Development of a dual-polarized slotted waveguide array antenna made of injection-molded resin

*Tomoya Matsuda[1], Ikuya Kakimoto[1], Yoshihiko Konishi[2], Narihiro Nakamoto[1], Takashi Uesaka[1], Takashi Uno[1], Tomoyuki Koyanagi[1], Takeshi Yamamoto[1]

1. Mitsubishi Electric Corporation, 2. Hiroshima Institute of Technology

1. Introduction
We have developed a dual-polarized antenna mainly used for C-band (5.25-5.37 GHz) phased array weather radar. Our developed antenna is a slotted waveguide array antenna made of injection-molded resin, which has good performance compared with conventional patch array antenna in terns of cross-polarization characteristics and antenna efficiency, as well as contribution of weight reduction and cost. We will introduce the result of measured antenna pattern which satisfies the severe requirements of the weather radar.

2. outline of the antenna
A C-band dual polarized phased array radar requires high specsification for the antenna array, especially for Cross polarization level (<-35dB) and Sidelobe level (<-30dB) to achieve accurate polarization parameters for received signals of raindrops. On the other hand, it is necessary to reduce system cost. To solve this conflict between the higher-requirement and low-cost, we have decided to develop a waveguide antenna system which is made of “resin”.

We have adopted an beam-scanning method of scanning mechanically in azimuth and electronically (digital beam forming is used for scanning) in elevation to achieve rapid scanning in the coverage.

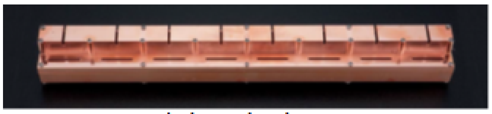
The aperture length of the antenna is set to be 3.2 m x 3.2 m for system requrements. The antenna array consists of 74x16 subarrays for each polarization, and each subarray has 4 radiating elements. The beam width of the array is less than 1.2 deg.

3. Dual polarized slotted waveguide array antenna

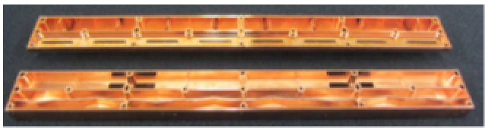
To answer the higher requirement in low cross-polarization and high antenna efficiency, we adopt the slotted waveguide array antenna. The two types of the slotted waveguide array are arranged side by side to achieve a dual-polarized antenna. One is a novel ridged waveguide slotted array, in which slots are arranged linearly on the center of the broad wall of a waveguide with a meandering ridge, is for the vertical polarization, and the other is an untitled edge-slotted waveguide array for the horizontal polarization. To achieve a sidelobe level lower than -30 dB, radiation from each slot was finely adjusted and the array was designed to have Taylor distribution on the aperture. Though conventional metallic waveguide array antennas offer excellent performance, they are heavy and expensive because they are made with machining processes. The developed antenna is made by manufacturing approach that combines resin injection molding and plating to acheive reduced weight and low cost. Figure.1 shows photos of a fabricated subarray and a prototype array consisting of 296 subarrays (a half of whole array for the weather radar). The measured radiation patterns for the horizontal polarization are also shown in Figure.1. The beam width in the azimuth plane is 1.17 deg. The measured sidelobe level in the azimuth plane is lower than -31 dB, and the measured cross-polarization is –47 dB. High antenna efficiency of 94% is also achieved. To suppress ground clutter, the radiation pattern in the elevation plane is controlled to have a null in the direction of -1 to -4 deg. direction by DBF technology. The calculated nulling two-way array pattern (the product of transmit and receive array pattern) using measured subarray radiation pattern is also shown in this figure, and desirable two-way array pattern is also achieved.

This research is supported by Adaptable and Seamless Technology transfer Program through targetdriven R&D from Japan Science and Technology Agency,(JST).

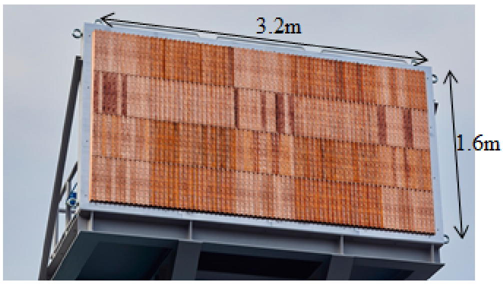
Keywords: phased array radar, waveguide slotted antenna, injection-molded resin



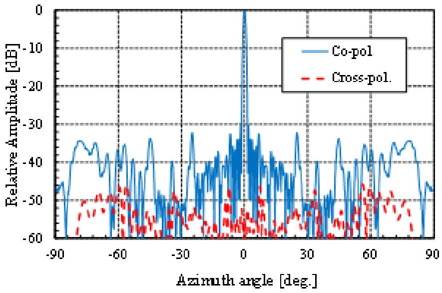
Fabricated subarray



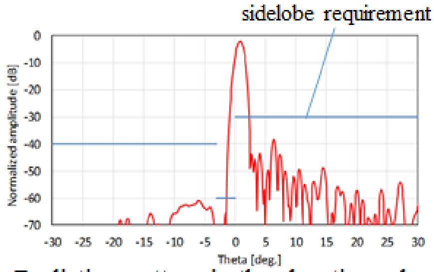
Inside of fabricated subarray



Prototype of array



Radiation pattern in the azimuth plane



Radiation pattern in the elevation plane