Wideband Characteristics of Planar Loop Antennas

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Abstract

Broadband antennas have been required to establish ultra wideband (UWB) systems. This paper proposes a wideband planer loop Antenna with wideband characteristics and simple structure. This antenna is modified from a double rectangular loop printed antenna that has 76% relative bandwidth. Here, a wideband planar loop antenna with slit is studied for slit parameters. By the simulation, it is clarified that the frequency characteristics of the antenna depend on the vertical slit. Through some trial, maximum relative bandwidth 143% is achieved at Zo=103Ω.

1. Introduction

The demand for higher speed radio communication systems has been increased. In order to realize such higher-speed communication systems, broadband antennas must be required.

The wideband antennas have already been developed for measurements, however, it is important to develop low cost and compact antennas that have wideband characteristics for practical use. The authors have proposed the double loop rectangular printed antenna as a simplified wideband antenna [1]. This antenna has a wideband characteristic that has the maximum value of the relative bandwidth of 76% within 1.5 for VSWR. The authors have also proposed the wideband planer loop antenna [2] that has wide band characteristics and simple structure by modifying the double rectangular loop printed antenna in VSWR characteristics.

And it is clarified the cause of that wideband planer loop antenna became wideband than double rectangular loop printed antenna, through observing the change of characteristics by changing the slit width.

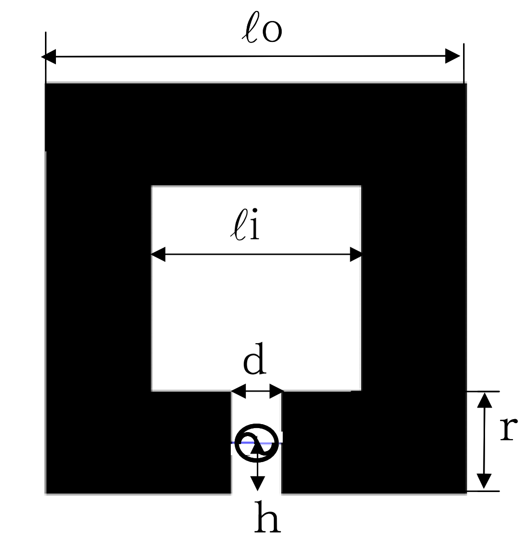
In Section 2, the structure of the Wideband Planer Loop Antenna is described. In Section 3, the influence of slit width and characteristic impedance on frequency characteristic is discussed. And effect of loop size on wideband characteristics is discussed in Section 4.

2. Configuration ob Planar Loop Antennas

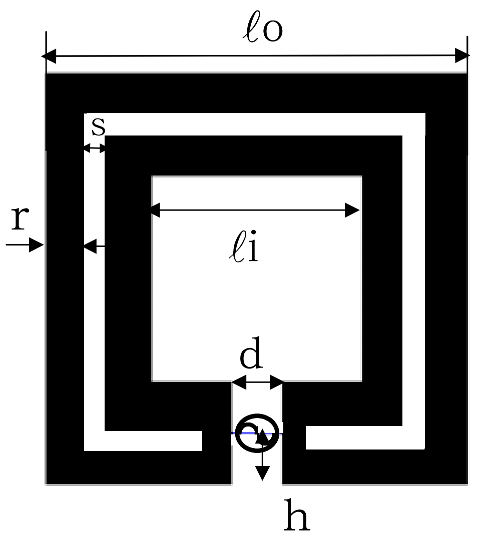
The structure of a wideband planar loop antenna that is improved from a double rectangular loop printed antenna is shown in Fig.1 (a).

The structure of wideband planar loop antenna corresponds to the shape that the space between an inner loop and an outer loop of a double rectangular loop printed antenna filled up with conductor. The feed point is located at the joint of loops. The length of the outside of loop, the length of inside of loop, and the distance between the feed point and bottom of the antenna are ℓo, ℓi , and h, respectively. The width of the feed point and the width of the conductors are d and r, respectively.

And, the structure of wideband planar loop antenna with slit is shown in Fig.1 (b). In Fig.1 (b), the width s indicates the width of the slit, and the slit is located at the center of the conductors. The shape of s=0 is correspond to the original structure of wideband planar loop antenna. We analyzed the antenna using the moment method (EEM-MOM).



(a) Single Loop (without slit)



(b) Double Loop (with slit)

Fig.1 Structure of Wideband Planer Loop Print Antenna

3. Effects of Slit on Wideband Characteristics

A. Effects of Slit Width

Figure 2 shows the relationship between slit width and frequency band when ℓi = 0.5ℓo, h=0.2r, and characteristic impedance Zo=100Ω. f1 is the lowest frequency and f2 is the highest frequency within 2.0 for VSWR .Figure 2 shows the change of f1 and f2 when characteristic impedance is changed from 50Ω to 200Ω.

The hatched area in Fig.2 indicates the frequency band within 2.0 for VSWR. It is found that the hatched area is separated to two bands of a high frequency band and a low frequency band. When the slit width is changed 0 to 0.05r, the band is divided into three areas in lower frequency band. And each band becomes narrow as the slit width is increased.

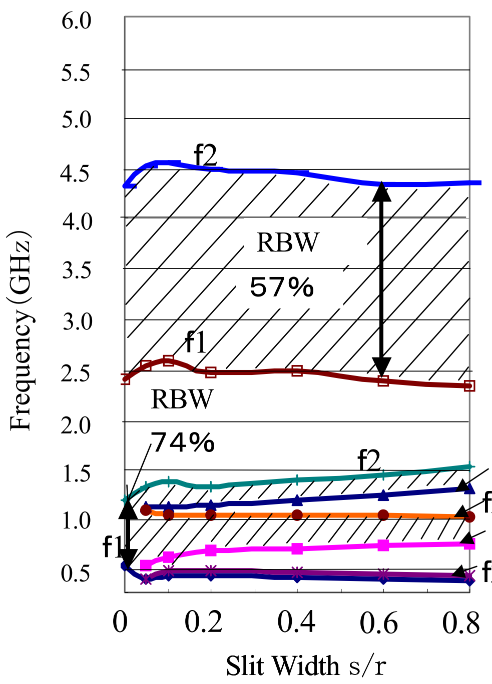
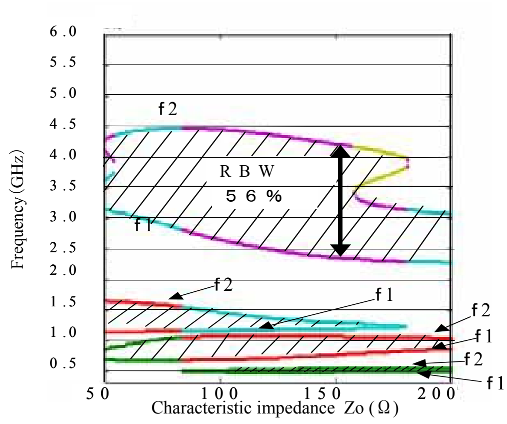


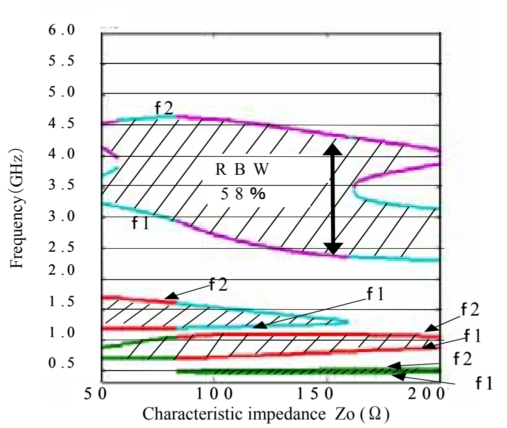
Fig.2 Effect of Slit Width on Frequency Band

B. Effects of Characteristic Impedance

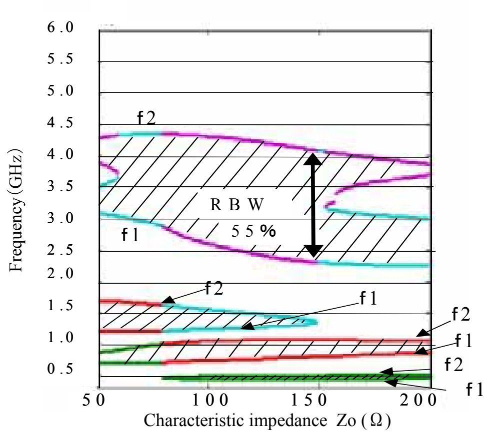
In Fig.3 (a), the band at low frequency separates to three band even characteristic impedance Zo is changed. And the tendency is not so changed even if the slit width was changed as shown Fig.3 (a), (b), (c). Thus, It is expected that the structure without slit has better performance in frequency characteristics.



(a) s =0.2r



(b) s =0.4r



(d) s =0.6r

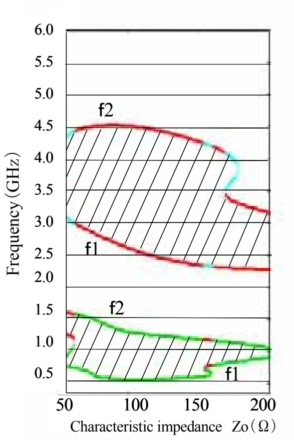
Fig.3 Effect of Characteristic Impedance on Frequency Band

C. *Effect of Location of Slit*

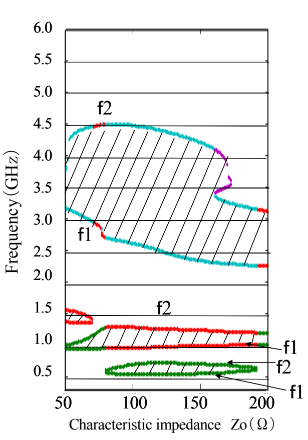
Figure 4 shows the effect of characteristic impedance on frequency band when s=0.2r. Figures 4 (a), 4 (b), 4 (c) and 4 (d) indicated result when without slit, only vertical slit, only upper side horizontal slit, and only lower side horizontal slit.

It is found that Figures 4(c) and 4 (d) are almost the same characteristics as Fig.4 (a). But, Figure 4 (b) is different from Fig.4 (a) in low frequency band. In Fig.4 (b), low frequency band that VSWR value below 2.0 is divided into three. This is the same characteristic as Fig.3 (a).

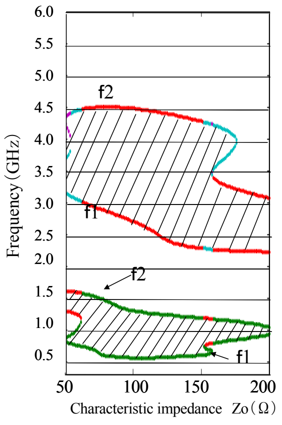
So, it is understood that the vertical slit influences on the frequency band characteristics of lower frequency band. And each of upper part slit and lower part slit doesn't influence on band characteristics.



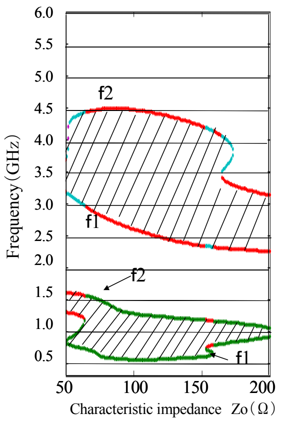
(a) Without Slit



(b) With Only Vertical Slit



(c) With Only Horizontal Slit at Upper Side



(d) With Only Horizontal Slit at Lower Side

Fig.4 Effect of Slit on Frequency Band

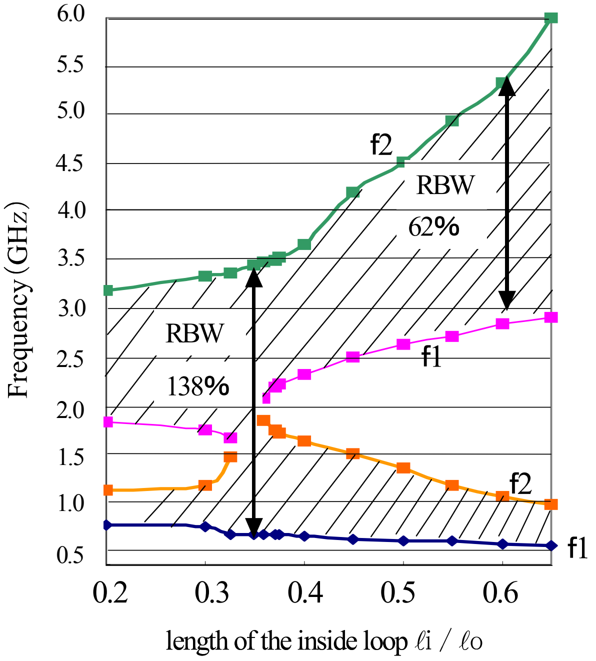


Fig.5 Effect of Length of the Inside Loop (Zo=100Ω)

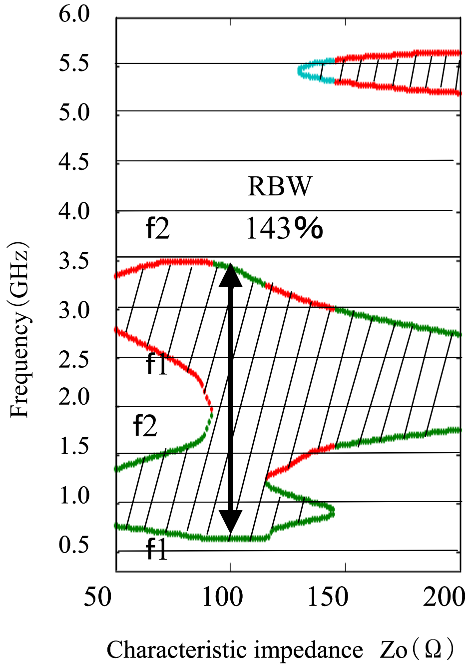


Fig.6 Highest Frequency (f2) and Lowest Frequency (f1) (*ℓi /ℓo* =0.35)

4. Effect of Loop Size on Wideband Characteristics

Figure 5 shows variation of frequency band within 2.0 for VSWR when Zo=100Ω. The values in the figures show percentage of relative bandwidth. In Fig.5, the maximum relative bandwidth of 138% is obtained when *ℓi /ℓo* =0.35, and 62% in *ℓi /ℓo* =0.6. When the *ℓi* is increased from *ℓi /ℓo* =0.2 to about *ℓi /ℓo* =0.35, space between two band becomes narrow, and they jointed together at *ℓi /ℓo* =0.35. And when the *ℓi* is increased from *ℓi /ℓo* =0.32 to *ℓi /ℓo* =0.65, distance between f2 and f1 at center of the figure is extended. But, the band is separated into two areas. So, it is understood that the maximum relative bandwidth is obtained at *ℓi /ℓo* =0.35.

Figure 6 shows the variation when characteristic impedance is changed. We can see that the distance of the highest frequency f2 and lowest frequency f1 are extended when Zo is approximately 100Ω. And, the high frequency band and the low frequency band are combined together and the maximum relative bandwidth 143% is achieved at Zo=103Ω.

5. Conclusion

The wideband characteristics of planar loop antennas with slit or not were studied to clarify the cause of that wideband planer loop antenna became wideband than double rectangular loop printed antenna.

By the simulation, it was clarified that the frequency characteristics of the antenna depended on the vertical slit. Through some trial, maximum relative bandwidth 143% was achieved at Zo=103Ω.

References

[1] S. Tanaka, T. Hori, M. Fujimoto, "Broadband printed antenna with double rectangular loops," Proc.of ISAP'04, Sendai, Japan, 3B2-5, pp.681-684, Aug., 2004.

[2] N. Oomura, T. Hori and M. Fujimoto, "Wideband Planer Loop Printed Antenna," Proc. IEICE Conf., B-1-101, Mar. 2006. (in Japanese)

[3] N. Oomura, T. Hori and M. Fujimoto, "Structure of TV reception antenna suitable for car window installation," Proc. IEICE Conf., AP2005-73, Sep. 2005. (in Japanese)