# Power Amplification via Parasitic Resonator inside Waveguide Cavity

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Abstract

In this work, a parasitic dipole was mounted inside a waveguide cavity. The amplitude of the oscillating wave through the waveguide was amplified 15% by the negative impedance reflected from the parasitic resonator to the waveguide.

## Introduction

It was found that the negative reflected impedance can amplify the transferred power from the transmitter to the receiver in wireless power transfer [1-5]. The previous studies show that transferred power is amplified between two coils and two dipoles. However the gained power cannot be extracted because most of it irradiate into space. The transmitter and receiver must be enclosed in order to extract the gained power. In this work, we mounted dipoles inside a waveguide cavity. We found that the interaction between the dipole and waveguide contributes to the power amplification instead of the mutual interaction between dipoles.

## Method and measurement

The Fig. 1 shows the transverse section of a rectangular waveguide. A parasitic short dipole is mounted in the center of the waveguide. The resonation can be tuned by adjusting the inductivity or capacitivity of the parasitic resonator. The wide dimension corresponds to the lowest frequency that can propagate inside the waveguide. When the wave propagates inside the waveguide, there is alternative current along the wall and alternative charge accumulated on the top and bottom surface of the waveguide. Both the charge on the surface and the current along the wall can induce current along the parasitic dipole. The reflected impedance from the parasitic dipole to the waveguide is negative so that the wave amplitude is amplified.

The Fig. 2 shows the side view of the waveguide with parasitic dipole. There is one input/output probe (left) and one parasitic dipole (right) inside the waveguide. The wide dimension is 8.0 inch. The height is 4.0 inch. The length is 16.0 inch. The height of the input/output probe is 2.75 inch. The length of parasitic dipole is 3.5 inch. Both the probe and the dipole were mounted along the central axis. The distances from the probe to the left end and from the dipole to the right end are 4.0 inch. Since the length of parasitic dipole is less than half wavelength, there is an inductive coil in the middle to compensate its capacitivity.

The input/output probe was connected to a Vector Network Analyzer (Model: DG8SAQ). We scanned from 1010MHz to 1050MHz. It was observed that the parameter S11 increased significantly from 1025MHz to 1050MHz. As shown in Fig. 3, the upper data shows S11 without parasitic dipole and the lower data shows S11 with parasitic dipole. The value of S11 increases 15% at 1042.8MHz, corresponding to 32% power increase in reflected wave.

## Discussion

When the parasitic dipole was not inside the waveguide, the value of S11 should be around 1.0, while our values are around 1.06 due to the different connector other than the calibration kits. When the parasitic dipole was inserted inside the waveguide, the mutual induction between the current along the dipole and the current along the waveguide wall has retarded phase shift. Such phase shift results to the negative reflected impedance from the dipole to the waveguide. The magnitude and phase of the reflected impedance also depends on the self-impedance of the dipole. The frequency region where S11 was increased can be shifted by adjusting the inductive coil in the middle of the dipole. If multi amplifiers can be connected sequentially, the output power should be much larger than the input power.

References:

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[4] Xiaodong Liu, Qichang Liang, Yu Liang, Wireless Power Transmission in Near-Field Range Utilizing Retardation Phase Shift, Feb. 2014, http://vixra.org/abs/1402.0162

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Figures:

Figure 1: Transverse section of a rectangular waveguide. A parasitic short dipole (in green color) is mounted in the center of the waveguide.

Figure 2: The side view of a power amplifier. There is one input/output probe (left, in blue color) and one parasitic dipole (right, in green color).

Figure 3: Measured S11 parameter. The upper data represent S11 when parasitic dipole was not inside the waveguide. The lower data represent S11 when parasitic dipole was inside the waveguide.

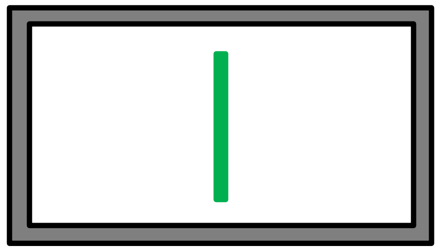

Figure 1

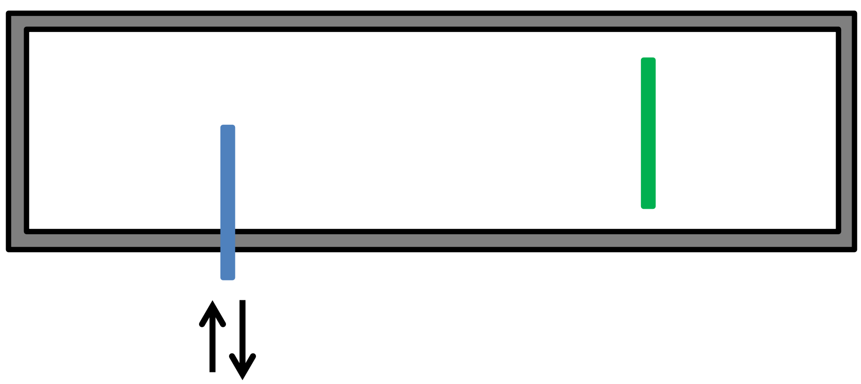

Figure 2

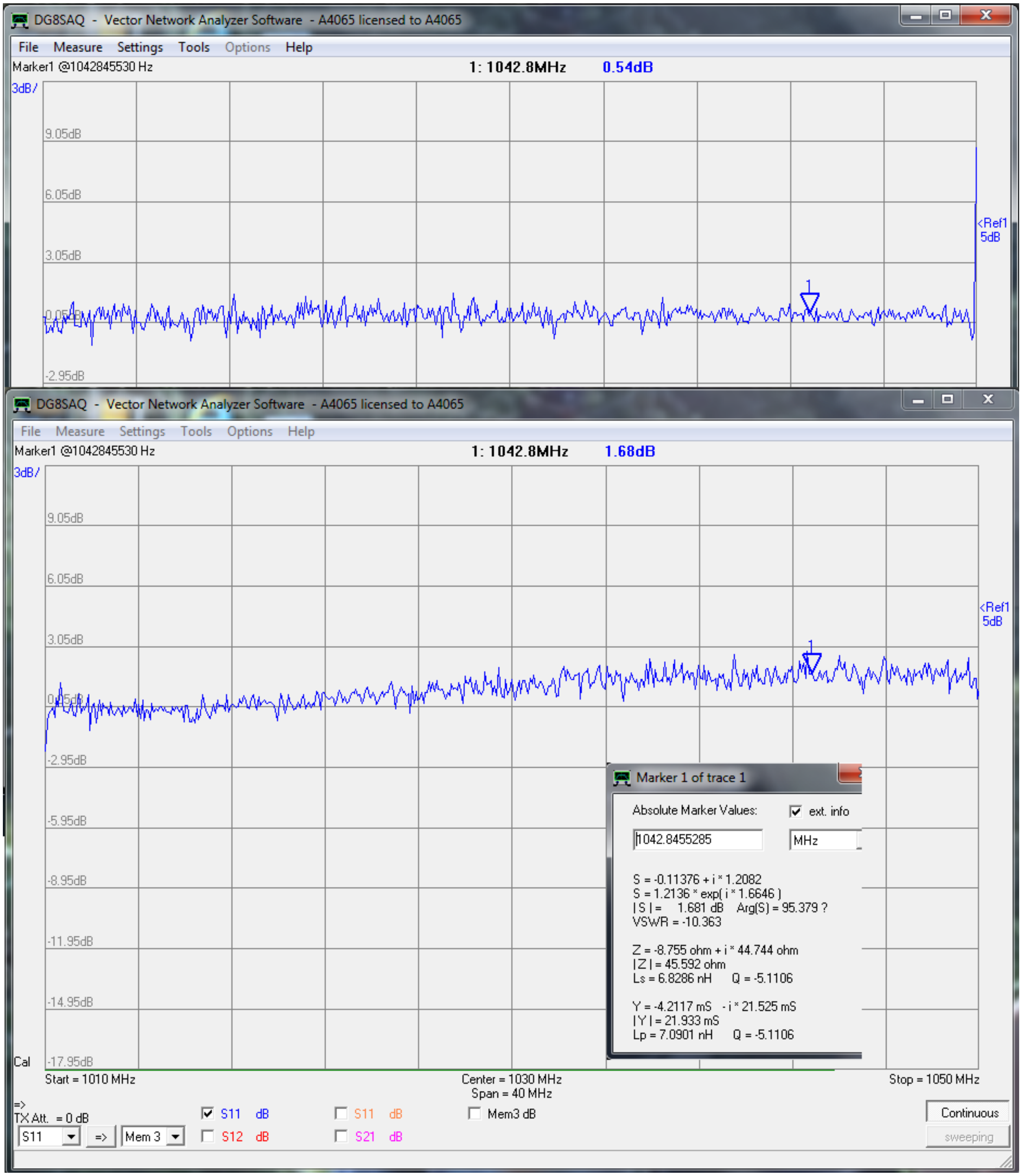
DG8SAQ - Vector Network Analyzer Software - A4065 licensed to A4065
File Measure Settings Tools Options Help
Marker1 @1042845530 Hz
1: 1042.8MHz 0.54dB
3dB/
9.05dB
6.05dB
3.05dB
-2.95dB
<Ref1 5dB
DG8SAQ - Vector Network Analyzer Software - A4065 licensed to A4065
File Measure Settings Tools Options Help
Marker1 @1042845530 Hz
1: 1042.8MHz 1.68dB
3dB/
9.05dB
6.05dB
3.05dB
-2.95dB
-5.95dB
-8.95dB
-11.95dB
-14.95dB
-17.95dB
Cal
<Ref1 5dB
Marker 1 of trace 1
Absolute Marker Values:
ext. info
1042.8455285
MHz
S = -0.11376 + i * 1.2082
S = 1.2136 * exp( i * 1.6646 )
|S| = 1.681 dB Arg(S) = 95.379 ?
VSWR = -10.363
Z = -8.755 ohm + i * 44.744 ohm
|Z| = 45.592 ohm
Ls = 6.8286 nH Q = -5.1106
Y = -4.2117 mS - i * 21.525 mS
|Y| = 21.933 mS
Lp = 7.0901 nH Q = -5.1106
Start = 1010 MHz
Center = 1030 MHz
Span = 40 MHz
Stop = 1050 MHz
TX Att. = 0 dB
S11
=>
Mem 3
S11 dB
S12 dB
S11 dB
S21 dB
Mem3 dB
Continuous
sweeping

Figure 3