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A Filtering Quasi-Yagi Antenna With High Selectivity and Wide Stopband

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***Abstract*—A filtering quasi-Yagi antenna with high selectivity and wide stopband is proposed. To realize filtering function, a parallel absorptive branch, which composed by a bandstop filter and a resistor, is employed at the feed line to obtain absorptive type radiation nulls on the both stopbands to improve the out-of-band suppression level and the width of stopband. Directors are employed symmetrically to improve the gain. According to the simulation results, the bandwidth of proposed antenna is 9% (2.52 to 2.75 GHz), and the realized gain is from 8.6 to 9.3 dBi. High out-of-band suppression and low sidelobes level are achieved with 15 and -14 dB.**

Keywords—Quasi-Yagi antenna, absorptive branch, high selectivity

I. Introduction

The quasi-Yagi antenna is widely used in the rapid development of wireless communication systems due to its low profile, light weight and endfire characteristics [1-2]. Moreover, filter units are needed to suppress interferences and guarantee the signals quality. With the excellent suppression capability and compact structure, filtering antennas are widely used to overcome the interferences and realize system integration and filtering performance [3-6]. Traditionally, researchers design filtering antenna by cascading the antenna and filter circuits. In [7], by integrating filter unit in slotline, the filtering function is implemented, while the size of filtering antenna is large by using such design method. To reduce the size of structure, treating the antenna radiator as the final stage of the bandpass filter circuit is a good method [8-9]. While the insertion loss the occupied size of filtering antenna is unavoidable. To avoid the drawback, the integration design of filtering antenna by exploiting the intrinsic filtering characteristics is the third method. In [10], through using offset double-sided parallel-strip line, the performance of filtering and low profile has been acquired. However, this designing method will increase the complexity of structure. Therefore, the design of filtering quasi-Yagi antennas with simple structure remains a challenge.

In this paper, a filtering quasi-Yagi antenna with high selectivity and wide stopband is proposed. According to the reflectionless filtering principles, the absorptive branch, which composed by a bandstop filter and a resistor is employed at the feed line to achieve two absorptive-type radiation nulls (RNs) on the lower and upper stopband, respectively. Compared to the traditional filtering antenna, the reflection of RF-input-signal power can be well avoided by the absorptive branch. Directors is symmetrically employed to get a higher and flatter gain. The HFSS software is used to simulate the proposed prototype.

II. Antenna Design

A. Antenna Configuration

Fig. 1 is the proposed planar printed filtering quasi-Yagi antenna, which is printed on the substrate of Rogers5880, whose permittivity is 2.2 and loss tangent tanδ is 0.0009. The whole size of the substrate is 80 × 230 × 0.762 mm^3. The proposed antenna can be divided into the following parts: feed line, driven dipole element, and the absorptive branch with grounded resistor of 50 Ω. The final parameters of proposed filtering quasi-Yagi antenna are as follows: L=230, W=110, L_1=14.5, L_2=15, L_3=34.4, L_4=6.7, L_5=27.08, L_6=19.7, L_7=24, L_8=20.5, L_9=8.3, L_{10}=13.5, L_{11}=16.5, L_{12}=52.5, L_{13}=7.5, L_{14}=35 L_{15}=30 W_1=2, W_2=2.3, W_3=2.8, W_4=2.8, W_5=9.1, W_6=3.4, W_7=10, W_8=9.6, W_9=4.7, W_{10}=4.9, W_{11}=1.4, W_{12}=0.1, W_{13}=0.3 W_{14}=2, W_{15}=2, D_1=22.5, D_2=20 D_3=15 (Unit: mm).

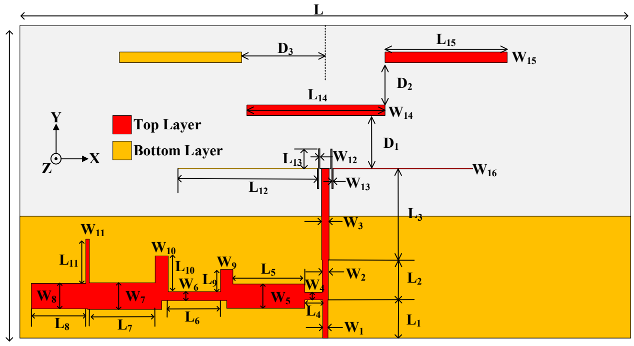


Fig. 1 The structure of proposed third order mode filtering antenna

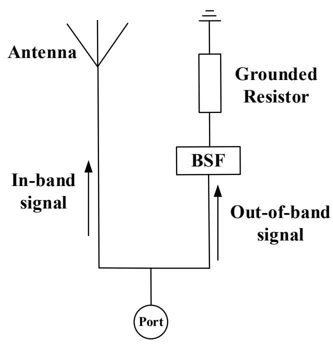


Fig. 2 Principle of realizing filtering antenna

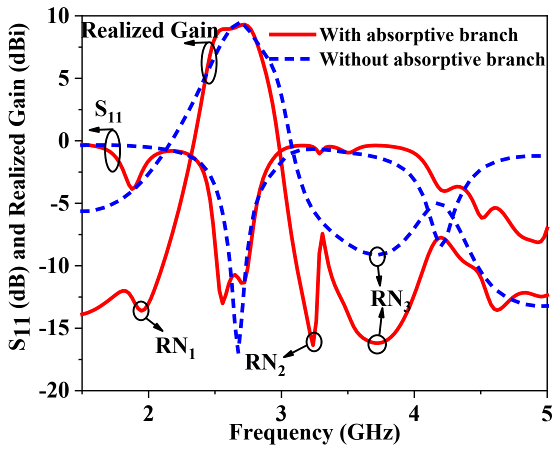
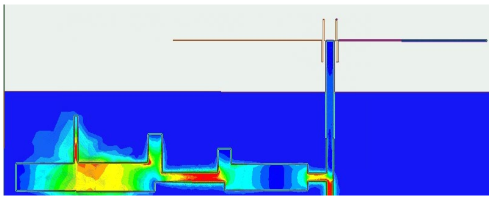


Fig. 3 Simulated results of proposed antenna with/without absorptive branch

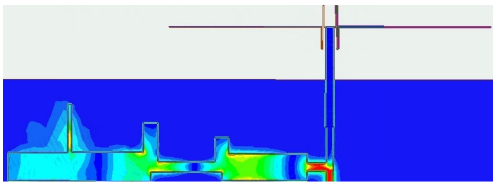
B. *Mechanism of Proposed Antenna*

Based on the structure of the third order mode quasi-Yagi antenna, an absorptive branch composed by a bandstop filter and a resistor is parallel added, as can be seen in Fig. 1, to obtain the filtering function, and the topology of proposed antenna is shown in Fig. 2.

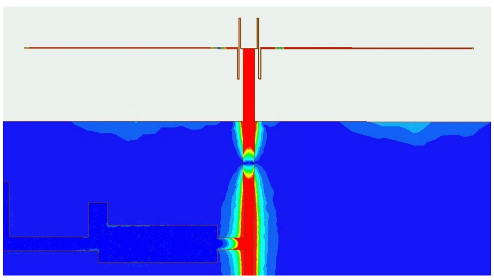
To ensure the energy flows as described in Fig. 2, the reflection coefficient between the antenna and the bandstop filter should be complementary, which means the passband of the antenna corresponds to the stopband of the bandstop filter and vice versa. Therefore, on the stopband of the antenna, the energy flows to the bandstop filter and absorbed by the grounded resistor. Different from design filtering antenna by cascading a bandpass filter unit, the reflection of RF-input-signal power can be well avoided by the absorptive branch, and the wide stopband is thus obtained.



(a)



(b)



(c)

Fig. 4 Current distribution of proposed antenna at (a)RN_1, (b)RN_2, and (c)f_0

Fig. 3 depicts the performance comparison of proposed antenna with/without the absorptive branch. A parasitic resonance point is generated by the absorptive branch to broaden the bandwidth. Two new radiation nulls (RN_1 and RN_2) are obtained to realize the filtering function with high selectivity and sharp rejection. To better clarify the role of absorptive branch, Fig. 4 shows the current distribution of proposed antenna at RN_1, RN_2 and f_0. It can be found that the current of the absorptive branch is strong at $RN_1$and RN_2 while it is weak at f_0, which proves the radiation nulls are absorptive type, and generated by the parallel absorptive branch.

III. Simulation Results

Fig. 5 shows the simulation results of S_{11} and realized gain of proposed antenna. As is seen from Fig. 5 that the bandwidth of proposed antenna is 9% (2.52-2.75 GHz). The realized gain on the passband is from 8.6 to 9.3 dBi. Additionally, proposed antenna achieves a good rejection level with at least 15 dB with a wide stopband. Fig. 6 is the radiation pattern in the XOY and YOZ plane at f_0. As shown in Fig. 6, good endfire characteristics is acquired by proposed antenna and the sidelobes are well suppressed with the level of -14 dB.

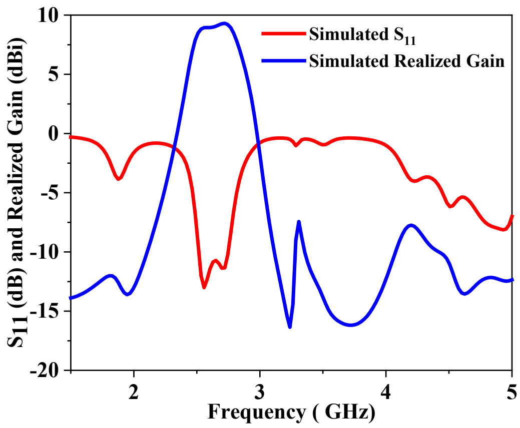


Fig. 5 The simulated results of proposd antenna

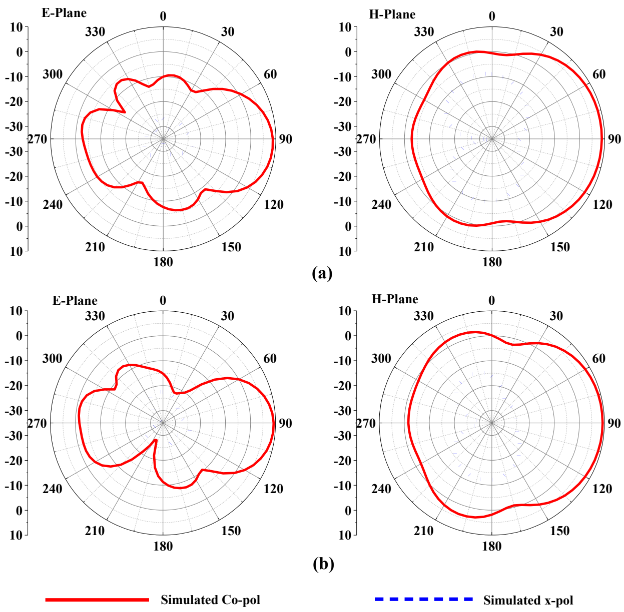


Fig. 6 Radiation patterns of proposed antenna at two resonance points

IV. CONCLUSION

A filtering quasi-Yagi antenna with high selectivity and wide stopband is proposed in this paper. An absorptive branch is parallel employed at the feed line to generate two absorptive type radiation nulls on the stopband of antenna to realize filtering characteristics. Compared to the traditional filtering antenna, the reflection of RF-input-signal power can be well avoided by the absorptive branch. Directors are employed symmetrically to improve the gain. The proposed antenna is a good candidate in the wireless communication system with high gain requirement..

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