

Configuration of a One-body Two-dimensional Switching Matrix with a 4×4 Triangular Lattice of Beams

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Cascading a vertical and a horizontal stack of one-dimensional beam-switching matrices is a conventional way to create a two-dimensional one. To reduce the length of such matrices, two-dimensional coupling components are used (D.-H. Kim, et al., IEEE Trans. Microw. Theory Techn., vol. 64, no. 3, pp. 776-784, 2016). A triangular lattice of beams can have a lower gain roll-off compared with a square one. A change in lattice from square to triangular by connecting networks has been studied (N. J. G. Fonseca, et al., IEEE J. Microwaves, vol. 1, no. 2, pp. 646-658, 2021). One-body two-dimensional switching matrices with a triangular lattice of beams without connecting networks have also been proposed (J. Hirokawa, et al., IEEE Antennas Wireless Propag. Lett., vol. 18, no. 10, pp. 2056-2060, 2019). This manuscript realizes one solution of the one-body two-dimensional switching matrix with 4×4 beams provided in the latter reference. The matrix is realized using hollow waveguides operating over a frequency band from 27 GHz to 29 GHz.

The layers for the realized solution are shown in Fig. 1. Each layer consists of a sub-layer of couplers and the other sub-layer of phase shifters. The total number of layers is five. The five layers are cascaded in order from Layer 1 to 5. The layers are revised from the configuration presented in the reference paper. Circles refer to phase shifters. Squares show two-dimensional couplers. Rectangles represent one-dimensional couplers. “2D H” and “2D C” mean two-dimensional hybrid coupler and crossover, respectively. “H H,” “H C,” “E H,” and “E C” refer to one-dimensional H-plane hybrid coupler, H-plane crossover, E-plane hybrid coupler, and E-plane crossover, respectively. The squares and circles without marks are straight waveguides. Phase shifters before and after a crossover can be combined into one phase shifter. Since layers 2 and 5 only have crossovers and straight waveguides, all of the phase shifters along the crossovers and the straight waveguides in layers 1 and 4 can be combined with the phase shifters in layers 2 and 5 so that they all become zeros. Besides, the differences between the transmission phases of different couplers need to be compensated in order to avoid the influence on the output phase. Layers 1, 3, and 4 do not need compensation because they use exactly the same couplers in the same layers. However, the phase shift values are adjusted in layers 2 and 5 due to the different couplers they use. The adjusted phase shift values are highlighted in purple color. Finally, the transmission phase of a straight waveguide having the same length as phase shifters is added to all phase shifters so that the output phase differences will not be affected. The design of the components and the results of the realized full matrix will be explained at the conference.

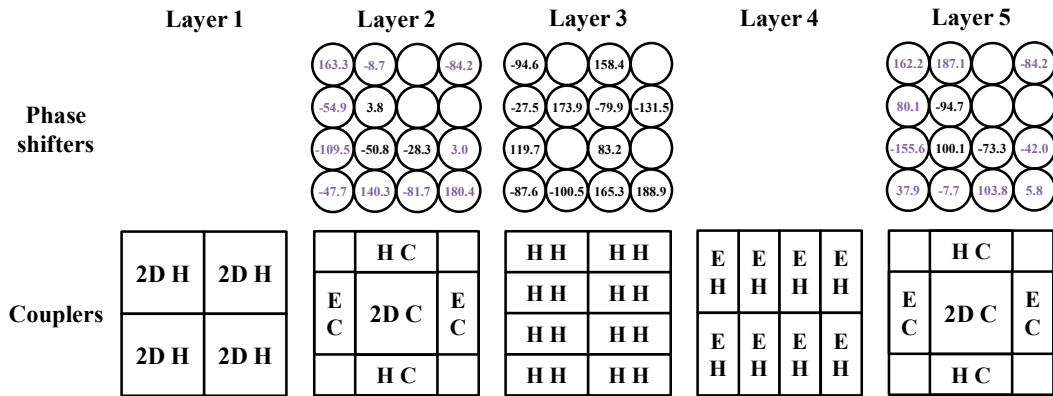


Figure 1. Revised layers for one-body two-dimensional matrix with a 4×4 triangular lattice of beams.