. 8. Measured radiation patterns in the H- and E-planes at (a) 4.8, (b) 8.5,and (c) 10 GHz.

Simulation was performed using the commercial software Ansoft HFSS. The final design was optimized taking several aspects into consideration such as bandwidth of the antenna, bandwidth of the notched bands, and level of band rejection. The antenna has a compact volume of 25X 29X 0.8 mm^2 on FR4 substrate with a relative dielectric constant of 4.4 and loss tangent of 0.02. It is composed of a 50-ohm microstrip feed line, a planar radiating patch with an arc-shapededge, a simple rectangular ground plane, and slots.Fig.4,5&6 shows simulated and measured of the antenna with three notched bands. The measurement was performed with an Agilent 8719 A network analyzer. It is observed that the antenna notches three intended bands while maintaining broadband performance with less than 10 dB, covering the entire UWB frequency band. The discrepancy in between measured and simulated results is mostly attributed to thetolerance in fabrication and loss tangent of the FR4 substrate.Measured radiation patterns in the H-plane and E-plane. The antenna displays a good omnidirectional radiation pattern in the H-plane, even at high frequencies.

VII. CONCLUSION

In this letter, a compact printed microstrip-fed dual bandnotched UWB antenna has been presented and analyzed in detail. To obtain three notched bands, two types of slots—a straight open-ended quarter-wavelength type and a semicircular halfwavelength type—were etched in the radiating patch. We introduced a new term, an effective length of a slot, and used this concept along with the surface current distributions and transmission line models to analyze the physical effects of these slots generating the band-notched characteristics. The antenna was fabricated and measured, showing broad bandwidth, three designed notched bands, and good omnidirectional radiation patterns.

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