Compact Repeater Antenna System with Extremely High Isolation in the 800MHz band

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1. Introduction

The radio repeater is an attractive solution for cost-effective expansion of coverage in cellular systems. The direct relay radio repeater (not the frequency conversion type) is particularly cost-effective due to its simple structure. However, when this type of repeater is used to extend coverage in open areas, radio echoes tend to occur between the two antennas at the repeater station. Since repeater stations require high RF gain, especially in rural areas, the antenna directed toward the base station and the antenna directed toward the mobile stations must be installed separately so as not to cause radio echoes and this separate installation increases the installation costs. To address this problem, antennas with high isolation using a choke at the antenna reflector but at the expense of greater physical size have been proposed [1]; however, they do not yet provide an effective solution. This is because the repeater antenna systems need to be compact in order to withstand high winds. This issue is extremely critical especially for 800 MHz band systems compared to 2 GHz band systems.

This paper proposes a small repeater antenna system for the 800 MHz band with extremely high isolation characteristics.

2. Antenna Structure and Radiation Pattern

Figure 1 shows several views of the repeater antenna system we developed. It consists of two antennas mounted on a single pole. The two antennas are placed 140 mm away from each other. Each of the two antennas has a vertical polarized port and a horizontal polarized port.

In addition to the above-mentioned prototype antenna system (Type-A), a pair of optimized antennas (Type-B) has also been developed. Table 1 summarizes parameters for Type-A and Type-B, where λ_0 is the wavelength of the radio wave at 840 MHz. Each antenna is composed of a 2(vertical) x4(horizontal) array with vertically-polarized printed dipoles, and a 4x2 array with horizontally-polarized printed dipoles. The width and height are the same for both antennas, although the thickness is slightly different. Figure 2 shows the radiation patterns of these antennas. The solid lines indicate the vertical polarization, and the dotted lines indicate the cross polarization. This figure shows that the side-lobe and back-lobe levels are successfully suppressed, which is due to the implementation of a tapered array for Type B. This yielded back lobe levels of less than -30dB, although the beam width of the main lobe was slightly increased compared to Type A. The cross polarization outside of the main beam was also reduced.

3. Antenna Isolation Results

The isolation performance of these antennas was evaluated in an anechoic chamber. Two of these antennas were mounted on a metallic pole located at the center of the anechoic chamber. The coupling levels (reverse of the isolation level) were measured for both Type A and Type B systems.

Figure 3 shows the isolation measured by frequency domain analysis with a network analyzer. The solid lines show isolation at the vertical-vertical (V-V) polarized antenna ports and the dotted lines show isolation at the vertical-horizontal (V-H) polarized antenna ports. The thin lines and the thick lines indicate Type A and Type B, respectively.

The V-H polarization characteristics were obtained by selecting the vertical polarized port of one antenna and horizontal polarized port of the other antenna. The coupling level between Type B antennas is lower than that for Type A, which means that the back-lobe and side lobes of Type B are smaller than those of Type A as shown in Figure 3. Among these, the coupling between Type B antennas with V-H polarization was less than -75 dB, which includes not only direct coupling but also delayed waves. Figure 4 shows the isolation by time domain analysis. In this figure, three peaks are observed. The first peak is the direct coupling between two antennas, the other peaks are the delayed waves reflected by the wall of the chamber. It was confirmed from the figure that direct coupling between antennas was achieved at less than -80 dB.

4. Conclusion

A small repeater antenna system for the 800 MHz band having extremely high isolation was developed. Through a performance evaluation of the developed antenna system in an anechoic chamber, it was confirmed that an isolation of more than 80 dB can be achieved where two antennas are mounted close together on the same pole. We firmly believe that this new antenna system will be very useful for radio repeaters in the 800 MHz band, which provide cost-effective coverage in rural areas.

Acknowledgments

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References

[1] Y. Kimura, Y. Ebine, K. Cho, N. Michishita, “Verification of Mutual Coupling Characteristics of Booster Antenna for IMT-2000 in Radio Blind Areas”, IEICE Society B-1-134, 2004 (In Japanese)

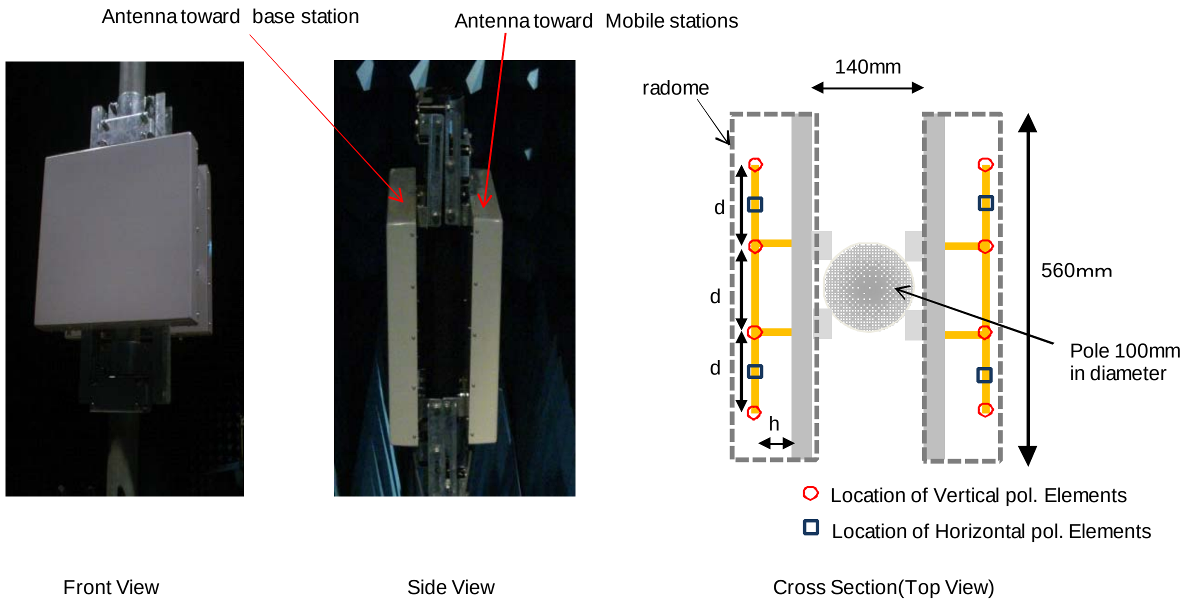

Figure 1 Repeater antenna system.

Table 1 Antenna parameters.

	Prototype(Type A)	Optimized(Type B)
Service Frequency Band	815-875 MHz	
Polarization	Vertical / Horizontal Dual Polarization	
Gain	13 dBi	
Taper between elements in horizontal plane	Uniform	Center elements: 0 dB Edge elements: -6 dB
Distance between elements(d)	0.8 λ_0	0.7 λ_0
Distance elements height(h)	0.2 λ_0	0.25 λ_0
Outer Dimensions	W560*H560*D80 mm	W560*H560*D98 mm

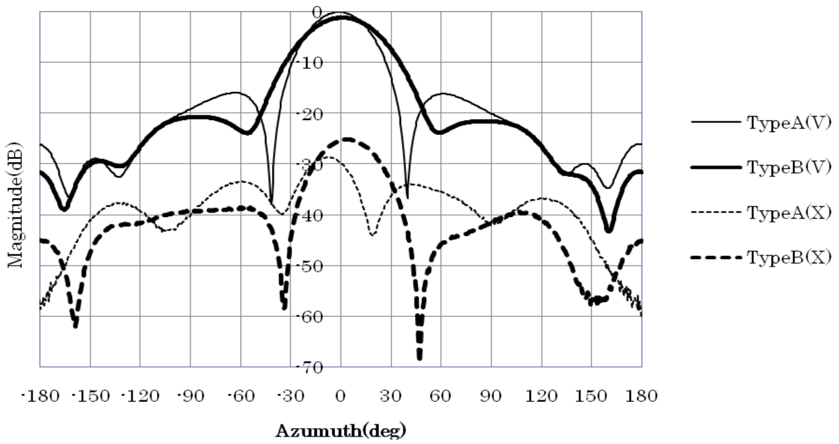

Figure 2 Radiation pattern on horizontal plane.

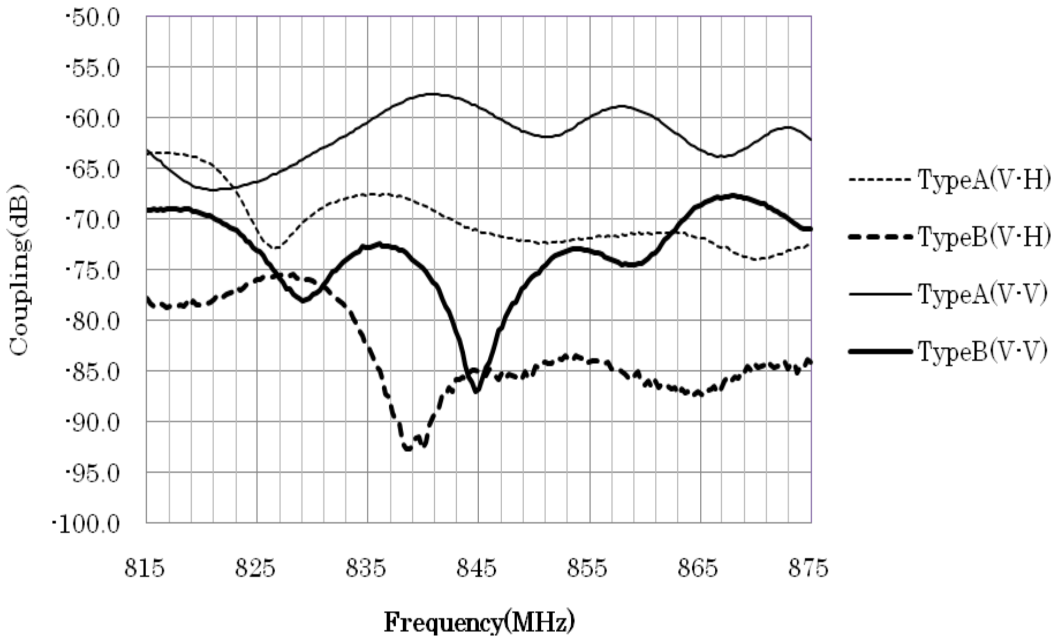

Figure 3 Measurement of coupling characteristics (frequency domain analysis).

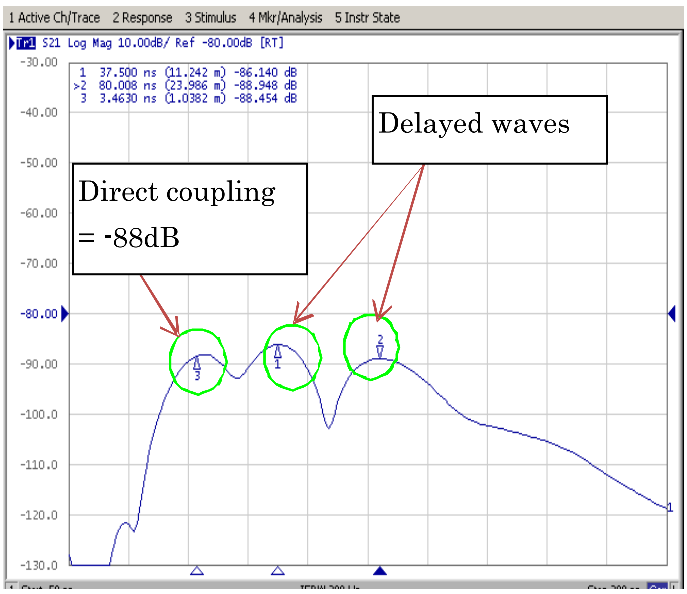

Figure 4 Measurement of coupling characteristics (time domain analysis).