An Experimental Measurement of Power Amplification Effect via Parasitic Dipole inside Waveguide

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Abstract

In this work, transmission coefficient S21 was measured through a waveguide. The electromagnetic wave entered into a waveguide through a horn at one end and it was measured at the other end. By inserting a parasitic dipole inside the waveguide, the wave amplitude at lower adjacent frequency of dipole resonant was amplified. This effect is similar to that of Yagi-Uda antenna in open space. It is stated in textbook that a Yagi-Uda antenna can diffract the electromagnetic wave in open space and focus the power in forward direction. However, a dipole inside a waveguide cannot diffract electromagnetic wave from the open space. The observation in this work indicated that the wave was amplified by the parasitic dipole.

Method and measurement

The reflection coefficient S11 from a parasitic dipole inside waveguide was measured in 2017[1]. It was shown that a parasitic dipole can amplify the reflected wave in waveguide. However, the amplification effect is small. It was anticipated that transmission coefficient S21 would show larger amplification effect. A measurement of transmission coefficient S21 was performed in this work. The Fig. 1 shows the schematic of the setup. The waveguide was composed of four parts: horn, resonating cavity, junction, and receiving end. A transmitter was placed at 2.5 meters away from the horn. The wave entered the waveguide through the horn and propagated to the receiving end. The transmitter and receiver probes were connected to a Vector Network Analyzer (DG8SAQ, v3). The resonating cavity has height of 22.6cm, width of 28.3cm, and length of 56.6cm. The waveguide at receiving end has height of 14.1cm, width of 28.3cm, and length of 42.4cm. The junction between resonating cavity and receiving waveguide has length of 14.1cm. A parasitic short dipole was inserted in the center of resonating cavity. Since short dipole has a large component of capacitive impedance, an inductive coil was added in the middle to counterbalance its capacity.

We scanned from 700MHz to 800MHz. As shown in Fig. 2, the red upper line was S21 without parasitic dipole, which was normalized to 1.0. The blue line was S21 with parasitic dipole. The resonating frequency of parasitic dipole was 756MHz, where there was an absorption peak. The value of S21 increased at the frequency between 713MHz and 751MHz. A marker was placed at 746.3MHz, where S21 increased 21.7% and the gain was 1.7dB compared to without parasitic dipole. The lines on the down side were S11 with and without dipole. The S11 lines overlapped together indicating no change of emission power from the transmitter with and without dipole.

Discussion

The observation in this measurement is similar to Yagi-Uda antenna in open space. For a Yagi-Uda antenna, the director has higher resonating frequency than the transmitter because its length is shorter. When a director is driven by a wave at a lower frequency, the emitted wave from the director overlaps onto the forward wave so that the forward wave is amplified. When a director is driven by a wave at a higher frequency, the emitted wave from the director counterbalances the forward wave so that the forward wave is reduced. It is stated in textbook that the director of Yagi-Uda antenna diffract wave from open space to the forward direction. Such a statement is not true for our observation because the parasitic dipole inside the waveguide is isolated from the outer space.

When the wave entered the horn, the amplitude of received signal depends on how much power entered the horn. The parasitic dipole does not change the power of wave that entered into the waveguide. It cannot absorb power from outer space neither because it is enclosed by the walls of waveguide. There are two working modes on parasitic dipole. One is filter mode when the dipole connects to the walls of waveguide through capacitive coupling. In this mode, the dipole would absorb wave or reflect wave back resulting lower delivered power to the receiver. Another mode is self-resonating when the dipole has no connection to the walls of waveguide. The self-resonating mode is similar to a director of Yagi-Uda antenna in open space. The forward wave is amplified in self-resonating mode. In order to eliminate the filter mode component on parasitic dipole, the dipole need be kept away from the walls of waveguide so that the dipole need be short and the height of resonating cavity need be increased.

References:

[1] Xiaodong Liu, Qichang Liang, Yu Liang, *Power Amplification Via Parasitic Resonator Inside Waveguide Cavity*, 2017-01-29, http://vixra.org/abs/1701.0666

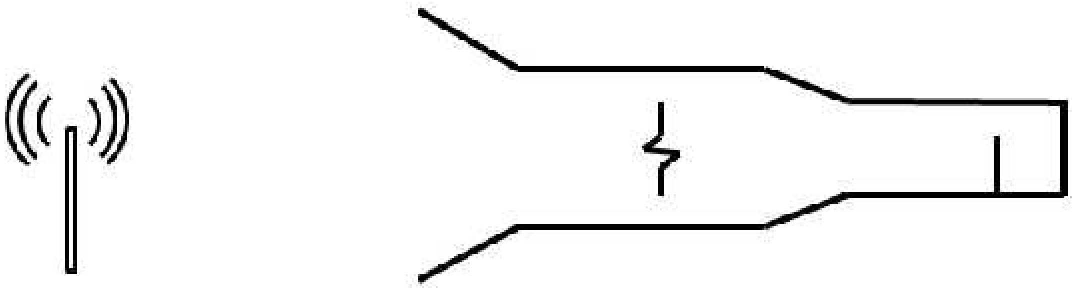

Fig. 1 Schematic of experimental setup

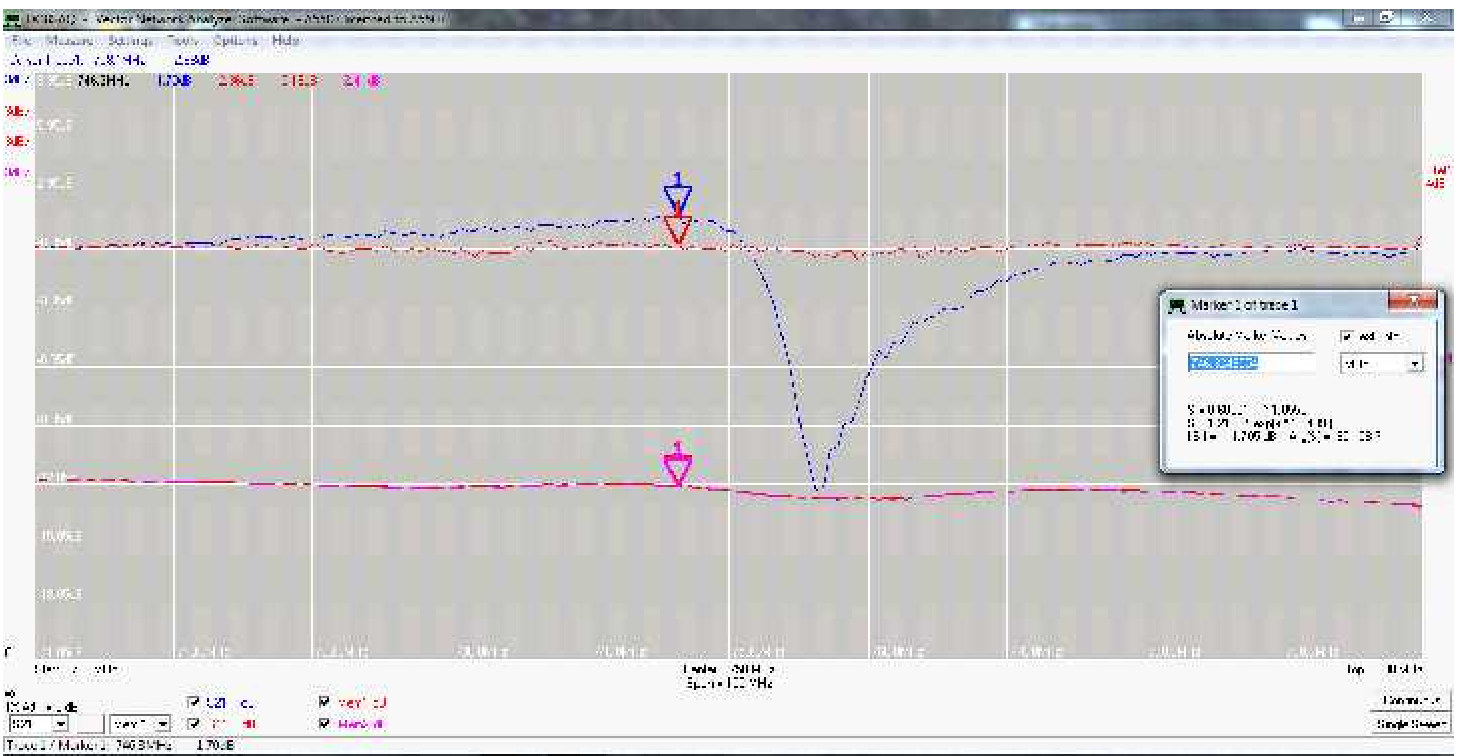

Figure 2: Measured data of S21 (upper) and S11 (lower).