Design of a Dual-band Coupled-fed Dipole Antenna for PCL systems

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***Abstract*-This article proposes the design of a dual-band coupled-fed dipole antenna element for PCL systems. The proposed coupled-fed antenna consists of an internal and an external dipoles which resonate in FM and DMB frequencies, respectively. To verify the suitability of the proposed coupled-fed antenna, antenna characteristics such as the bore-sight gain and reflection coefficient are compared with the conventional single dipole antenna. The results confirm that the proposed antenna structure can achieve the dual-band operation with broadband matching characteristic using the coupled-fed mechanism.**

Index Terms — Passive Coherent Location, dual-band dipole, coupled-fed structure.

I. INTRODUCTION

The Passive Coherent Location (PCL) system is a passive bistatic radar using commercial frequencies such as FM radio, analog TV, digital TV, and mobile communications. Since the PCL system does not require any transmitter, it has advantages in locating targets with a low overall system cost while minimizing the exposure of the observation site. This system can use multiple observation sites to increase accuracy, and the advantage of low RCS target is also well known recently [1-2]. The characteristics of individual elements in PCL array are key factors from a system performance standpoint, because the PCL system implements an antenna array that uses the amplitude and phase difference of the induced current at each port [3]. However, most of previous researches are focused on signal processing, while the characteristics of individual antenna elements have not been fully studied yet [4].

In this paper, we propose the design of the dual-band coupled-fed dipole antenna element for the PCL system. The proposed antenna structure consists of internal and external dipoles which can operate in the dual-band of FM and Digital Multimedia Broadcast (DMB) frequencies. The internal dipole is directly fed by balanced transmission line like a conventional single dipole, and the external dipole is then electromagnetically coupled with the internal dipole to improve dual-band characteristics. The proposed coupled-fed antenna has over 0.5 dBi realized gain in the frequency band higher than 83 MHz.

II. DUAL-BAND DIPOLE ANTENNA

Fig. 1 shows the geometry of the dual-band coupled-fed dipole antenna structure. The proposed antenna consists of an internal and an external dipoles which is designed to operate in FM and DMB bands. The external dipole is electromagnetically coupled to the internal dipole for dual-band operation with broadband matching characteristics. The operating frequency bandwidth is affected by the radius of the external dipole and internal dipoles (R_{in} and R_{out}), however we limit the maximum radius of the antenna due to the increase in weight. The detailed parameters are optimized by a genetic algorithm and are listed in Table I.

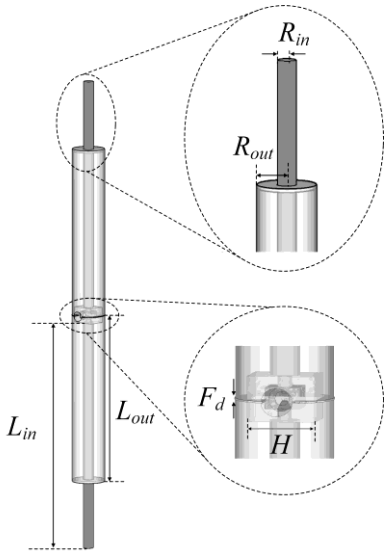

Figure 1. Geometry of proposed antenna element.

TABLE I
Parameters of the proposed antenna (mm)

Parameter	Size	Parameter	Size	Parameter	Size
L_{in}	680	L_{out}	430	F_d	3.2
H	45	R_{in}	15	R_{out}	70

Fig. 2 illustrates reflection coefficients of the proposed coupled-fed antenna (solid line) and the conventional single dipole element (dotted line). The reflection coefficients of proposed antenna are −17.1 dB and −12.1 dB at 98 MHz and 200 MHz. The proposed antenna shows reflection coefficients of less than −10 dB in both FM and DMB frequencies, while the single dipole does not resonate in the DMB frequency band.

In Fig. 3, the bore-sight gains of the proposed antenna are 2 dBi and 2.8 dBi at 98 MHz and 200 MHz, respectively, while the bore-sight gain of the single dipole antenna is -1 dBi at 200 MHz. The bore-sight gain of the proposed antenna is more than 0.5 dBi in the entire frequency band from 83 MHz to 250 MHz.

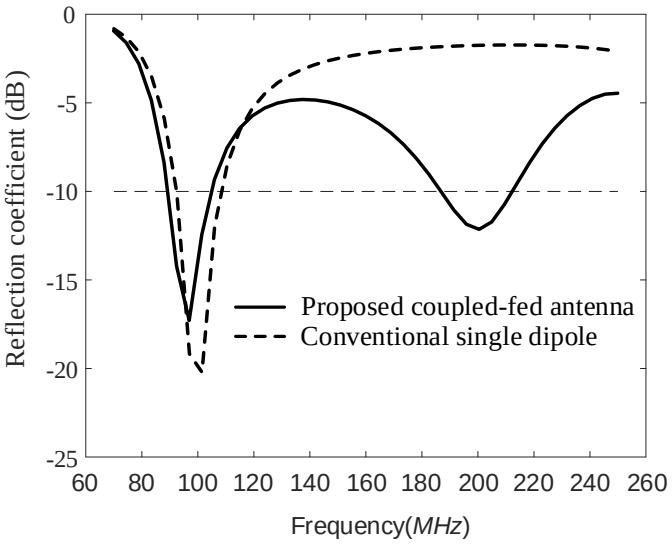

Figure 2. Reflection coefficients of the proposed antenna and single dipole.

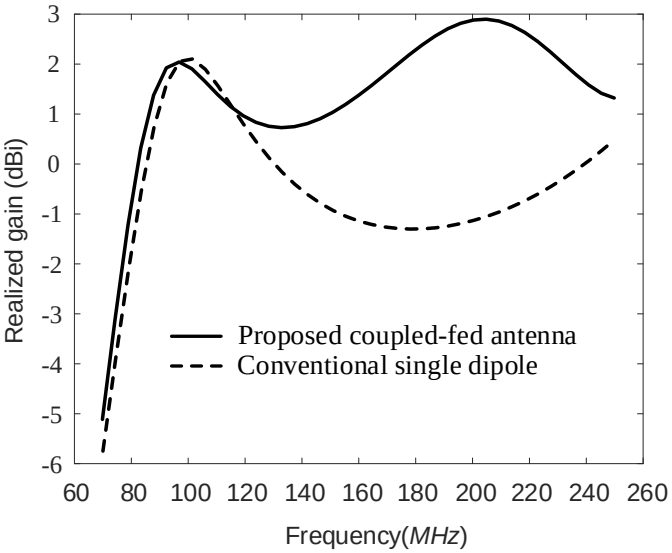

Figure 3. Realized gains of the proposed antenna and single dipole.

III. Conclusion

We have investigated the design of the dual-band coupled-fed dipole antenna. The proposed antenna consists of an internal and an external dipoles, and the external dipole was electromagnetically coupled to the internal dipole for dual-band operation for broadband matching characteristics. The proposed antenna had simulated reflection coefficients of −17.1 dB and −12.1 dB at 98 MHz and 200 MHz, respectively. The bore-sight gains were 2 dBi and 2.8 dBi at each operating frequency. The bore-sight gain of the proposed antenna was more than 0.5 dBi in the entire frequency band from 83 MHz to 250 MHz. The results demonstrated that the proposed antenna for PCL systems can achieve the dual-band operation with broadband matching characteristics using the coupled-fed mechanism.

Acknowledgment

This research was funded by the Agency for Defense Development and supported by HANHWA SYSTEMS.

References

[1] H.D. Griffiths, C.J. Baker, “Passive coherent location radar systems. Part 1: performance prediction,” *IEE Proceedings - Radar, Sonar and Navigation*, vol. 152, pp. 153-159, June 2005.

[2] H.D. Griffiths, C.J. Baker, “Passive coherent location radar systems. Part 2: Waveform properties,” *IEE Proceedings - Radar, Sonar and Navigation*, vol. 152, pp. 160-168, June 2005.

[3] G. Byun, H. Choo, and H. Ling, “Optimum Placement of DF Antenna Elements for Accurate DOA Estimation in a Harsh Platform Environment,” *IEEE Trans. Antennas Propagat.*, vol. 61, no. 9, pp. 4783-4791, Sep. 2013.

[4] P.E. Howland, D. Maksimiuk, G. Reitsma, “FM radio based bistatic radar,” *IEE Proceedings - Radar, Sonar and Navigation*, vol. 152, pp. 107-115, June 2005.