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STUDY OF INPUT IMPEDANCE OF RECTANGULAR MICROSTRIP ANTENNAS

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ABSTRACT

This paper gives a new model of current density in the patch of rectangular microstri p antennas . Using improved moment method with fewer terms of basis functions , formulas for calculating the impedance are derived and software is achieved .The results show that higher precision can be obtained without any correction .

Key words: microstrip antennas, current density model, moment method, input impedance

1 Instruction

After proposed in 1953 , microstrip antennas have been developed rapidly until 1970's . With its special advantages , microstrip antennas are used widely in space technology and earth equipment in recent years [1,2].

The input impedance is a very important term in the design and analysis of microstrip antennas. Among the analysing methods , integral equation method has special advantages over transmisson line method and cavity model theory method [1-4], and if it is connected with moment method , it can be used widely .

Using integral equation and moment method with fewer terms of basis function , in order to achieve useful results in wider frequency , this paper gives a new model of the current density on the patch and then studies the input impedance of rectangular microstrip patch antenna fed by a probe .

2 The formulas for input impedance

To solve the input impedance of microstrip antennas with moment method

, use the reactive intergral equation :

$$\int_s \vec{J}_s \cdot \vec{E}_T dS = -\int_{Vi} \vec{J}_i \cdot \vec{E}_T dV \tag{1}$$

Give the current density expression on the patch as:

$$\vec{J}_s(X,Y) = \sum_{n=1}^{N} I_n \cdot \vec{J}_n(x,y) + \vec{J}o \tag{2}$$

in it :

$$\vec{J}_o = \vec{x}J_{ox} + \vec{y}J_{oy}$$

and :

$$Jox = \begin{cases} -X/L-1/2 & -L/2<X<Xs \\ -X/L+1/2 & Xs<X<L/2 \end{cases}$$

$$Joy = \begin{cases} -Y/W-1/2 & W/2<Y<Ys \\ -Y/W+1/2 & Ys<Y<W/2 \end{cases}$$

it can be obtained easily :

$$\vec{J}_s(Kx,Ky) = \sum_{n=1}^{N} I_n \cdot \vec{J}_n(Kx,Ky) + \vec{J}_o(Kx,Ky)$$

and :

$$\vec{E}_T(x,y) = \frac{1}{4\pi^2}\iint_{-\infty}^{\infty} \vec{\epsilon}_T(Kx,Ky) \cdot e^{-j(KxX+KyY)} \quad dKxdKy \tag{3}$$

$$\vec{\epsilon}_T(Kx,Ky) = \vec{\vec{G}}(Kx,Ky) \cdot \vec{J}s(Kx,Ky) \tag{4}$$

where : $\vec{\vec{G}}(Kx,Ky)$ is the dyadic Green's function in the space .

Substitute formula (2) and (3) into (1) , and then substitute (4) into (1) , we can obtain :

$$[Znm][In] = [Vn]$$

And then we can solve out [In], after that , we can obtain $\vec{J}s(Kx,Ky)$, $\vec{\epsilon}_T(Kx,Ky)$ and so on:

$$Pin = -\frac{1}{8\pi^2}\iint_{-\infty}^{\infty} \vec{\epsilon}_T(Kx,Ky) \cdot \vec{J}s(Kx,Ky)dKxdKy \tag{5}$$

but :

$$P_{in} = I_o^{\ 2} \cdot Z_{in}$$

and so :

$$Z_{in} = P_{in} / I_o^{\ 2} \tag{6}$$

3 Software and some expression [5]

To obtain calculation of input impedance ,we use an adaptive automatic integration based on Newton-Cotes 9 point rule .Adaptive automatic integration is a method which automatically places abscissas density where the integrand f (x) changes rapidly ,or sparely where it changes gradually .This is currently a very good method for automatic integration in terms of reliability and economy.

In the procedure of solving the input impedance , many variations are complex . To avoid complicated complex calculation , we do the intergration for the real part and imaginary part separately .

In order to achieve more exactly results , we at first solve the singularities in the integand , and then take the singularities as endpoint , to divide intergration interval into some subintervals with the singularities as endpoints , and then do the intergrations at each subintervals .

This software is achieved with FORTRAN language and passed on the computer MS-340.

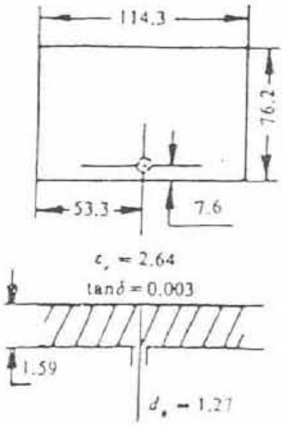

Fig.1 Rectangular micro-strip patch antenna

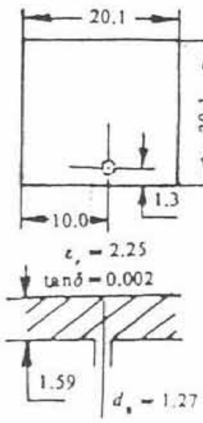

Fig.2 Rectangular micro-strip patch antenna

4 Results.

Using improved moment method , we give the new model of the current density on the patch . And with two terms of basis function (except $\vec{J}o$):

$$\vec{J}s(x,y) = \vec{x}I_1 \cdot J_1(x,y) + \vec{y}I_2 \cdot J_2(x,y) + \vec{J}o$$
$$= \vec{x}I_1 \cdot \sin(\pi X/L) + \vec{y}I_2 \cdot \sin(\pi Y/W) + \vec{J}o$$

By calculating the input impedance of two examples (sizes show as Fig.1 and Fig.2), the results agree very well with that of experiments and calculation in [3] ,show as in Fig.3 and Fig.4. But the method doesn't need the step to correct calculated results as [3] , so this method has great values for the studies of microstrip antennas with other shape of patch ,or with many substrate layers covered on it .

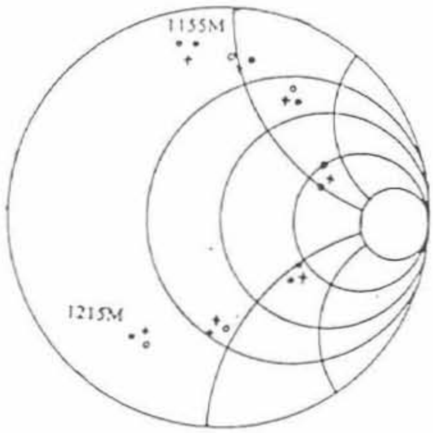

Fig.3 Input impedance of rectangular microstrip patch antenna (showed in Fig.1)
● Calculated [3]
○ Measured [3]
+ Calculatedthis paper
Increment :10 MHZ
(Increasing clockwise)

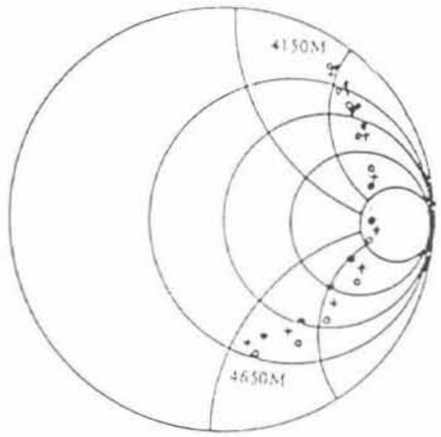

Fig.4 Input impedance of rectangular microstrip patch antenna (showed in Fig.2)
● Calculated [3]
○ Measured [3]
+ Calculated this paper
Increment: 50 MHZ
(Increasing clockwise)

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