# Enhanced Bandwidth Printed Folded Loop Antenna for Mobile Communications

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## I.  INTRODUCTION

Mobile communications is the most rapidly developing sector in the telecommunications industry for the last few years. The growing market demand generates interest in the performance of printed compact antenna elements mounted on portable devices. Some of the desired features for mobile antennas include omnidirectional radiation pattern on the horizontal plane, broad bandwidth, low profile geometry, and ease of conctruction. Printed antennas are attractive candidates over convetional antennas due to their inherent advantages. These antennas are low profile, low weight, low cost, and can be easily integrated into planar circuit designs. In the past some antennas, like the monopole [1] and PIFA [2], [3], have received attention and were analysed extensively. This paper presents the characteristics of an enhanced bandwidth printed folded loop antenna mounted on a dielectric covered box to simulate a mobile telephone. Radiation patterns and input impedance are determined by both measurements and computer simulations based on the FDTD method.

## II.  PRINTED FOLDED LOOP ANTENNA CONFIGURATION

The basic configuration of this antenna is shown as inset in Figure 2. The antenna is printed on a homogeneous and lossless dielectric substrate. It is mounted on a dielectric covered box to simulate a portable telephone with a plastic case surrounding the metal chassis. The dielectric constant of the dielectic material is $\epsilon_r = 2.6$ and the thickness 2.5 mm for both the substrate and the dielectric coating of the box. The length of the loop is 2.75 cm, the height is 2.125 cm, the strip width is 2.5 mm, and the element is fed on the left side by a coaxial cable. The dimensions of the substrate are 4 cm x 6 cm. The antenna element is covered with a dielectric layer of the same dimensions as the substrate with permittivity $\epsilon_r = 2.6$ and 2.5 mm thickness. The entire antenna element structure takes the form of a sandwich with a superstrate cover, which is needed to protect the printed antenna from environmental conditions (corrosion) and give the antenna an attractive appearance.

The existing mobile systems operate in the 820-960 MHz frequency band. Therefore, it is desirable for the antenna element to resonate within this operating band. The radiation pattern on the azimuthal plane (xy-plane) was calculated at 900 MHz using the FDTD and was found to be nearly isostropic for the copolar $E_\theta$ component, as shown in Figure 1. The FDTD predicted pattern compares favorably with measurements as illustrated in Figure 1. Similar comparisons were made for the elevation patterns (xz and yz planes) with very good agreement between measurements and calculated data. Figure 2 illustrates the variation of return loss versus frequency. The measured resonant frequency is 878 MHz, the predicted is 904 MHz and the percent bandwidth for 2:1 VSWR is about 5.60 %.

# III. PRINTED FOLDED LOOP ANTENNA LOADED WITH PARASITICS

One of the major disandvantage of printed antennas is their narrow bandwidth. The problem of increasing the bandwidth of microstrip antennas has received some attention in the literature in the past [4]. The parasitic element approach is followed in this printed antenna design to enhance the bandwidth, as illustrated in Figure 4. The parasitic elements used in this case for loading are the two small strips with dimensions 2.5 mm x 5.0 mm inside the folded loop and the long strip with dimensions 0.5 cm x 5.5 cm outside the loop. The separation between the antenna and the upper parasitic element is 2.5 mm. The size of the dielectric substrate and the sandwich form of the entire structure remain the same as in previous case. The combination of these parasitic elements, their size, and their position are chosen to optimize the design in terms of bandwidth and resonant frequency. The radiation pattern of $E_\theta$ is illustrated in Figure 3. The calculated pattern is compared with measurements and is found to be in very good agreement. The return loss versus frequency is plotted in Figure 4. where the measured resonant frequency is 862 MHz and the predicted is 889 MHz with a 2:1 VSWR bandwidth of about 9.8 %. This illustrates that the bandwidth has been increased about 4.2 % with the parasitic loading. A very good agreement with measurements is also obtained in this case.

# References

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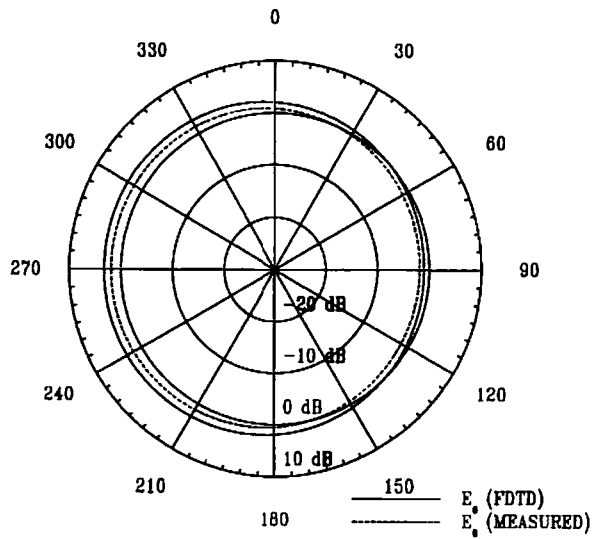
Figure 1: Radiation pattern ($E_\theta$ component) on xy-plane of printed folded loop antenna without parasitics mounted on a dielectric covered box.
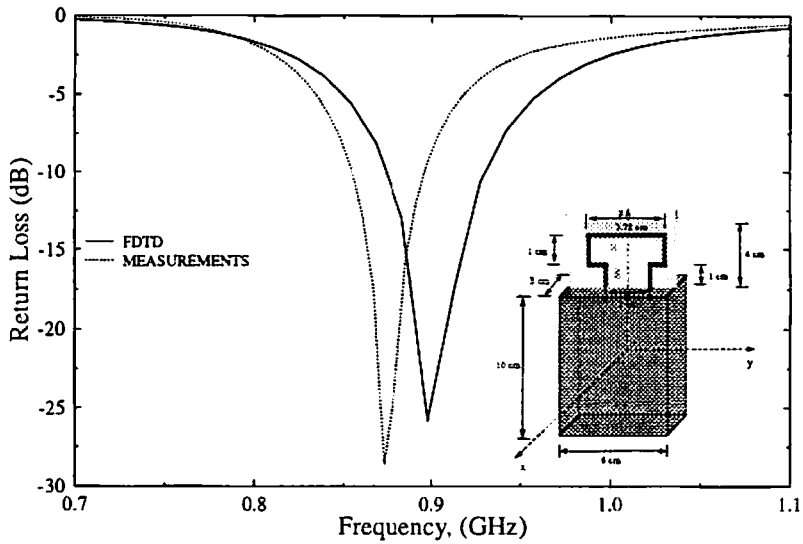


Figure 2: Return loss versus frequency of printed folded loop antenna without parasitics mounted on a dielectric covered box.
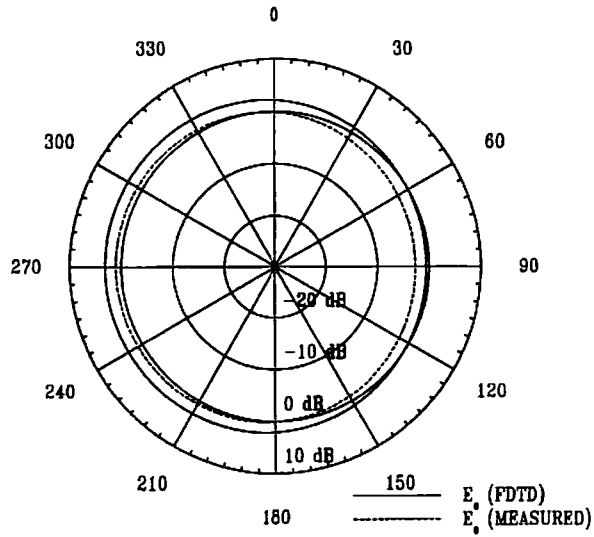
Figure 3: Radiation pattern ($E_\theta$ component) on xy-plane of printed folded loop antenna with parasitics mounted on a dielectric covered box.
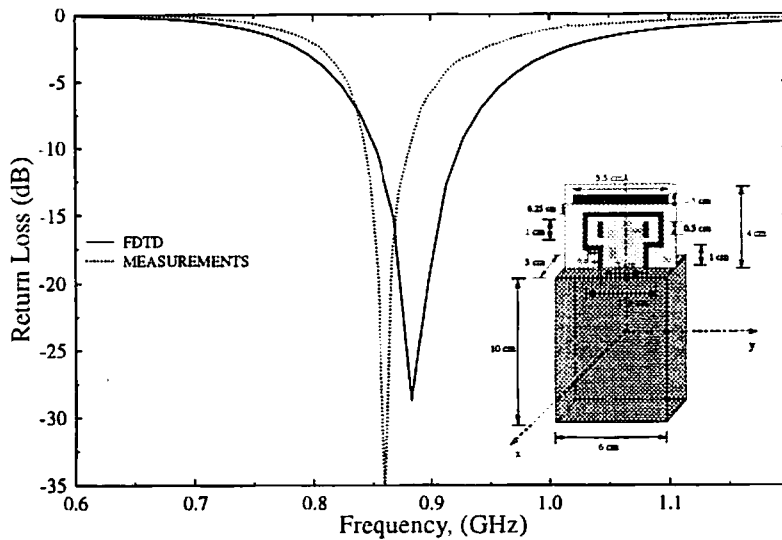


Figure 4: Return loss versus frequency of printed folded loop antenna with parasitics mounted on a dielectric covered box.