Abstract - The 21-GHz band is expected to be used to transmit signals of the next-generation broadcasting services. Thus, we have developed a wide band transponder configured with an array-fed reflector antenna that enables to combine enough power for large capacity signal transmission. In addition, it can also alter its radiation pattern to mitigate fading. We proposed an array-fed shaped reflector antenna that is an assembly of a feed-array and dual shaped reflectors. Here we evaluate the radiation patterns of the prototype proposed antenna.

Index Terms — 21-GHz band BSS, phased array antenna, beam forming network, fading mitigation technology.

1. Introduction

Satellite broadcasting in the 21-GHz band is expected to be able to transmit multi-programs of 8K SHV and the other advanced services [1]. Achieving a high data rate, we assume the allocation of two 300-MHz-class wide-band channels in the 21.4–22.0 GHz band [2]. It is required to be approximately 2 kW for a channel of the total output power of the onboard high power amplifiers while receiving with a small user terminal antenna whose diameter is 45cm [3].

We have developed an array-fed imaging reflector antenna (array-fed IRA). It consists of a feed array and dual parabolic reflectors. Since the radiated pattern of the feed array is magnified with dual parabolic reflectors, it has a large aperture and reconfigurable radiation pattern with relatively small numbers of array elements compared with a direct array antenna. We introduced a prototype array-fed IRA configuration. It consisted of 32 feed horn antennas and a main-reflector whose diameter is 1.8m. We showed calculated radiation patterns of the array-fed IRA with measured radiation patterns of the feed array [4].

However, grating-lobes appeared in the radiation pattern of the array-fed IRA due to the sparse array of the magnified arrangement. To reduce the grating-lobes, we proposed an array-fed shaped reflector antenna (array-fed SRA) that is an assembly of a feed-array and dual shaped reflectors [6]. In this paper, we evaluate the radiation pattern of a prototype antenna.

2. Array-fed Dual Shaped Reflector Antenna

(1) Antenna Configuration

Configuration of the array-fed SRA is illustrated in Fig.1. The divided RF signal passes through the phase shifter, TWT amplifier, and filter. The output signals of the filter are connected to each feed horn. The main reflector is shaped to configure a radiation pattern to cover the main area of Japan with uniform power (JP-beam) when it is configured as a single offset reflector (SOR). Then, the sub reflector is shaped to approximate the radiation pattern of a feed-horn antenna for a SOR when the phases and amplitudes of the feed elements are equal.

(2) A Prototype Antenna

A prototype array-fed SRA is depicted in Fig.2. The main reflector, whose aperture diameter is 1.9m, was originally fabricated for a SOR antenna [5]. We designed the surface of the 0.25m sub reflector. The difference between the parabolic and designed shaped surface is depicted in Fig. 3. The red and blue represent the convex and concave, respectively. We assembled the feed array, the sub reflector, and the main reflector. When the phases and amplitudes of 31 feed elements were equal, the array-fed SRA configured a JP-beam.

Fig.1. Block diagram for 21-GHz band BS

Fig.2. A prototype array-fed SRA
The excitation coefficients of each array element were controlled to be equal phase and amplitude by the prototype beam forming network (BFN). The control accuracy of the phase and amplitude were less than 7 deg. RMS and 1dB RMS, respectively [4].