

A Self-Diplexing Antenna Using Slitted Patch Antenna

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1 Introduction

In a mobile terminal antenna for satellite communications, a diplexer with high internal isolation between transmitting and receiving port is required and it has already proposed that several types of self-diplexing antennas act as a part of diplexer in the antenna itself [1] [2]. For example, the two-layer self-diplexing antenna which consists of a circular microstrip patch and a ring patch, which has a shorted ring structure, is suitable for reducing the size and weight of the array antenna including diplexer. In order to solve the problem of this antenna, the shorted ring made by through holes is not easy for manufacturing, it has already proposed two-layer self-diplexing antenna, a patch antenna with a hole and a concave shaped patch for the lower antenna [3]. These two self-diplexing antenna structures suppress the mutual coupling between upper and lower antenna. The stacked antenna using concave shaped patch is easier for manufacturing. However, from the radiation characteristics of this antenna, the cross polarization is increased because of using concave shaped patch instead of patch with a hole.

In order to suppress the cross polarization of the stacked antenna using concave shaped patch, this paper proposes two-layer self-diplexing antenna, a patch antenna for upper antenna and a patch antenna with two slits for the lower antenna. The frequency and radiation characteristics of this antenna are calculated by FDTD analysis.

2 Analysis model

Fig.1 shows the radiation characteristics and current distribution at the resonant frequency of the concave shaped patch. By using the concave shaped patch, the cross polarization level of the antenna is increased up because of the current distribution. The current is strong at not only top edge and bottom edge but also both side edges. In order to cancel the current of side edge and suppress the level of cross polarization, we consider one more slit opposite side of concave slit.

Fig.2 shows novel self-diplexing stacked patch antenna. This antenna consists of an upper patch and a lower patch with two slits. The upper patch antenna is excited by electromagnetic coupling by using slit part of the lower patch. The size of upper patch antenna is 30×30 mm and that of lower patch antenna is 33×33 mm with slit. The dielectric constant of bottom layer is 2.6 and that of upper layer is 4.0. To find parameter suppressing the mutual coupling between two antenna and also suppressing the cross polarization of each antenna, we change the size of slit, the feed point location of the antenna. We simulated the antenna characteristics by using FDTD method.

3 Patch antenna with one slit and two slits

First, we examine the influence of two slit part on the characteristics of stacked antenna. Geometries of the stacked antenna with one and two slits are shown in Fig.2. The antenna of (a) has one slit and that of (b) has two slit on the lower patch antenna. Second slit of (b) is just added the same size slit opposite side of concave part of (a). The S parameter characteristics of these two antennas are shown in Fig.4. Fig.4(a) shows the characteristics by using concave shaped antenna, that is one slit, and (b) shows the characteristics by using patch with two slits. The resonant frequency of both antennas are not changed because the current length is not changed. However the return loss levels are changed because impedance is changed. At the resonant frequencies of the upper and lower antenna, the mutual coupling characteristics (S₂₁) are both suppressed less than -25dB . Fig.5 shows the radiation characteristics of each stacked antenna. The cross polarization of the antenna using concave shaped patch is nearly -10dB at second frequency (Freq.=2.5GHz) as shown in Fig.5(a). However, by using the lower patch with two slit, the cross polarization is suppressed less than by using concave shaped patch. Therefore, we use the patch antenna with two slit for lower antenna.

4 Antenna characteristics

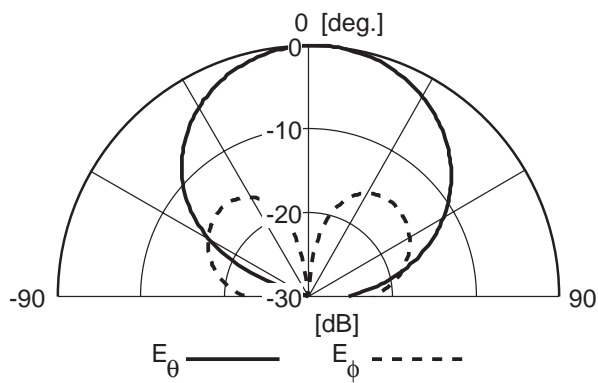
Fig.6 shows the S parameter characteristics of stacked antenna by changing the size of slit opposite side of slit used for exciting upper patch. The resonant frequency of the upper patch is not changed. The resonant frequency of the lower patch shifts to lower side when the slit length becomes large because of the current flow. The mutual coupling is suppressed less than -30dB at both of resonant frequencies. Therefore, both antennas are operated independently at both resonant frequencies. However, the return loss level is high because the impedance matching is not good. By changing the location of feed point of the lower antenna, we examined the return loss characteristics. The return loss level is changed by the feed point location but the level isn't suppressed less than -10dB . By changing the size of slit, the radiation characteristics are also examined. The level of cross polarization is changed by the size of slit. By using the same size of slit, the level of cross polarization is suppressed.

5 Conclusion

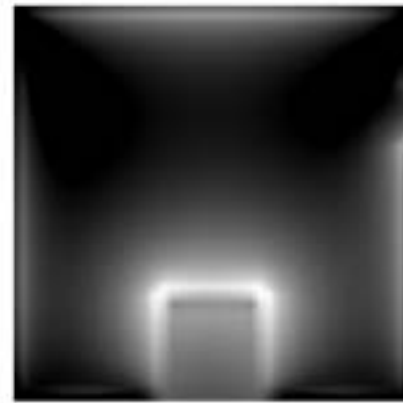
In this paper, we presented the stacked self-diplexing antenna which consists of a electromagnetic coupled patch as the upper antenna and a patch antenna with two slits as the bottom antenna. We simulated the S parameter characteristics and radiation pattern. Our proposed self-diplexing antenna structure suppress the mutual coupling between upper and lower antenna less than -30dB and the cross polarization level less than -15dB .

References

- [1] W.Chujo, M.Fujise, M.Nakano, H.Arai and N.Goto, "A two layer self-diplexing antenna using a circularly polarized ring patch antenna", IEICE Transactions, vol. E-74, no.10, Oct. 1991.
- [2] Y.Rikuta and H.Arai, "A Self-Diplexing Antenna Using Patch With A Hole", Asia Pacific Microwave Conference '99, pp.2208-2211, Dec. 1999.
- [3] Y.Rikuta and H.Arai, "A Self-Diplexing Antenna Using Stacked Patch Antennas", Antennas and Propagation Society '00, pp.2208-2211, July. 2000.



(a) Radiation pattern



(b) Current distribution

Figure 1: Antenna characteristics of concave shaped patch

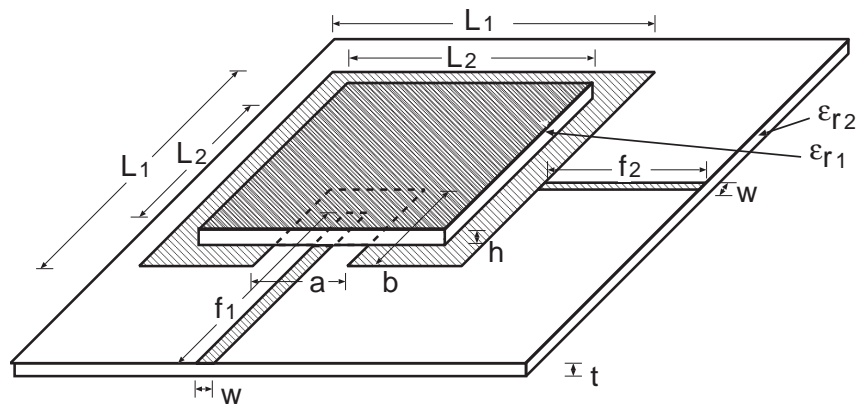


Figure 2: Geometry of self-diplexing antenna using concave shaped patch (1 slit)

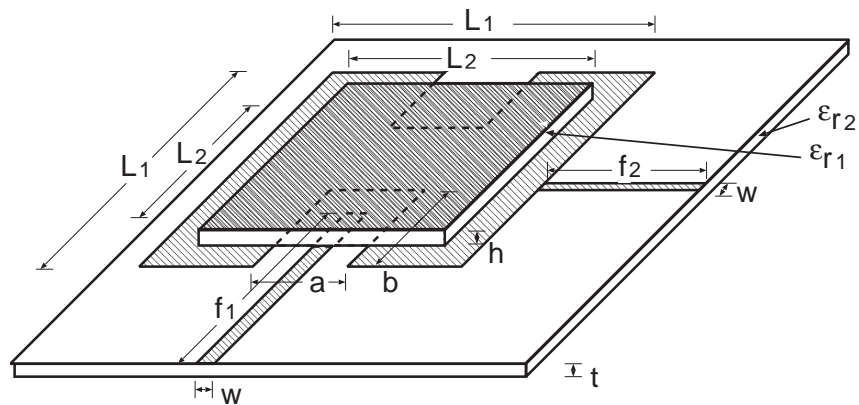


Figure 3: Geometry of self-diplexing antenna using 2 slit for lower patch
 $L_1=33, L_2=30, w=4.8, t=h=1.6$ [mm], $\epsilon_{r1}=2.6, \epsilon_{r2}=4.0$

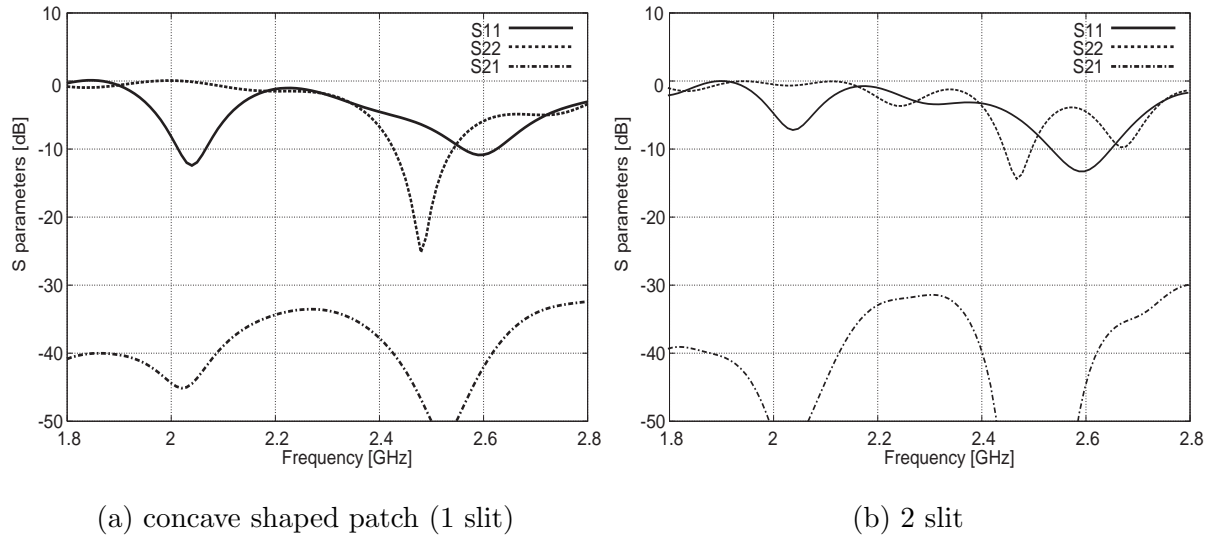


Figure 4: S parameter characteristics per number of slit

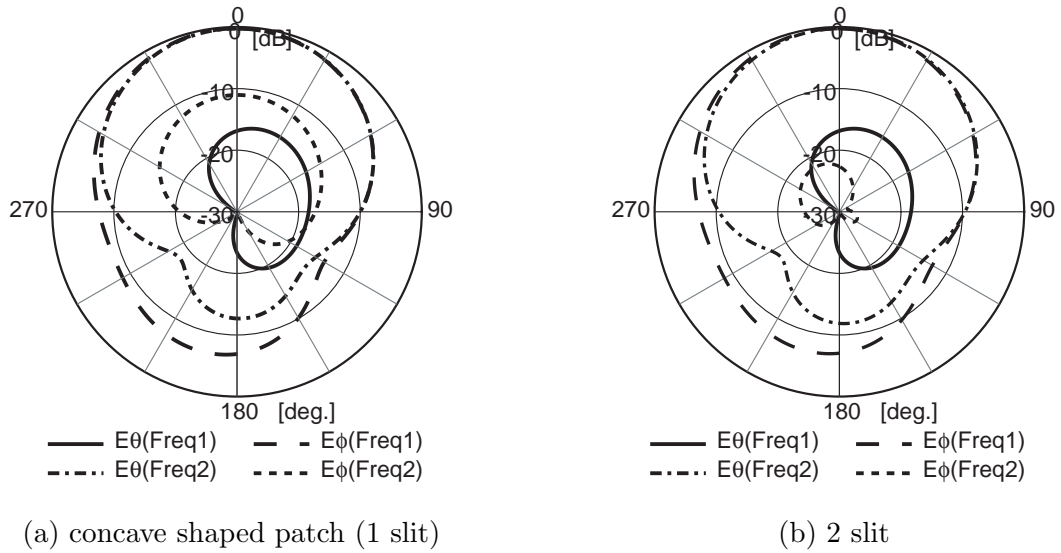


Figure 5: Radiation pattern per number of slit

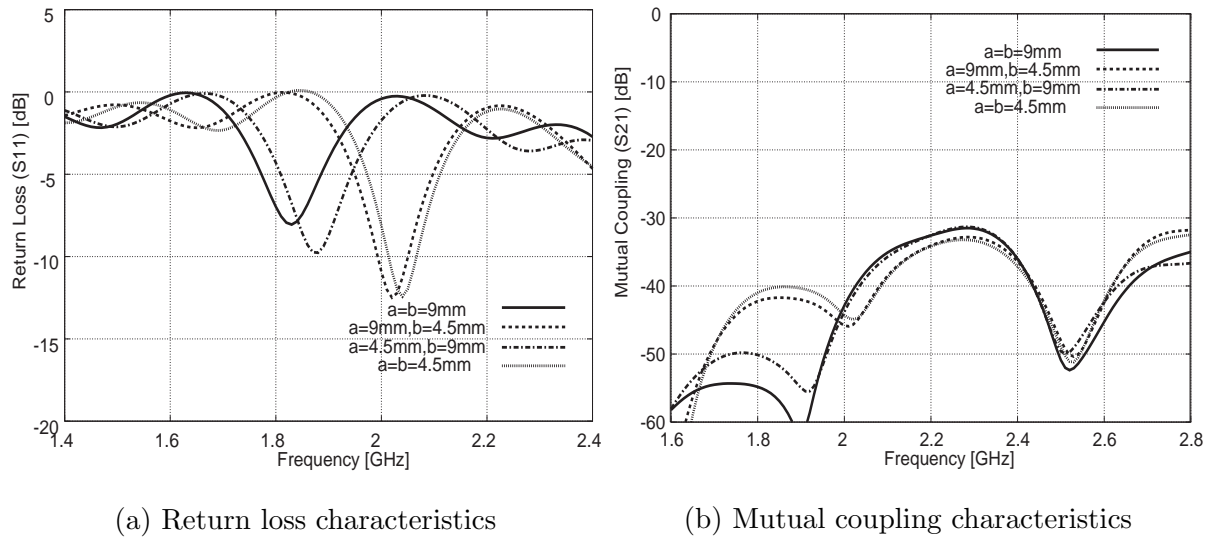


Figure 6: S parameter characteristics per size of slit