A Proposed System with Negative Input Impedance

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Abstract

In this paper, we configured a system with negative input impedance by a pair of Yagi-Uda antennas. The two Yagi antennas were placed face to face feeding by the same source. The input impedance is the sum of self-impedance and mutual impedance. Since Yagi antenna has significantly reduced self-impedance and amplified mutual impedance, it is anticipated that this system present negative input impedance.

Description

In the course of pursuing negative input impedance [1-5], we designed a new system composed of two Yagi antennas. Let’s first consider two dipole antennas in parallel, as shown in Fig. 1.

\[ U_1 = Z_1 I_1 + Z_{12} I_2 \]  \hspace{1cm} (1)

\[ U_2 = Z_2 I_2 + Z_{21} I_1 \] \hspace{1cm} (2)

\[ Z_1 \text{ and } Z_2 \] are the self-impedance of each dipole respectively. \[ Z_{12} \text{ and } Z_{21} \] are the mutual impedance between dipoles, \[ Z_{12} = Z_{21} \]. \[ I_1 \text{ and } I_2 \] are the current in each antenna. The graphic curve of mutual impedance vs. distance between dipoles are shown in Fig. 2 [6]. The mutual impedance at zero distance is the self-impedance. Since the mutual impedance is always less than the self-impedance, we cannot obtain negative input impedance by merely two dipole antennas.
Figure 1: Two dipole antennas face in face feed by the same power source.

Figure 2: Graphic curves of mutual impedance vs. distance between dipoles [6].
Now we change the dipole antennas to Yagi antennas, as shown in Fig. 3. Since the two antennas have symmetrical configuration, the equations 1 and 2 become

\[ U_0 = Z_0 I + Z_{12} I \]  

(3)

\( Z_0 \) is the self-impedance of Yagi antenna, which value is normally less than the dipole’s standard impedance. \( Z_{12} \) is the mutual impedance. The sign of mutual impedance can be flipped by switch the polarity connectivity to antenna. Since the two antennas are symmetrical, they have the same current \( I \). If the gain of Yagi antenna is 4 times (6.0 dbd), the mutual impedance will be 16 times larger than the value in Fig. 2. Based on Fig. 2, the mutual impedance of dipoles at \( d = 1.7 \lambda \) is -10 ohm. Then the mutual impedance of Yagis at the same distance could be up to -160 ohm. Since the self-impedance of Yagi is normally around 20 ohm, the input impedance of individual Yagi antenna could be around -140 ohm.

As a proposal, we don’t perform detail calculations in theory. We also ignored the interference between Yagis. However, an experimental measurement is desired to verify the characteristics of this device. If the system does present negative input impedance, it can be used as a power generator.
References


