Multi-band Reconfigurable Basestation Antenna for Green Mobile Communication Infrastructure

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Abstract

A multi-band reconfigurable basestaton antenna is presented. This antenna can be operated in three bands and has the active antenna configuration including various active and passive components. The overall antenna operation can be controlled by an external control unit, thus we can select the operation frequency and control the antenna beam direction and the radiating power using a remote control program. From performance test, we confirmed that this antenna meets the required electrical performances for basestation service in Korea.

Keywords : Reconfigurable antenna, basestation, multi-band, mobile communications

1. Introduction

The reconfigurable antenna has been receiving a lot of attention recently. This antenna's aperture is dynamically modified so that it can perform different functions at different frequencies and create any required radiation pattern. In most systems, several antennas are used on a single platform to perform a variety of functions. An improved performance with reduced cost can be obtained if a single antenna could be reconfigured to operate over various frequencies, thus covering a large bandwidth or having multi-band operation. But the reconfigurable antenna research has been concentrated for mobile terminals and the antenna aperture is typically reconfigured using PIN switches, MEMS switches, or photonically controlled devices [1-9].

In this paper, we proposed a multi-band basestation reconfigurable antenna which can electrically control the antenna beam direction and radiating power. Thus, mobile communications service providers can reduce the cost of infrastructure and operating expenses. Besides, the multiband basestation antenna can solve the human hazard problem of RF signal, thus it will be a key engineering issue in next generation mobile service for eco-friendly green environment.

2. Multiband Basestation Antenna design

Table 1: Main specifications of proposed multi-band basestation antenna

Items	Operation bands		
	B_1 band	B_2 band	B_3 band
Operating Frequency Band	Tx:869~894MHz Rx:824~849MHz	Tx:2.11~2.17GHz Rx:1.92~1.98GHz	Tx:2.3~2.39GHz Rx:2.3~2.39GHz
VSWR	1.5 Max.	1.5 Max.	1.5 Max.
Antenna Gain	16 dBi Min.	16 dBi Min.	16 dBi Min.
Half Power Beam Width (HPBW)	65° ±5° @Az. < 8° @El.	65° ±5° @Az. < 7° @El.	65° ±5° @Az. < 7° @El.
Electrical Beam Scanning Range	-	0°~20°	0°~20°
Sidelobe level (SLL)	15 dBc Min.	13 dBc Min.	13 dBc Min.

The main specification of the proposed multi-band basestation antenna is summarized in Table. 1. The proposed antenna is operated in three bands; B_1 for cellular, B_2 for WCDMA (Wideband Code Division Multiple Access) and B_3 for WiBro (Wireless Broadband) service in Korea. In the services, WiBro adapts TDD (Time Division Duplexing), thus the TX and RX frequency are identical. The most of the antenna specifications are similar to that of the general single band basestation antenna because the proposed basestation antenna should be operated in the same communications environment. And, this antenna has the active antenna structure to control the antenna beam direction, the radiating power and so on. Using this feature, we can change the communication service coverage and provide high quality service using beam pattern shaping optimized in communications environment. In this design, the electrical beam scanning range is 0°~20° for B_2 and B_3 band.

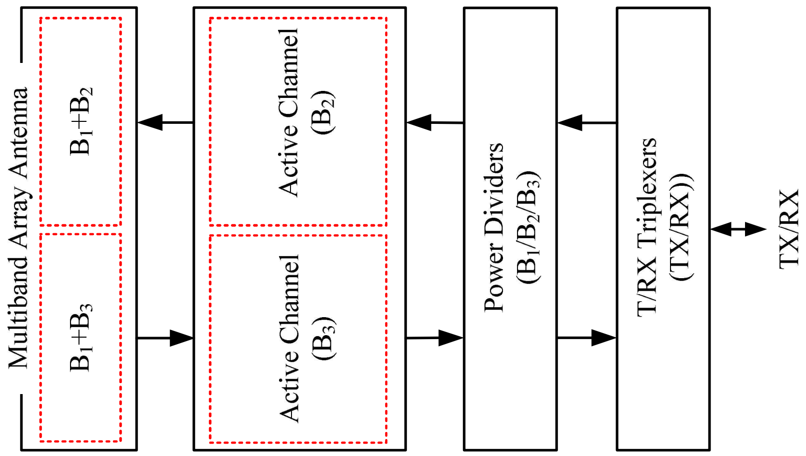

Figure 1: Block diagram of the proposed multiband antenna

Figure 1 shows the proposed antenna structure. The antenna can be mainly divided by 4 parts. First, the multiband array antenna is composed of two types of array. The array for B1+B2 is operated in two bands of B_1 and B_2, and the other is operated in B_1 and B_3. This structure was designed to minimize the array size using the optimal arrangement of individual radiators operated in single band considering the radiator size. Next, the active channels are connected with the B_2- and B_3–band radiators and composed of several components written below to control the frequency band selection, the antenna beam direction and the pattern shape.

- Amplifiers: RF signal power amplification (Power amplifier for TX and LNA for RX)
- Phase shifter: phase control of RF signal (antenna beam control)
- Attenuator: TX radiating power and channel power control
- BPF: T/RX isolation and interference suppression from near frequency band signal
- RF switch: RF signal On/Off control

The power dividers (combiners) are used to distribute the TX signal power from T/RX triplexer to each active channel and combine the RX signal received by the radiators. Lastly, the T/RX triplexer separates and combines TX and RX signal from a common input port which is connected with basestation indoor equipments using RF cable.

3. Antenna Performance Test

A prototype antenna was fabricated and the antenna size is 300 mm (W) × 2560 mm (L) × 150 mm (H). The fabricated antenna was tested in anechoic chamber using a compact range of chamber of *Orbit/FR Inc.* as shown in Figure 2. Figure 3 shows the antenna radiation patterns measured in the center frequencies of B_1 ~ B_3. The radiators are commonly used for TX and RX, thus the patterns for them are identical. From the results, we can confirm the realized electrical performance of the proposed antenna. The minimum gain of the fabricated antenna is16.5 dBi (HPBW = 65° ~ 68°), 16.2 dBi (HPBW = 61° ~ 69°) and 16.4 dBi (HPBW = 60° ~ 63°) for B_1, B_2 and B_3 respectively. The SLL is 17.5 dB for B_1, 14.0 dB for B_2 and 13.2 dB for B_3. The array spacing among the element antennas for each frequency bands are different, thus the antenna has the difference of SLL performances for each bands. The maximum radiating power of the antenna is about 30 W and the electrical beam scanning range is 20° in elevation.

Figure 2: Photo of the antenna performance test in compact range chamber

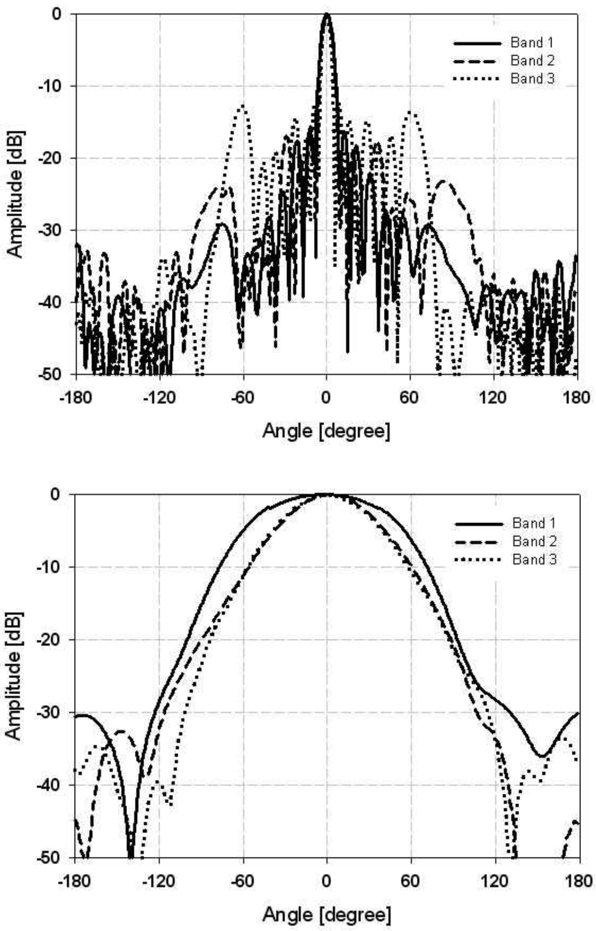

Figure 3: Measured radiation patterns of the proposed antenna

4. Conclusions

The multiband basestation reconfigurable antenna is presented. This antenna can provide thee mobile communications services, Cellular, WCDMA and WiBro in Korea. The antenna array was designed that thee single band radiators are arranged in a row with different array spacing. Also, the proposed antenna includes the active channels for B_2 and B_3 to control the frequency band selection, the antenna beam direction and the radiating power. Using this antenna, mobile service providers can provide multiple mobile services using only one antenna and considerably reduce the number of the basestations which can be used to realize the green mobile communications infrastructure.

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Acknowledgments

This research was supported by Basic Science Research Program through the National Researc h Foundation of Korea(NRF) funded by the Ministry of Education, Science and Technology (2011-0013213)