Detection of Multilayer Targets Using NRD Guide Pulse Radar at 60 GHz.

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Research and development of pulse radar systems have been undertaken by many companies, institutions and laboratories for car warning radar systems and tank level estimation systems (H. H. Meinel, IEEE Trans. Microwave Theory Tech., Vol. 43, No.7, 1995). In most pulse radar systems, oscillation power is divided by a junction circuit and is introduced into two parts, a transmission wave in the transmitter, and a LO wave to realize heterodyne detection in the receiver. The frequency of the former is up-converted so as to be different from the frequency of the LO wave, and thus an expensive millimeter wave amplifier must be installed on the transmission side due to the low power of the up-converted millimeter-wave (N. C. Currie and C/ E/ Brown, "Principles and Applications of Millimeter-Wave Radar," Artech House, Inc., Norwood, MA, 1987).
With this in mind, we developed a new circuit configuration, based on the NRD guide technology as shown in Fig.1. This radar front-end consists of a Gunn oscillator with two output ports to eliminate the junction circuit, a direct pulse modulator to obtain a high level of transmission power without an expensive millimeter-wave amplifier, and a filter-based down-converter with an up-converter as a local oscillator. Figure 2 shows a photograph of the fabricated planar antenna, which consists of a high ε LSE-NRD guide radiator located at a focal point of a 2-dimensional parabolic reflector in an oversized waveguide. The top metal plate is a metallized dielectric substrate, on which several ten slots are etched, and is exited by the oversized waveguide. Good pencil beam pattern having the half power beam widths of 2.8° in the E-plane and 3° in the H-plane was obtained, and the antenna gain was measured to be 33 dBi. An FPGA-based digital signal processor including high-speed counting, memorizing, and averaging was developed to remove rage-finding error due to multi-reflection between the radar and the target. By using this pulse radar system, good range finding was performed because the error was less than 1 % for the distance from 2 m to 40 m.

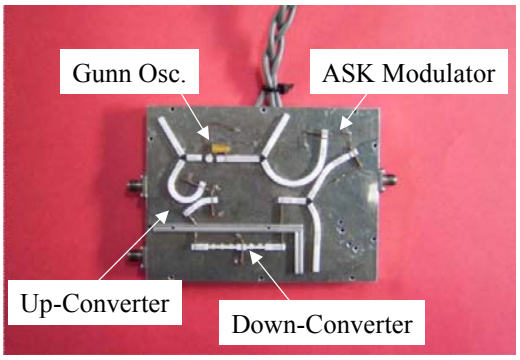

Fig. 1. Photograph of NRD guide pulse radar front-end

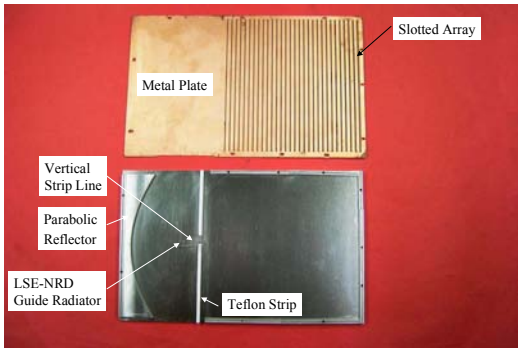

Fig. 2. Photograph of planar antenna fed by LSE-NRD guide radiator