DUAL-RESONANCE BROADBAND MICROSTRIP ANTENNA

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1. Introduction

The shorted rectangular microstrip antenna (SMSA) 1), 2) is a compact-sized antenna that can be composed in half the volume of the open rectangular microstrip antenna (MSA). As a mobile station antenna, which has to be as small as practical, the SMSA has the recommendable composition.

Because of its bandwidth, which is as narrow as that of the MSA, the improvement effort of its bandwidth is crucial to its field application.

This report contains the outcome of discussions made on the dual resonance broadband microstrip antenna (DRMSA), in which two SMSA elements that are power-fed together are arrayed in parallel, and the characteristics of DRMSA proven by its use on the portable radio equipment.

2. SMSA Characteristics

SMSA (Fig. 1-a) used as the element of the DRMSA can be considered to cause radiation by the magnetic current that may be generated on three sides other than the short-circuited side. Thus the isotropic radiation pattern exists on the Y-Z plane if the ground plane is infinitely large.

The directivity G over the Y-Z plane changes a little, as shown in Fig. 1-b, even if the SMSA width W was varied when W was equal to or less than $\lambda_0/2$ (λ_0=wavelength in free space). On the other hand, Q as shown in Fig.1-c, may show a great change, depending on W and t, or its change is almost reciprocally proportional to W x t.

The SMSA size is therefoere preferrable to satisfy any intended relative bandwidth, considering Q, rather than the directivity G.

While generally the radiation element and the short element of the SMSA are equal in the width, the resonant frequency decreases if the width of short element is made shorter than that of the radiation element. Using such characteristics the SMSA resonant frequency is determined by varying the length of its radiation element, and the width of its short element.

3. DRMSA Structure

The DRMSA is structured by arranging two SMSAs having different resonant frequencies in the way as shown in Fig. 2, both of which are then parallel-connected via the transmission line. As stated in the preceding section, the lengths of both elements are chosen equally, but their resonant frequencies differ from each other by varying the widths of their short elements Ws1 and Ws2. As a result, its volume becomes completely rectangular solid. Therefore this antenna is more suitable for the internal antenna of the portable radio equipment, as stated in the next section, than the antenna that provides the spacing between resonant frequencies by variation of the element lengths.

The equivalent circuit of each SMSA can be expressed by the LCR parallel reasonance circuit as shown in Fig. 3, provided that Q1, Q2, and the resonant frequencies f1 and f2 are determined by the SMSA dimension; likewise R1 and R2 depend on the feed location; the inductances Lf1, Lf2 are mostly attributable to the feeder pin effect. In such an equivalent circuit the dual resonance characteristics can be attained by appropriate selections of R1, R2 and the line lengths l1, l2. The resonance points are neary equal to the resonant frequency of each SMSA element, f1 and f2.

Accordingly, an appropriate selection of the SMSA size, feed location and feed line length makes it possible for the DRMSA to function with better dual-resonance characteristics. The gap g between SMSA elements is reduced to such an extent as not to lose the single resonance characteristics of each SMSA element due to the mutual coupling.

4. Typical DRMSA Applications

The test SMSA is mounted on the portable radio equipment, and it is attempted to compare its characteristics with those of the single resonance built-in antenna 3). The housing is made of metal, and the volume of portable radio equipment is about 500cc including the DRMSA, which is 16cc; the center frequency is then set to about 900MHz.

The SMSA characteristics is influenced by the housing, which in this test works as the SMSA ground plane. Hence Q, resonant frequency and input impedance are found different from those of SMSA as shown in Fig. 2 (a). The SMSA characteristics on the housing are experimentally verified to attain the dual-resonance characteristics by using the same technique as that explained in Sec. 3. The mutual coupling between both SMSAs tends to increase as the gap between the short elements of the SMSA decreases. Then for the test the short elements are set far apart from each other, as shown in Fig. 2. As a result the gap g can be narrowed to about 4mm($\lambda c/80$), thus allowing positioning of both SMSAs extremely close to each other.

Fig.4 shows the reflected power characteristics for the DRMSA and the conventional type; the desirable dual-resonance characteristics can be attained by the DRMSA. The comparison with the single-resonance antenna manifests that in spite of the equal volume, the bandwidth of the DRMSA is about 1.5 times as broad as that of the single-resonance antenna (evaluated with VSWR=2.6) and this figure indicates the success of considerable bandwidth expansion.

The DRMSA radiation pattern is shown in Fig.5. The comparison with the conventional type 3) proves further that there is no remarkable discrepancy of patterns between both types of antenna, and it leads to the conclusion that the splitting of antenna elements into two does not much affect its pattern.

5. Conclusion

The study on characteristics of the dual-resonance broadband antenna using the newly invented SMSAs has found, as mentioned earlier, that it had considerably broader characteristics than those of the conventional single-resonance antenna. Accordingly the DRMSA is quite usable for the portable equipment whose antenna size needs to be as small as possible, as already illustrated in this report.

ACKNOWLEDGMENTS

The authors wish to thank Mr. Matsuo for his guidance.

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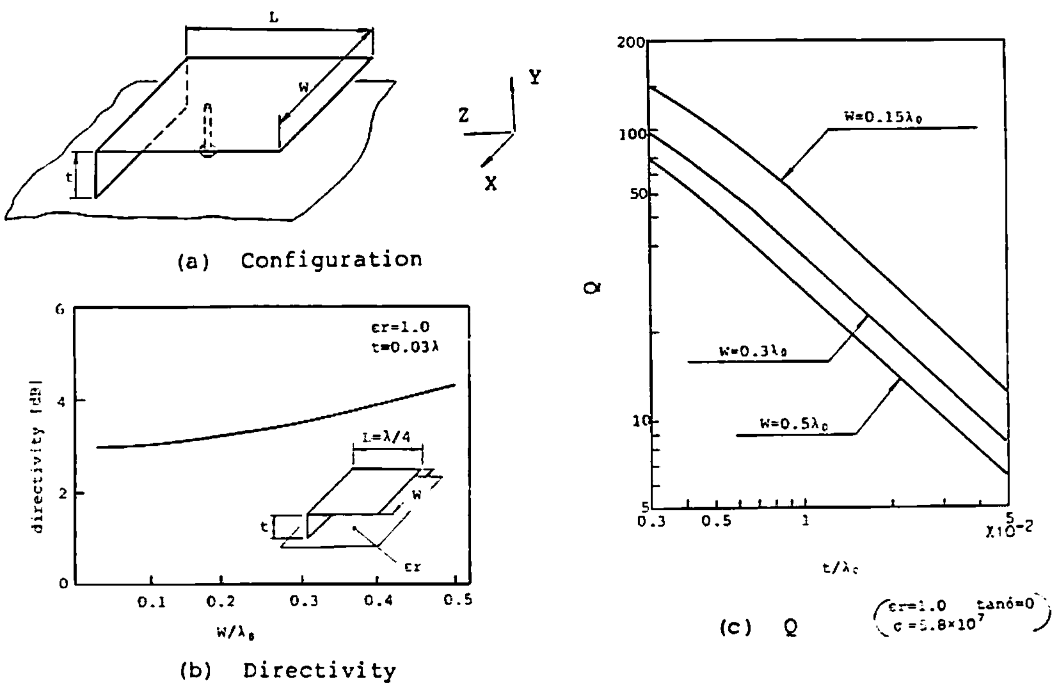

(a) Configuration

(b) Directivity

(c) Q

Fig. 1. Characteristics of SMSA

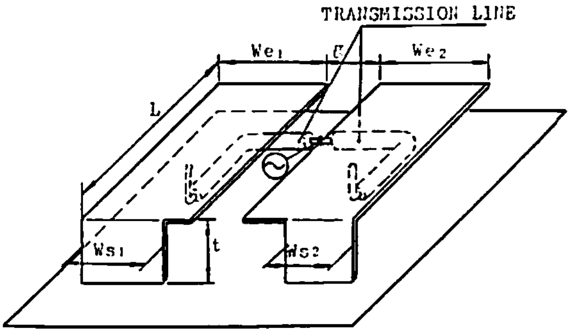

Fig. 2. DRMSA Configuration

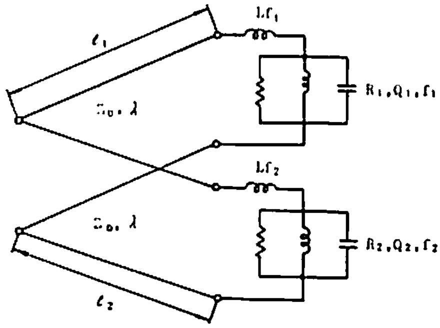

Fig. 3. Equivalent Circuit of DRMSA

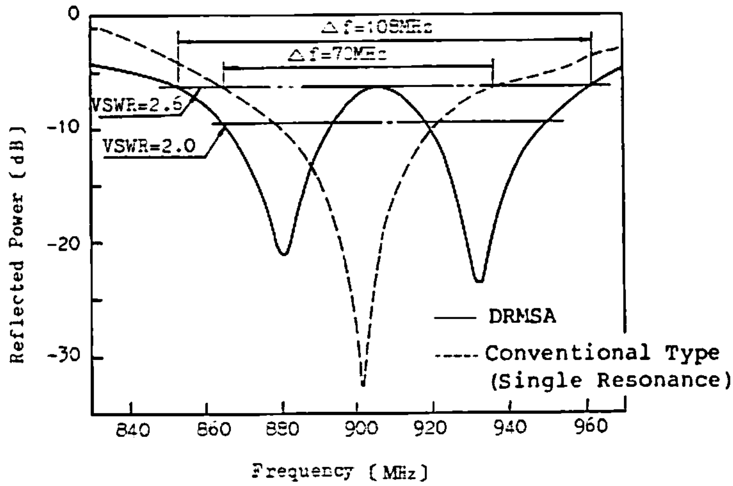

Fig. 4. Reflected Power Characteristics for DRMSA and Conventional Type; Mounted on the Portable Equipment.

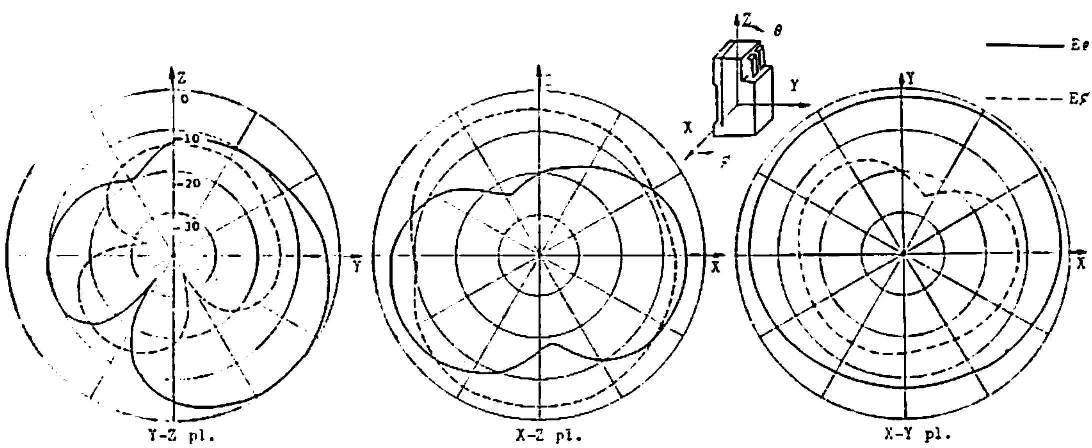

Fig. 5. Radiation Patterns for DRMSA mounted on the Portable Equipment.