THE MEASUREMENT OF ATTENUATION ALONG THE ARMS OF TRAVELLING WAVE RHOMBIC ANTENNA IN THE UHF BAND

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1. Introduction

In the design of a UHF travelling wave antenna, the attenuation per unit length along the arms of the antenna is an important factor because the gain and other characteristics depend on it. Earlier work on travelling wave V-antennas showed that the antennas radiate mainly from the input ends; the far ends of the antennas contribute very little [1,2,3]. This work is considered to be an extension to the earlier work. In this paper, the same feed and measurement techniques will be applied to the travelling wave rhombic antenna in the UHF band. It will be shown that the results obtained earlier for the V-antenna is also true for the rhombic antenna. The equation for the attenuation is derived and is given below. It is somewhat, different from that derived earlier for the previous antenna by a factor of 2 in the denominator. This is because the rhombic antenna has four arms whereas, the V-antenna has only two arms.

2. Antenna Design

Three different antennas were constructed using U-shaped alloy channels having three different cross sections as shown in figures 1 and 2. The length of each arm and the tilt angles are 1.5m and 60 degree respectively. Fifty-ohm coaxial cables type URM-67 of equal lengths were connected to the antennas using strip line feed technique [1,3]. The far ends of the antennas were terminated in tapered load of lossy materials to minimize any reflection which might occur from these ends and to overcome the problem of standing wave which might give maximum and minimum along the arms of the antennas. This method of eliminating the standing wave was also discussed in details in other works [4]. A schematic diagram of the terminating end is shown in Fig.3.

3. Measurement Method

The method is based on the measurement of the maximum and minimum values of the input impedance of the antennas to be substituted in the following equation [1,3].

$$\alpha = -\frac{1}{4l} \ln \frac{\sqrt{\frac{z_{max}}{z_{min}}} - 1}{\left(1 + \frac{z_l - \sqrt{z_{max} z_{min}}}{z_l + \sqrt{z_{max} z_{min}}}\right)\left(1 + \sqrt{\frac{z_{max}}{z_{min}}}\right)} \qquad (1)$$

where:

α = the attenuation (neper/m)

l = the arm length of the antenna (m)

z_l = load impedance (50 ohm)

z_{max} = the maximum value of the antenna input impedance (ohm)

z_{min} = the minimum value of the antenna input impedance (ohm)

In the procedure of measuring the input impedance, the frequency was adjusted carefully and the lengths of the antenna arms were altered by adding small lengths at the tilt points until maximum real impedance was shown in the measuring equipment. Further lengths were carefully chosen and added to the antenna arms until a real minimum is shown. This was repeated for three different frequencies. Considerable care were taken to ensure continuity at the tilt points of the antennas when the added lengths were attached.

The attenuation along the arms of the antenna was calculated by substituting the measured maximum and minimum values of the input impedance of the three antennas into Eq.1. This was repeated for the three different frequencies and the results are shown in Table 1.

Table 1. The calculated values of the attenuation for the three antennas.

Frequency (MHz)	Attenuation (neper/m)		
	5/2" x 1" x 1/8"	1" x 1" x 1/8"	1/2"x1/2"x1/16"
500	0.52	0.37	0.32
750	0.63	0.42	0.35
1000	0.57	0.38	0.32

It should be appreciated that the result in Table 1 is only an approximation for two reasons:

1. There is little radiation at the input end of the rhombic antenna, because at this end, the antenna arms are very close to each other and they can be regarded as a transmission line.

2. Altering the lengths of the arms at the tilt points introduces a discontinuty which might cause reflections at these points which was not taken care of when Eq.1 was derived.

However, the first problem was minimized by using fairly long length of arms, and the second was hoped to reduce to minimum by taking considerable care to ensure continuity at these points.

4. Conclusion

It will be observed from the results in Table 1, that the attenuation for the antenna with large cross section is greater than that for the antenna with the small cross section. One can also see that the attenuation for all the three cases are quite considerable. This implies that the antennas radiate most of their energy from the input ends leaving only little energy for the far ends to part with. These results agree with the previous results of the travelling wave V-antennas.

References

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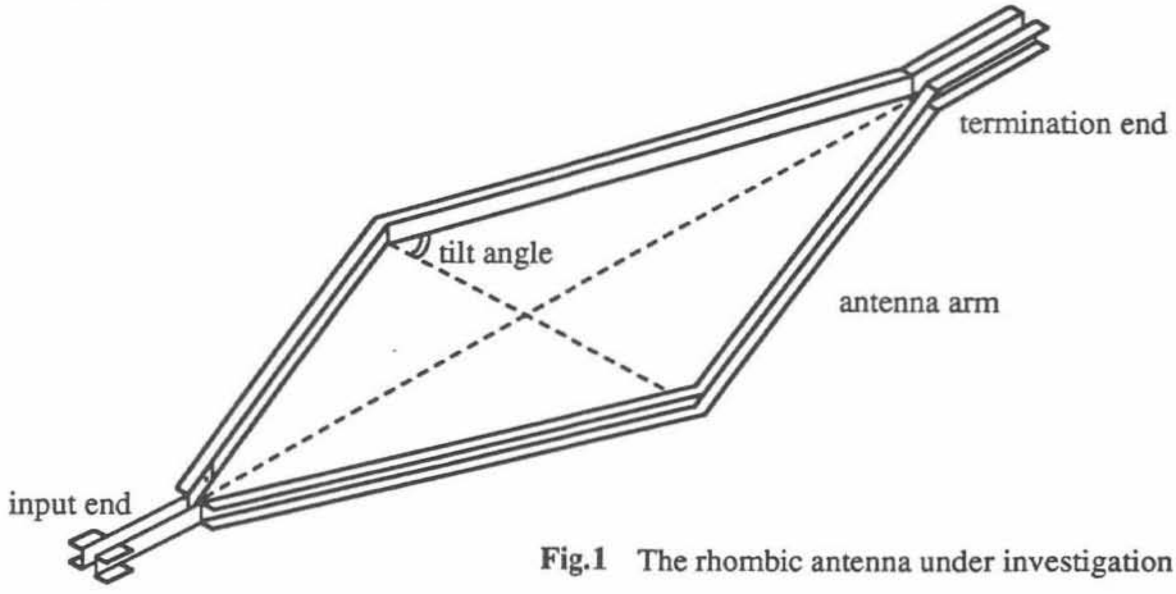

Fig.1 The rhombic antenna under investigation

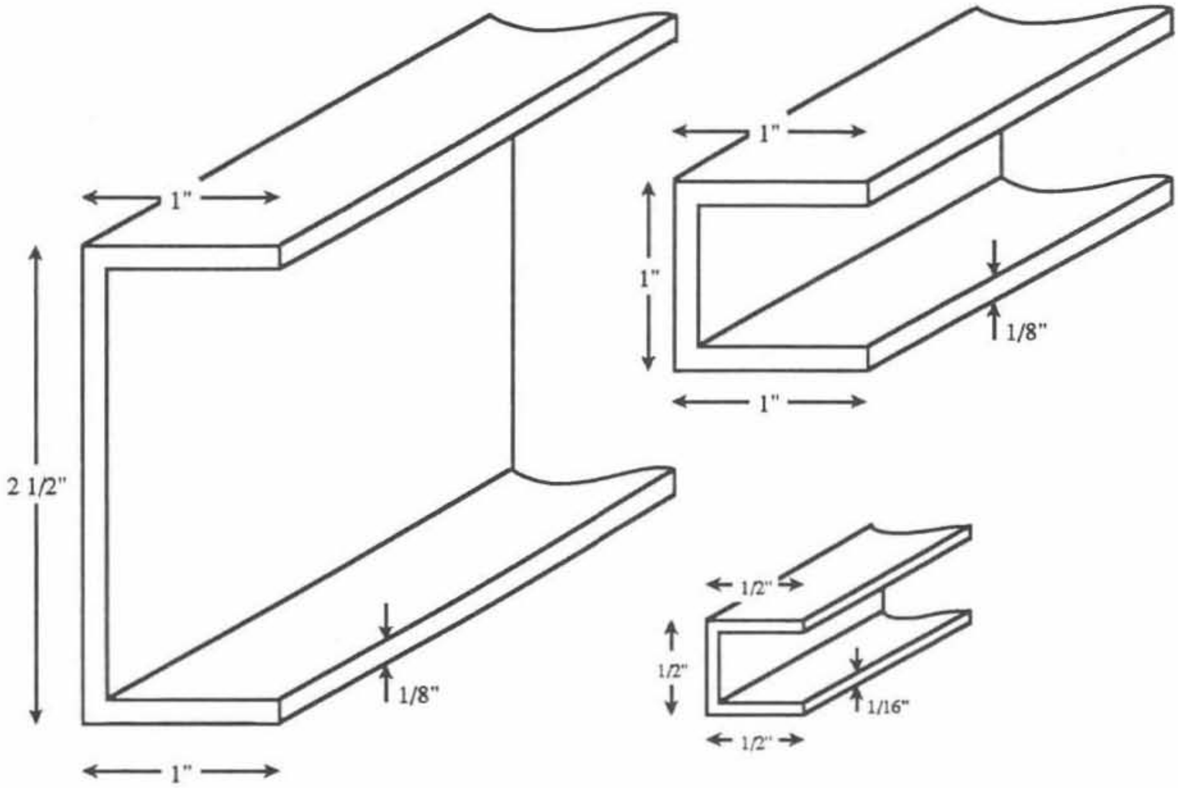

Fig.2 Schematic digrams showing the three different dimensions of the antenna arms

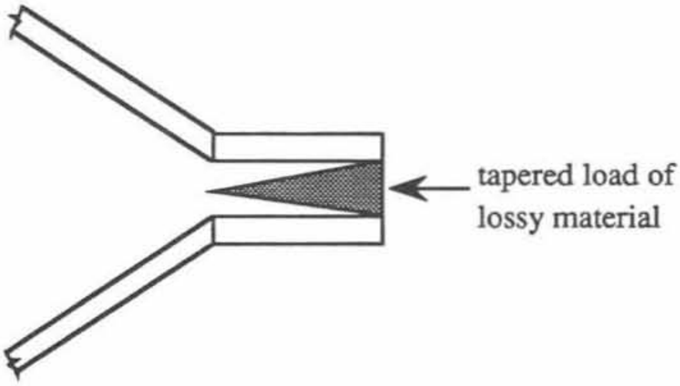

Fig.3 The far end of the antenna terminated in a load of lossy material