Phase Shifter Control Scheme Implementation for Steerable/Adaptive L-Band Phased Arrays

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There is a growing need to develop electronically steered antennas for BGAN services (S. Fu, *et. al.*, A Wideband Circular Polarization Antenna for Portable INMARSAT BGAN Terminal Applications, Micro. and Opt. Tech. Letters, 51, 2354–2357, 2009) and adaptive GPS antennas with anti-jamming capabilities (Q. Li, *et. al.* A Robust Anti-Jamming Navigation Receiver with Antenna Array and GPS/SINS, IEEE Comm. Letters, 18, 467-470, 2014). In phased arrays multiple antenna elements are excited simultaneously through a feed network. The steering capability of the main beam of the array is achieved by applying a progressive phase shift across the array aperture. The focus of this work is the implementation of the phase shift controlling scheme.

The implemented 4-element array control scheme consists of 4 phase shifter chips, 2 8-bit shift registers and a microcontroller. For the phase shifters, MAPS-010143 chips are used where the phase shift in each chip is controlled by 4 digital bits. Using the 4 bits, a phase resolution of 22.5^{o} can be achieved. The phase shifters can be operated both in parallel load or serial load mode. The proposed scheme uses the parallel loading mode where the 16 outputs from the 2 shift registers are used as the control bits for the 4 phase shifters. To achieve a particular steering angle of the beam, differential phase shifts required for each element are applied. The microcontroller is programmed in such a way that according to the user input, the appropriate control values are serially fed into the shift registers. When the outputs of all the registers are latched, the values act as the control bits of the phase shifters.

A PCB prototype was implemented for the proposed scheme which consisted of the phase shifters and the shift registers and an Arduino UNO board was used as the microcontroller module. Initially only the phase shifting scheme without the antennas was tested for different control configurations. After observing satisfactory results, the scheme was tested along with the L-band phased array to successfully demonstrate the beam steering capability and anti-jamming adaptive array capability. All of these results will be presented and discussed in detail.

The proposed method presents a simple implementation of phase shift control to accomplish beam steering capability in a phased array. With very minor modifications to the code and hardware, the method can be extended for higher resolution phase shifts (6-bit or even 8-bit phase shifters) and larger antenna arrays.