Path Antenna Design

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Abstract

The **Patch Antenna**, or microstrip antenna, sends electromagnetic field radiation towards another antenna structure. In addition to creating high frequency signals, it is light weight, low cost, with additional advantages such as ease of fabrication and integration with RF devices.

Overview

Approach

1. Optimizing the dimensions and impedance matching by designing a prototype patch for a frequency of 2.105 GHz, to check the functionality of the antenna and verify the design approach works.
2. Applying the previous design approach to design a patch antenna for the frequency of 845MHz.

Applications

The most common application of this antenna is in cellular telephone communication, Wi-fi, UMTS and other applications with a large requirement for a multi frequency antenna.

Challenges

- Not being able to calibrate a cellphone.
- No option for changing the board type or size.
- Difficulty in trimming the copper tape to get the frequency of such a narrow band design.

Design specifications

Finding the length and width of the patch

H=0.00157m

ε_r=3.0F/M

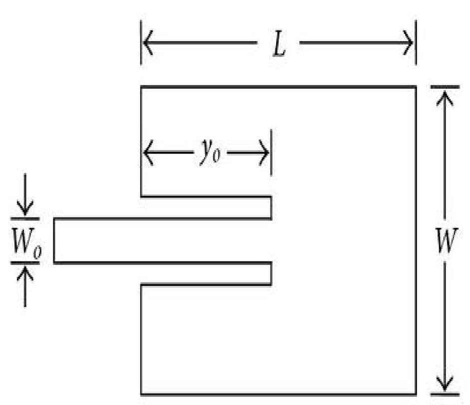
F_r= 842MHz

W_0=1mm

$r \geq 2\frac{W^2}{\lambda} \geq \frac{\lambda}{2}$

F_r= 2.105GHz→ $r = 20cm$

F_r=842MHz→ $r = 36cm$



$$\varepsilon eff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left[1+12\left(\frac{h}{w}\right)\right]^{-\frac{1}{2}} = 2.932470$$

$$\Delta L = 0.412h\frac{(\varepsilon eff+0.3)(\frac{w}{h}+0.264)}{(\varepsilon eff-0.258)(\frac{w}{h}+0.8)} = 0.706685mm$$

$$L_{eff} = L+2\Delta L = \frac{1}{2fr\sqrt{\varepsilon eff}\sqrt{\varepsilon 0\mu 0}} = 103.9835mm$$

$$W = \frac{1}{2fr\sqrt{\mu 0\varepsilon 0}}\sqrt{\frac{2}{\varepsilon r+1}} = 125.91212mm$$

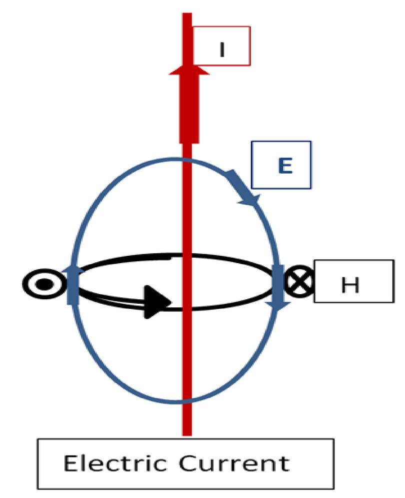
$L = L_{eff} - 2\Delta L$=102.5701613mm

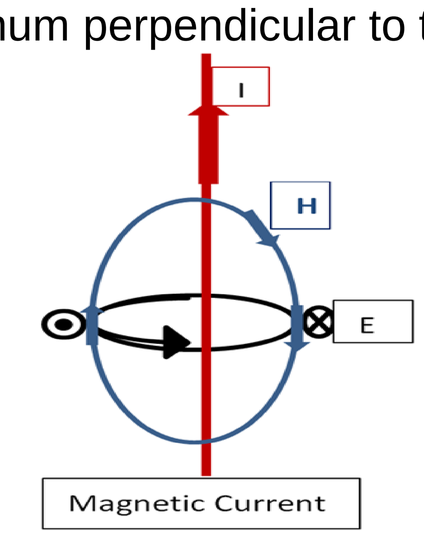
W_0=1mm

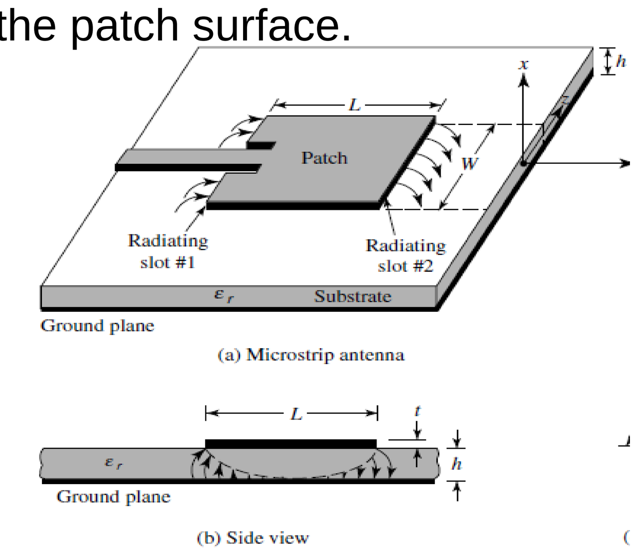
Procedure Description

Polarization of the Antenna

- Radiation, caused by the fields in the open edges, behaves like the radiation from a wire dipole antenna, but electric (E) and magnetic (H) fields radiated by the slot behave like the fields from a wire antenna with E and H reversed .
- The width is a microstrip transmission line . The slots at the right and left edges of patch are separated by a half wavelength.
- The fields extensions are known as fringing fields and cause the patch to behave like it is longer that its actual length.
- The electric field of both antennas should be aligned in space to transmit and receive the most power. E x H gives us the wave direction which is the maximum perpendicular to the patch surface.

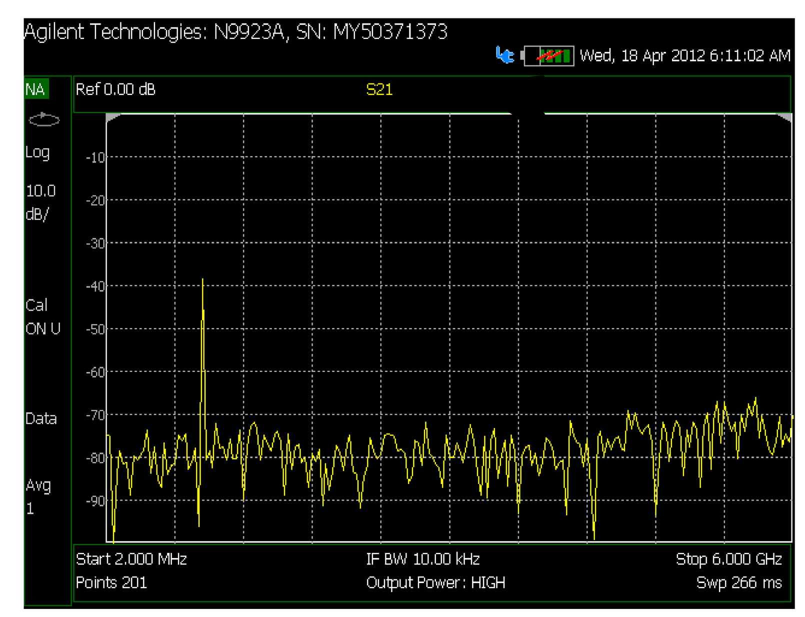




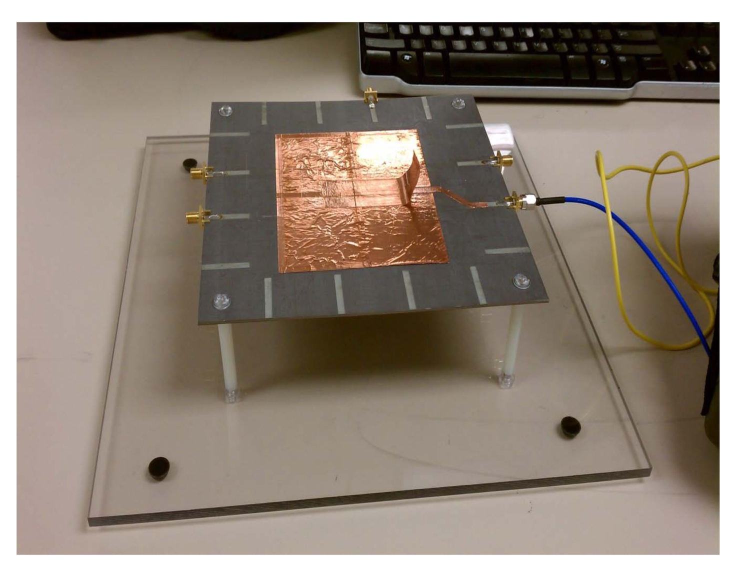


Capture Cellphone Frequency

The first step in the design is to find the right resonant frequency f_r for a cellphone antenna. The commercial antenna has a broader bandwidth, so they were used to determine the cellphone frequency. The peak frequency appears about 842MHz as soon as we face the cellphone to antenna and send signals.



Type of Feed Structure

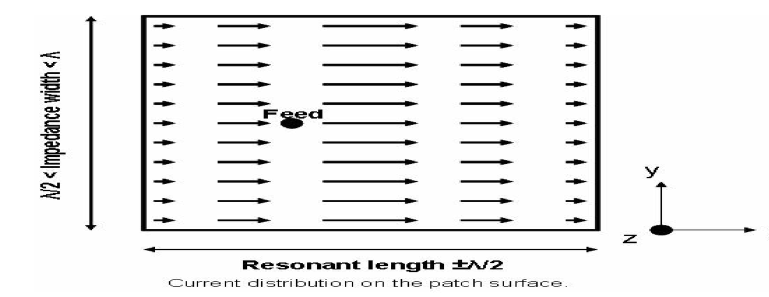


The type of feed is a microstrip line in which the conducting strip is directly connected to the edge of the patch. Since the board was small for the patch, a straight connection was not possible. Since the antenna board is fixed, it is the best possible feeding pattern which makes the fabrication and modeling easier as well as impedance matching. A small width of conducting strip, compared to the patch, has the advantage that the feed can be engraved on the same substrate to provide a planar structure. The connection was improved by cutting the edges of the right angle since there are more loses for a right angle.

Procedure Description and Results

Impedance matching

1. Impedance $Z = \frac{V}{I} = \frac{Electrical\ field\ varation}{Magnetic\ field\ varation}$
2. current is maximum in the center and minimum near the edges.
3. Input impedance > transmission line impedance
4. To have maximum power when Z0=Zin (Matched impedance)
5. The matching process involves adjusting the value y0 by recessing a distance y0 from the patch edge. Impedance matching is done by varying y0 . A 2inch wide conducting tape is located in about the middle of the board on the patch then the width and length of the copper tape is trimmed to implement desired resonant frequency.



Results

As a result, theIPhone is located in front of the designed patch and the frequency displaced in the network analyzer is about 840MHz.

Figure 1

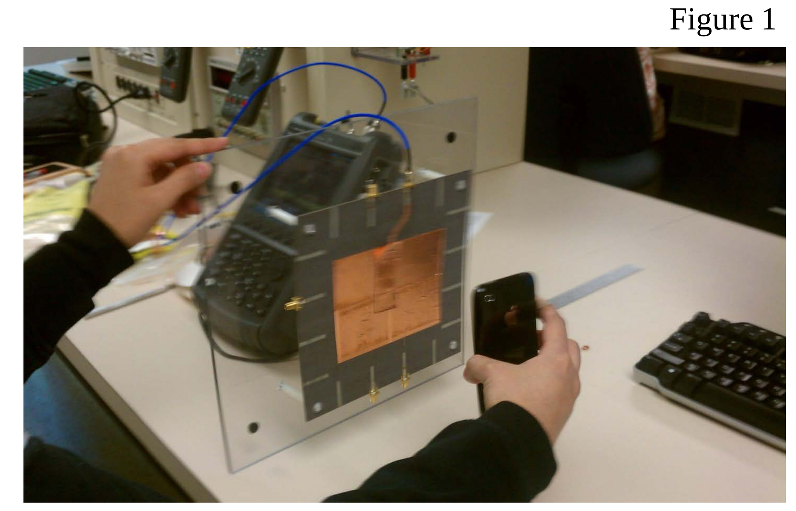


Figure 2

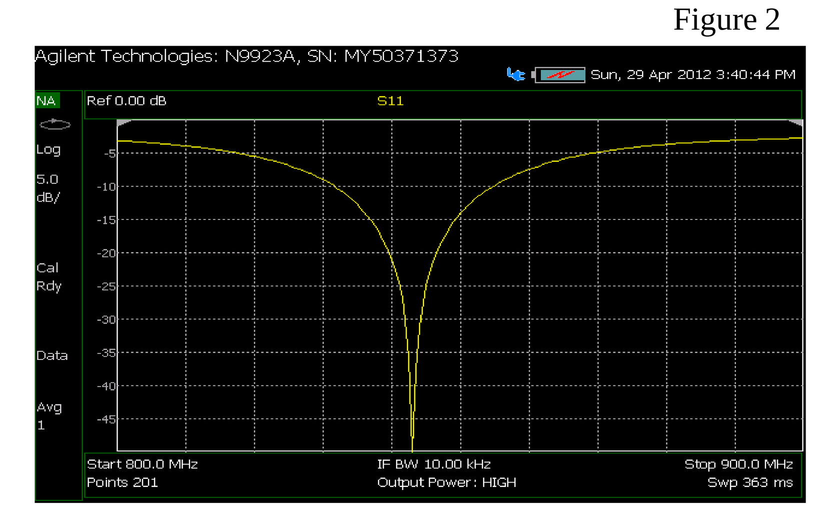


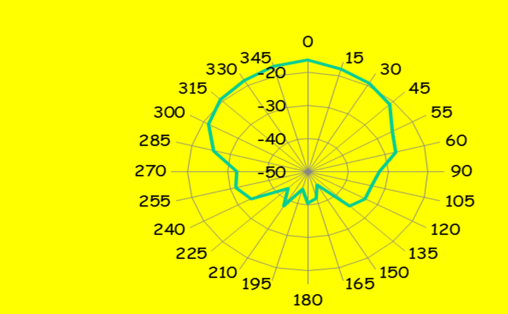
Figure1 shows the last procedure checking the performance of the proposed antenna with an iPhone.

Figure 2 demonstrates the significant improvement in impedance matching at the design frequency.

Figure 3 shows the radiation pattern of the antenna which resembles that of a half wave wire dipole. The beam width is about a 60 degree.

S21for diffrent angles

Figure3



Conclusion

As we see, the design met the requirement; the future goal is to make it smaller so it can be used in an actual cellphone or smart phone.

References

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