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LETTER

A Low-Profile Dual-Band Microstrip Antenna Having Open-Circuited Stripline-Stub

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SUMMARY A new type of dual-band microstrip antenna was presented and tested. The experimental results had high performance in both the radiation pattern and gain within the desired frequency range. The antenna presented here is, therefore, considered to be effectively applicable as a new type of dual-band antennas.

1. Introduction

Dual-band antennas are used as an efficient radiator in communication systems for vehicles, satellites and portable applications. Some dual-band microstrip antennas having a stripline or coaxial-line short-circuited stub have been reported in literatures[(1),(2)].

The low-profile dual-band microstrip antenna (DB-MSA) presented in this communication is constructed by mounting a conformal open-circuited stripline-stub on the same plane of rectangular microstrip antenna as shown in Fig. 1. Accordingly, this type of DB-MSA can be made compactly compared to short-circuited stub-type. This communication describes the fundamental designing technique and radiation characteristics of this DB-MSA.

2. Basic Configuration of DB-MSA

The basic cofiguration of DB-MSA is shown in Fig. 1. Two separate operating frequencies (dual-band) can be obtained simultaneously by regulating the length of the open-circuited stripline-stub. The DB-MSA can be fabricated easily compared to a short-circuited stub-type dual-band antenna, since the DB-MSA only requires mounting of a coplanar open-circuited stripline-stub to obtain dual-band operation. On the other hand, in the device, power is fed from the rear of the substrate via a semi-rigid coaxial cable, and the antenna is made of a copper-clad 1.2 mm Teflon fiberglass substrate having a dielectric constant of 2.55 and a loss tangent of approximately 0.0018.

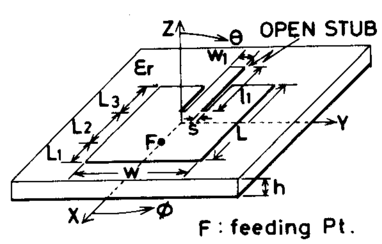

Fig. 1 Test DB-MSA and its coordinate system.

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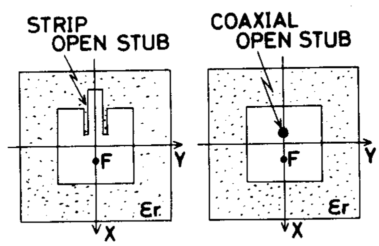
3. DB-MSA and Its Equivalent Circuit

The DB-MSA having an open stripline-stub may be regarded macroscopically to be equal to a microstrip antenna having an open coaxial-stub fed from the rear, as shown in Fig. 2. Therefore, the equivalent circuit of the antenna is indicated as Fig. 3, and the basic properties of this DB-MSA can be obtained from this equivalent circuit[(3)].

The input admittance (Y_{in}) at feeding point F can be determined with ease by application of a circuit



(a) (b)

Fig. 2 Typical types of dual-band MSA
(a) Test DB-MSA having open-circuited stripline-stub.
(b) MSA having open-circuited coaxial-stub.

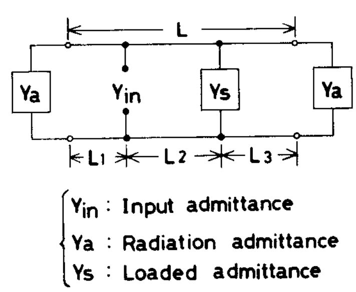


Fig. 3 Equivalent circuit for test DB-MSA.

theory to this equivalent circuit and is expressed by the following equations

$$Y_{in}=Y_0\left[\frac{Y_a+jY_0\tan\beta L_1}{Y_0+jY_a\tan\beta L_1}+\frac{Y_{ab}+jY_0\tan\beta L_2}{Y_0+jY_{ab}\tan\beta L_2}\right] \quad (1)$$

$$\left.\begin{aligned}&Y_a=G+jB\\&Y_{ab}=Y_0\left(\frac{Y_a+jY_0\tan\beta L_3}{Y_0+jY_a\tan\beta L_3}\right)+Y_s\\&Y_s=jY_{01}\tan\beta' l_1\end{aligned}\right\} \quad (2)$$

where Y_o is the characteristic admittance of MSA, β is the propagation constant of MSA and β' is the propagation constant of loaded-stub.

Since the imaginary part of Eq. (1) is reduced nearly to zero at the vicinity of resonance, resonant frequencies can be determined by this equation. G and B in Eq. (2) are the values derived by Carver et al[4].

Moreover, calculated values of Fig. 4 take into account the fringing effect given by Ref. (5).

4. Results

The calculated values of the resonant frequencies are shown in Fig. 4 as a function of the length of the open stripline-stub together with the experimental values. As anticipated, the calculated values considered the fringing effect agreed well with the measured values.

Variation in the stub-length from 8 to 43 mm resulted in shifting of the resonant frequency from 3 to 5 GHz (Fig. 4). It was thus demonstrated that DB-MSA produces simultaneously 2 resonant frequencies at proper stub length.

The DB-MSA having an open stripline-stub $l_1=11$ mm in length was constructed for testing. As expected, resonant frequencies were observed at 3.90 GHz and 4.54 GHz. The return losses at these frequencies were suppressed to below -25 dB. Moreover, excellent radiation patterns (E and H planes) were obtained at each resonant frequency as shown in Fig. 5. The gain of the DB-MSA had almost same value compared to ordinary microstrip antennas without a stub. The cross-polarized component was also suppressed to below -20 dB at the boresight.

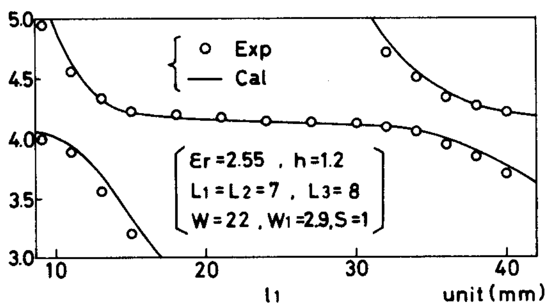


Fig. 4 Resonant frequencies versus open-circuited stub-length for test DB-MSA.

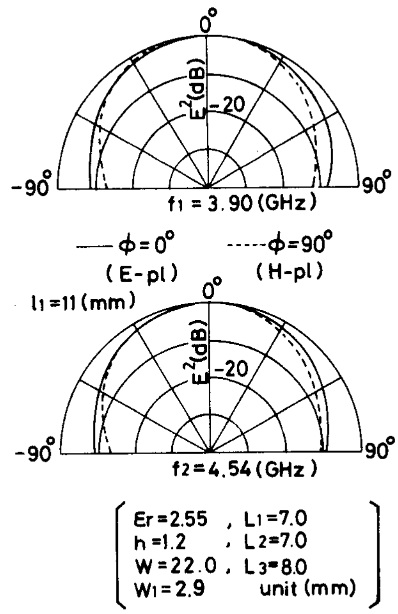


Fig. 5 Typical patterns for test DB-MSA.

5. Conclusion

A new type of dual-band microstrip antenna was presented and tested. The experimental results had high performance in both the radiation pattern and gain within the desired frequency range. The antenna presented here is, therefore, considered to be effectively applicable as a new type of dual-band antennas.

References

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