A Proposal of a Small Planar Loop Antenna which can Switch the Polarization Direction

Mitsuru MURAMOTO*, Kiyohiko ITOH*, Nozomu ISHII*, and Kanemi SASAKI**

* Department of Electronic Engineering, Hokkaido University
Nishi 8, Kita 13, Kita-ku, Sapporo, 060, JAPAN

** Kokusai Electric Co., LTD
3-14, Akedori, Izumi-ku, Sendai, 981-32, JAPAN

1. INTRODUCTION

It has been well known technology to provide a loop antenna inside a casing of a radio apparatus. These small antennas, however, have low radiation resistance, and so have extremely low efficiency. The directivity of these loop antennas depends upon the shape, and received gain extremely change in posture of the receiver. Moreover, the gain of the loop antenna depends upon the area of the loop, which is under the limitation of the shape or the size of the case, so that it is difficult to make a radio apparatus more portable and smaller without reducing the gain of the antenna.

This study has been made with a view to overcoming the problems involved with loop antennas used for the portable radio apparatus presently available. We propose a loop antenna consisting of two rectangular parallel boards which is small and thin. This small antenna has conductors which shorts the conductive boards. By switching the position of the conductors, it is possible to change the polarization direction[1],[2].

In this paper, first, we show the polarization directivity characteristic of the planar loop antenna. Next, we make an fundamental experiment for confirming the effect of changing the polarization direction. Finally, we introduce an application for watch-sized receiver.

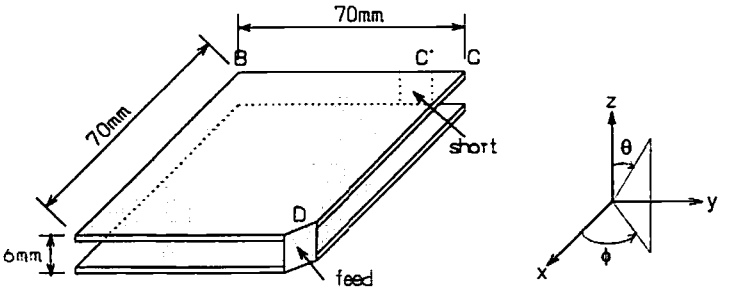

Fig. 1 : A planar loop antenna and spherical coordinates

2. A PLANAR LOOP ANTENNA

The perspective view of a planar loop antenna is shown in Fig. 1. This small antenna has two planar rectangular conductive boards (a length and a width are 70mm) placed in parallel at an interval 6mm. The size of this antenna is very small compared with the wavelength (1.07m) of the working radio wave (280MHz). This conductive boards comprise the case of a radio apparatus itself as well as the small loop antenna. Inside this case will be functional circuits for a radio apparatus. There are an oscillator (280MHz) and a dry cell this time. A feeding point is at a corner D. And there is a short conductor at C'. Fig. 2 shows the polarization directivity characteristic of the electrical field along the z axis[1],[2].

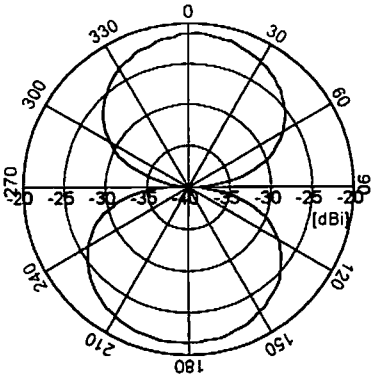

Fig. 2 : A polarization directivity characteristic (θ=0 plane)

We examine the polarization characteristic against the position of the conductor[3]. The conductor is moved from D through C to B. Fig. 3 shows the maximum gain and its direction versus position. From this figure, we know the polarization direction can be operated by the position of the conductor[4]. The polarization turns the vertical direction when the antenna is shorted near C' at distance 10mm from the corner C.

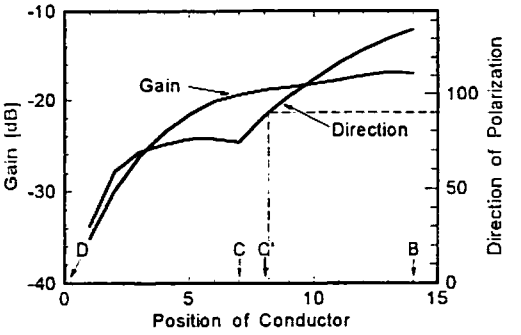

Fig. 3 : Maximum gain and its direction versus position of the conductor

The reason we use planar loop antennas is for increasing the gain compared with normal wire loop antenna. Fig. 4 shows various loop antennas. Fig. 4 (a) is normal wire loop antenna, (b) is a frame planar loop antenna, (c) is an one-sided plate planar loop antenna

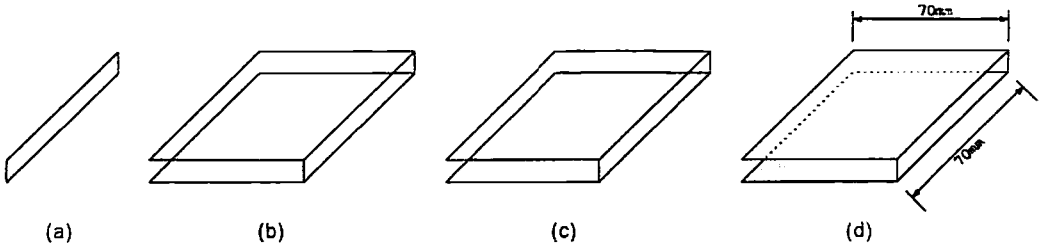

Fig. 4 : Loop antennas

and (d) is a both-sided plate planar loop antenna. The maximum gains of the polarization directivity are -25.0dB, -23.7dB, -21.4dB and -19.4dB, respectively.

3. A NOVEL PLANAR LOOP ANTENNA

It is possible to change the polarization direction of the electric field by switching the position of the conductor. If the short position is switched automatically, it is possible to keep the directivity of the antenna at the most desirable condition responsive to the direction of a desired radio wave[3].

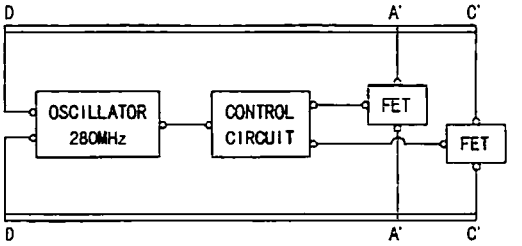

Fig. 5 : A Circuit for switching the conductors

Fig. 5 shows the circuit for switching the conductors automatically, and we use a planar loop antenna as depicted in Fig. 6. Inside the antenna, there are a switching circuit, an oscillator and a dry cell. We use GaAs FETs for open/short controllable switch at high frequency.

Fig. 7 shows the polarization directivity characteristic of the electrical field along the z axis while the circuit shorts the position A' and C' alternately. This figure indicates the good effect of switching, though FETs reduce the maximum gain by about 5dB in comparison without FETs due to the internal resistance of FETs. If we can control the short circuit successfully, there is only 3dB difference between maximum and minimum of the gain.

4. APPLICATION

We propose a loop antenna as shown in Fig.8 as a watch-sized receiver. The bottom of this antenna is a conductive planar plate, and the top has only wire frame because the top view has a dial plate. This shape makes a gain larger

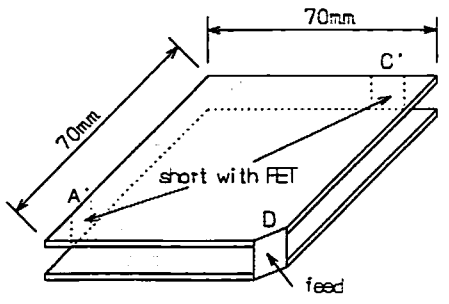

Fig. 6 : A planer loop antenna with changeable conductors.

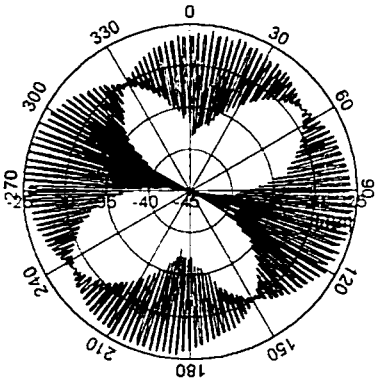

Fig. 7 : A polarization directivity characteristic (θ=0 plane)

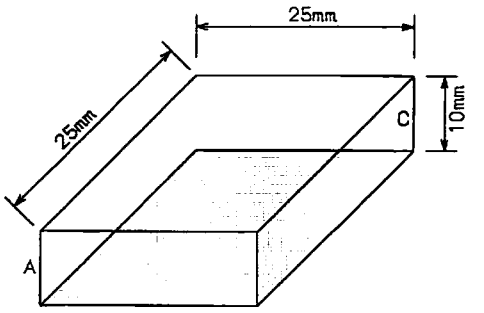

Fig. 8 : An antenna for a watch-sized receiver

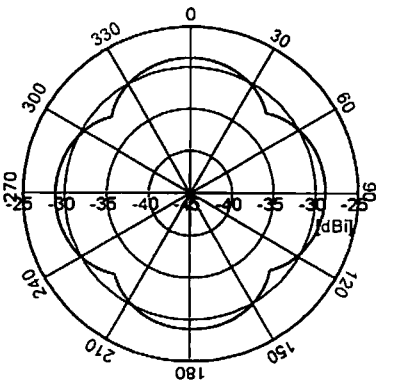

Fig. 9: A polarization directivity characteristic (θ=0 plane)

than normal wire loop, and the bottom plate is able to be combine with the ground of a circuit substrate. Fig. 9 shows the polarization directivity characteristic when we can control the conductors(A and C).

5. CONCLUSION

In this paper, a small planar loop antenna with switch(FETs) for portable radios have been proposed. The polarization directivity characteristics of the electrical field have been presented. The gain of the antenna with FETs decrease about 5dB compared with normal loop antenna because of the internal resistance of FET. But the null of the polarization directivity fade and the minimum gain is only 3dB smaller than the maximum. If we can control the short circuit successfully, it is possible to provide the more desirable condition responsive to the direction of the desired radio waves(polarization diversity). By way of example, we introduced an application of this idea to a watch-sized receiver.

ACKNOWLEGEMENT

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