POS-A-14

Proceedings of ISAP'04, Sendai, JAPAN

CHARACTERISTICS OF HALF-WAVE LENGTH MONOPOLE ANTENNA FOR VHF PORTABLE RADIO TERMINAL

Takayuki SASAMORI*, Taketo URATANI*, Teruo TOBANA*,
Kohshi ABE* and Kunio SAWAYA**
* Faculty of Systems Science and Technology, Akita Prefectural University
Honjo-shi, Akita, 015-0055 Japan
sasa@akita-pu.ac.jp
** Graduate School of Engineering, Tohoku University
Sendai-shi, Miyagi, 980-8579 Japan

1. Introduction

The VHF portable radio communications are very important because these are used for the socially important aims such as the fire and police communications. In the conventional portable radio terminal of the VHF radio communications, monopole antennas or normal mode helical antennas are installed on the body of the radio terminal. It is known that the characteristics of such antennas change greatly when the body of the terminal is held in hand [1]. This problem is caused by the fact that the size of the radio terminal is much smaller than the wavelength and the body of the terminal does not function as the earth ground. When the radio terminal is touched with the hand, the human body behaves as the earth ground or a radiating structure and the radiation characteristics change due to the influence of the human body. The half-wave length monopole antenna and the dipole type antenna were examined in order to overcome this problem [2, 3].

In this paper, a half-wave length monopole antenna with a matching circuit composed of a coil and a sleeve is proposed to decrease the influence of holding the radio terminal. The impedance characteristics and the radiation characteristics are presented experimentally.

2. Antenna Configuration

The geometry of the proposed antenna installed on a rectangular conducting box is shown in figure 1. In this paper, the operating frequency is 150MHz (λ = 2m). The length of the monopole antenna is half-wave length (1m) in order to reduce the current on the conducting box. The size of the conducting box is 75mm x 50mm x 150mm.

A matching circuit composed of a coil and a sleeve is installed between the monopole antenna and the conducting box. Figure 2 shows the sectional view of the matching circuit. The rectangular conducting sleeve of which the height is H is installed on the conducting box. The shape of the conducting sleeve at cross section is a square of which the internal length of a side is S_a = 17.0mm. The coil wound on a rectangular spool is in the conducting sleeve. The number of turns of the coil is N, and the length of the coil is L. The shape of the spool at cross section is a square of which the length of a side is S_b = 14.4mm. Two terminals of the coil are connected to a receptacle and end of the monopole antenna, respectively. The length of a part of the coil that is appeared from the conducting sleeve is defined as outside coil length l, as shown in figure 2.

3. Measured results

Figure 3 shows an example of the developed antenna's frequency characteristics of the voltage standing wave ratio with respect to the outside coil length l, where H = 25.9mm, N = 19 turns, L = 16.1mm. In this paper, the frequency at a minimum voltage standing wave ratio is defined as center frequency f_0. Figure 4 contains plots of the input impedance characteristics for the outside coil length l. It can be seen that the input impedance of this antenna is matched between l = 1.7mm and 2.4mm.

In figure 5, the center frequency f_0 is shown as a function of the outside coil length l with respect to the number of turns of the coil N, where N = 7 turns (H = 25.9mm, L = 6.1mm), N = 19 turns (H = 25.9mm, L = 16.1mm) and N = 34 turns (H = 36.1mm, L = 27.1mm). Figure 6 shows the voltage standing wave ratio at the center frequency f_0 as a function of the outside coil length l. These figures show that the impedance matching of this antenna is achieved by tuning the outside coil length l. We also examined some other numbers of turns of coil, and appropriate number of turns (VSWR $\leq$ 2 at 150MHz) could not be found out.

Figure 7 shows the frequency characteristics of the voltage standing wave ratio of the proposed antenna, where N = 19 turns, H = 25.9mm and l = 2.5mm. The bandwidth (VSWR $\leq$ 2) is about 3.3%. It can be seen that differences between the VSWR characteristics and the center frequency for the cases with or without the hand are almost negligible.

The measured radiation patterns on both E and H-planes at 150MHz for the proposed antenna are shown in figure 8, where N = 19 turns, H = 25.9mm and l = 2.5mm. The measured radiation patterns of a half-wave length dipole antenna are also shown in the figures for comparison. The directive gain of this antenna is 2.9dBi. It can be seen that the shape and maximum radiation strength of the radiation pattern of this antenna are highly similar to a half-wave length dipole antenna.

4. Conclusion

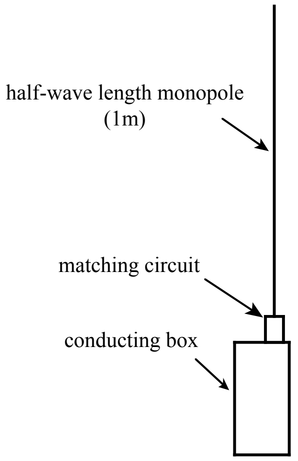
The half-wave length monopole antenna with a matching circuit composed of a coil and a sleeve has been proposed to increase the radiation efficiency and suppression of the influence of holding the body of the portable terminal. It is shown that the impedance matching of this antenna is achieved by controlling the outside coil length l. The differences between the voltage standing wave ratio and the center frequency for the cases with or without the hand are almost negligible. The radiation characteristics of this antenna are approximately same as a half-wave length dipole antenna.

References

[1] The Institute of Electronics, Information and Communication Engineers, Japan ed., "Antenna Engineering Handbook," p.319, OHM Tokyo, Oct. 1980.

[2] K. Fujimoto, A. Henderson, K. Hirasawa and J.R. James, "Small Antennas," John Wiley & Sons Inc., 1987.

[3] T. Sasamori, T. Ishimori and K. Sawaya, "A Helical Antenna Suppressing Body Effect for VHF Portable Terminals," Trans. IEICE, J84-B, no.5, pp.951-953, 2001.



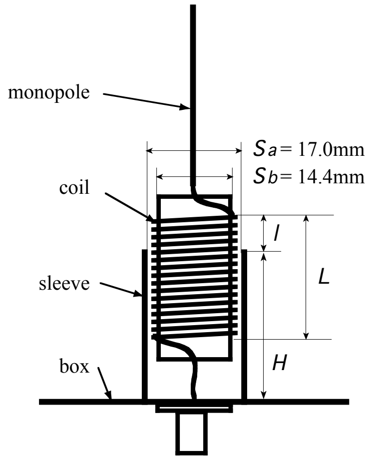


Figure 1. Configuration of the propose antenna.

Figure 2. Matching circuit.

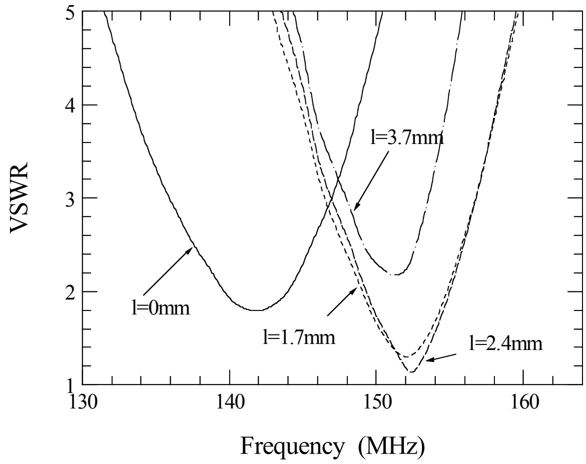


Figure 3. Frequency characteristics of measured VSWR.

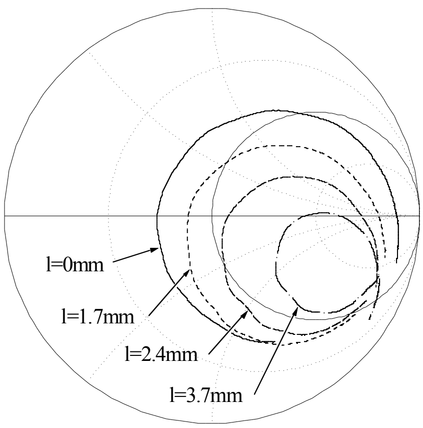


Figure 4. Measured input impedance.

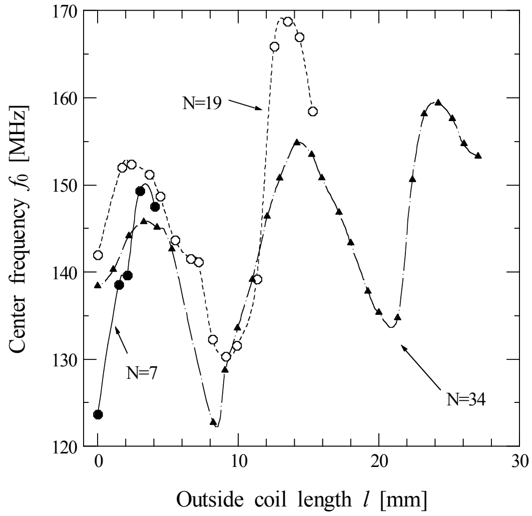


Figure 5. Center frequency versus outside coil length.

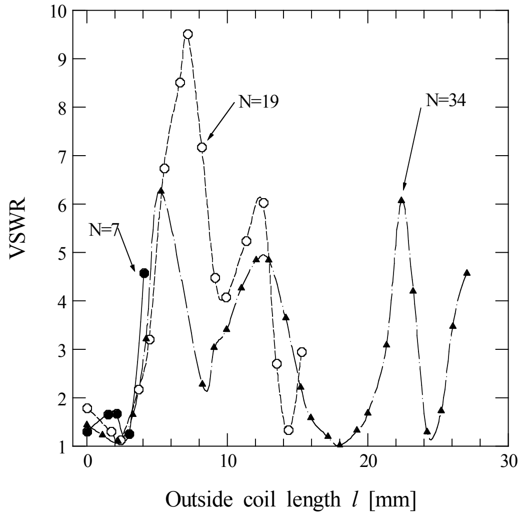


Figure 6. VSWR versus outside coil length.

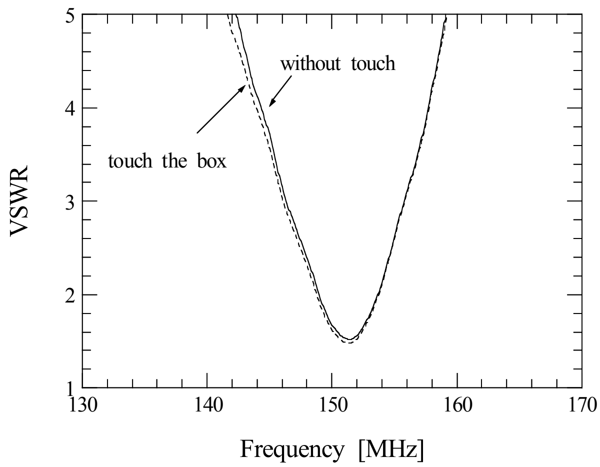
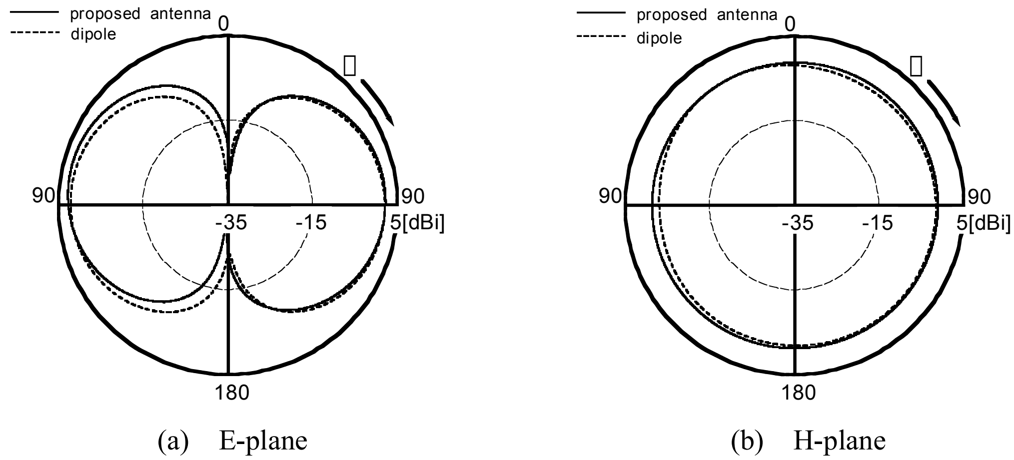


Figure 7. The influence of the hand on the VSWR.



(a) E-plane (b) H-plane

Figure 8. Measured radiation patterns.