



I. Introduction

For millimeter-wave (60 GHz) phase array system, a 4-bit phase shifter was fabricated using Dongbu Hitek 0.13 μm RFCMOS technology. The phase shifter were designed by combining loaded-line structure for 22.5 and 45 degree phase shifting, and switched-line structure for 90 and 180 degree phase shift. Simulation result of the 4-bit phase shifter showed an insertion loss of about 10 ± 0.5 dB at 60 GHz. Chip size of the 4-bit phase shifter was 1.2×0.7 mm². Initial evaluation of the switched-line phase shifter (90 and 180 degree phase shift) showed an insertion loss of 6.7 dB at 60 GHz.

II. 22.5 degree & 45 degree Loaded-Line Phase Shifter

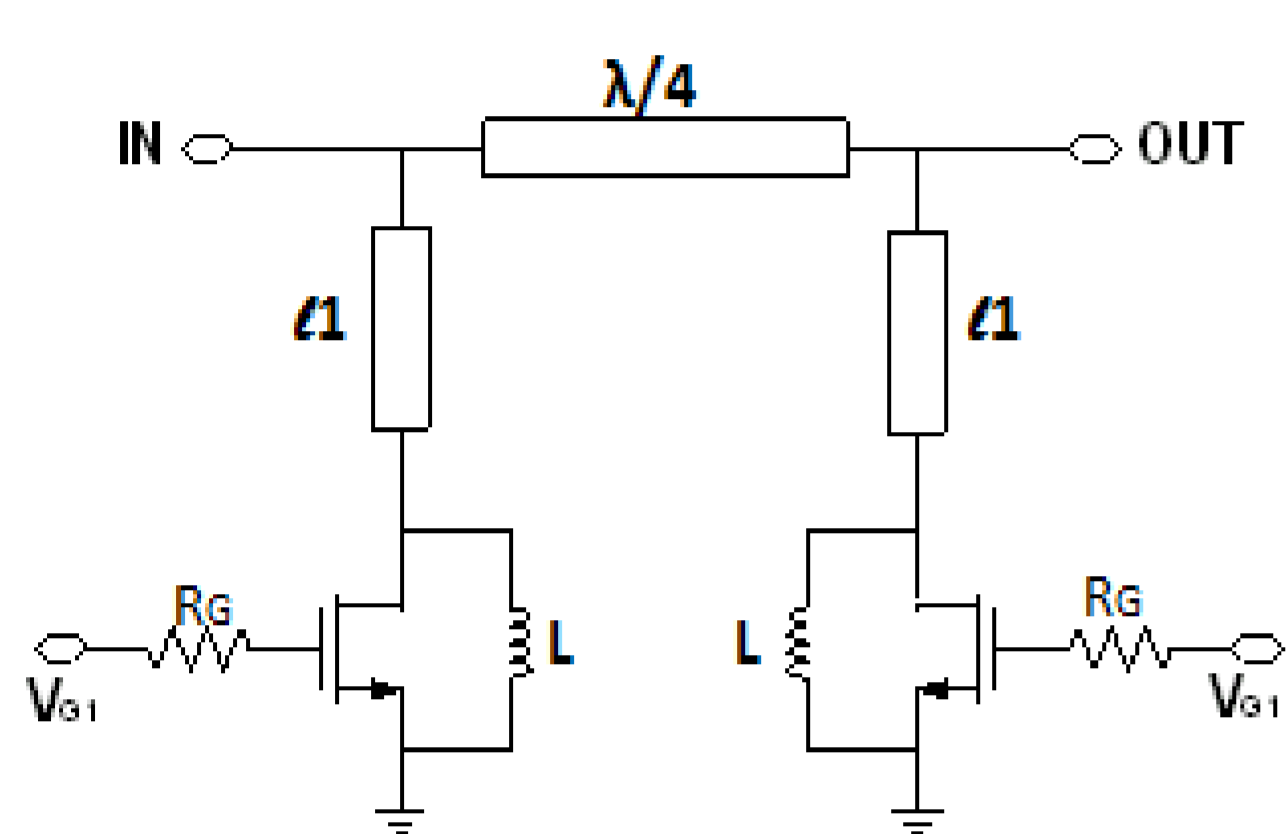


Figure 1. Circuit schematic of 22.5 and 45 degree loaded-line phase shifter.

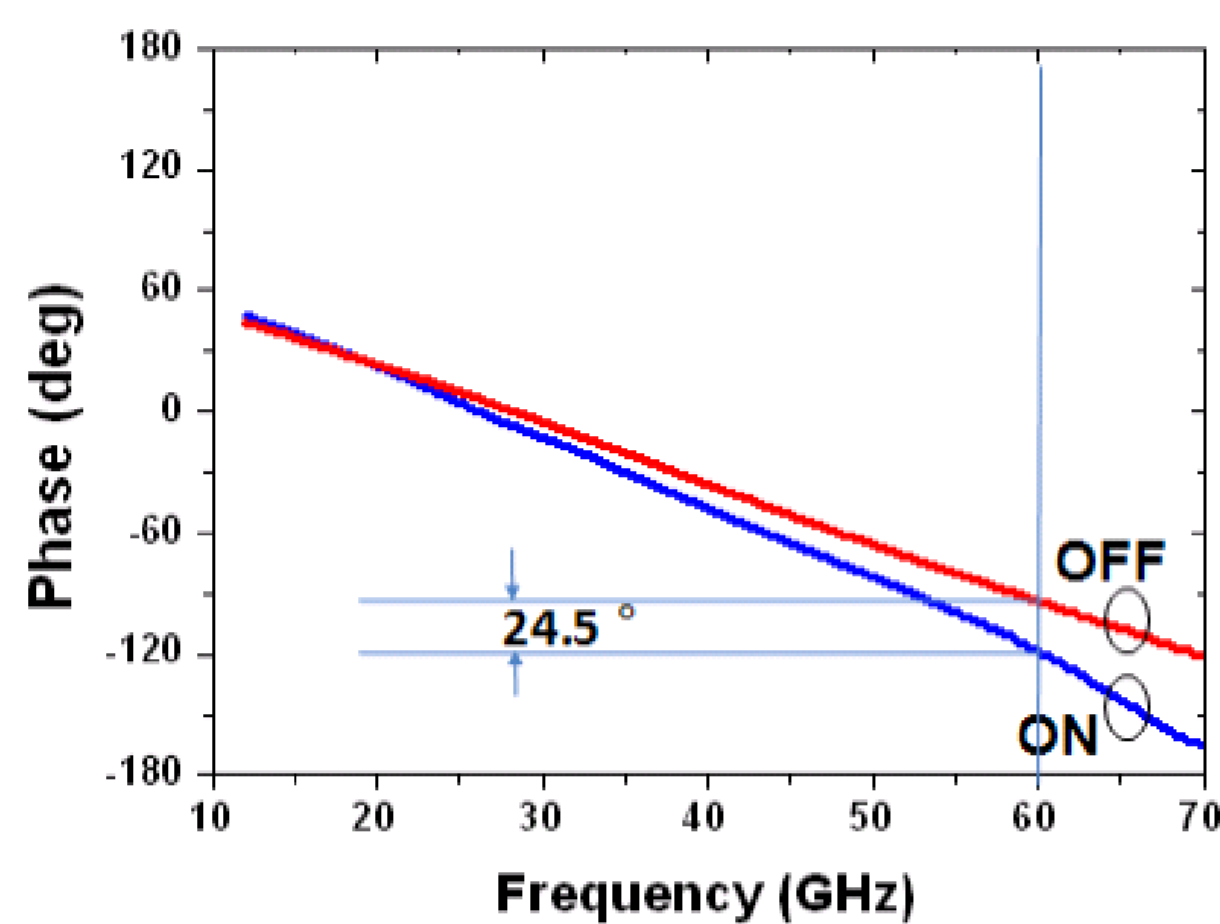


Fig. 2. 22.5 degree loaded-line phase shifter characteristics for ON and OFF states.

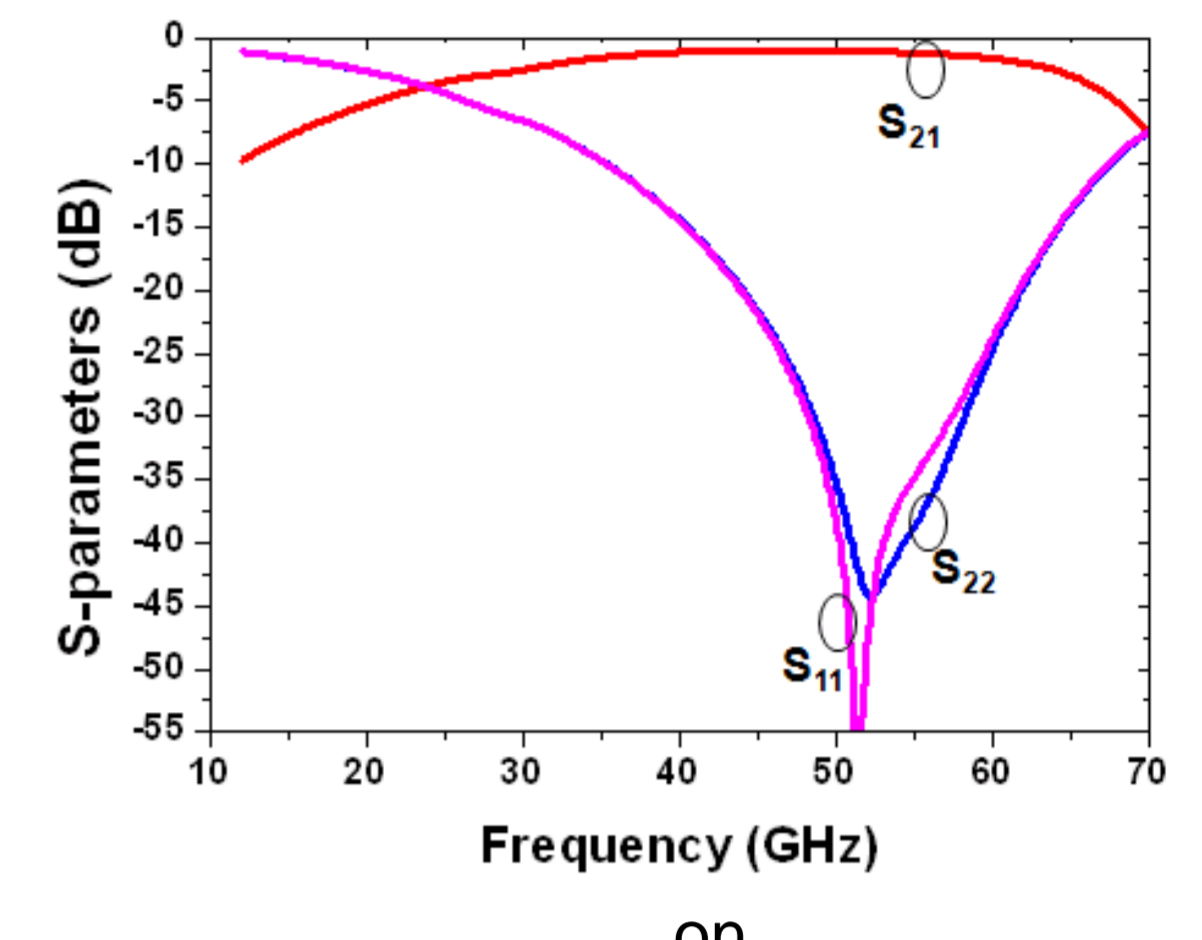
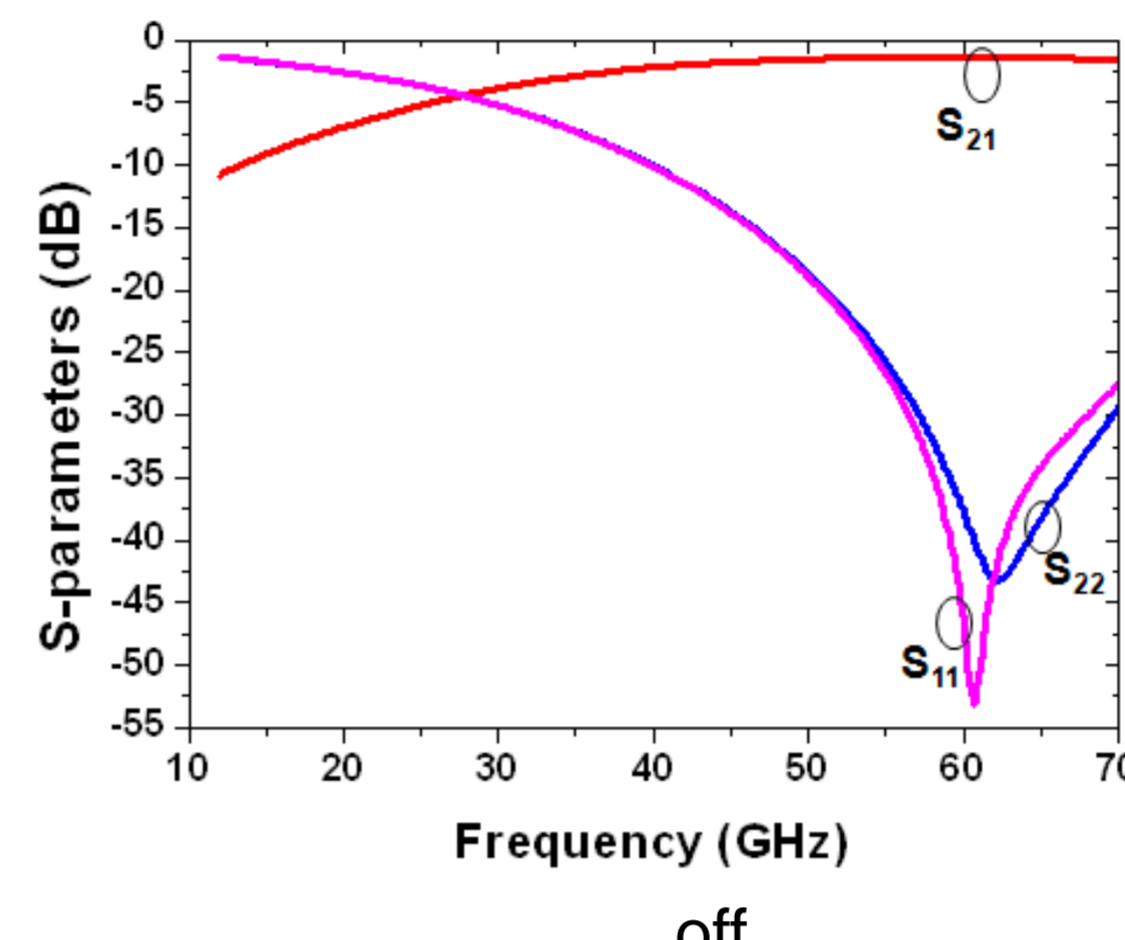


Fig. 3. S-parameters of the 22.5 degree loaded-line phase shifter for ON and OFF states.

III. 90 degree & 180 degree Switched-Line Phase Shifter

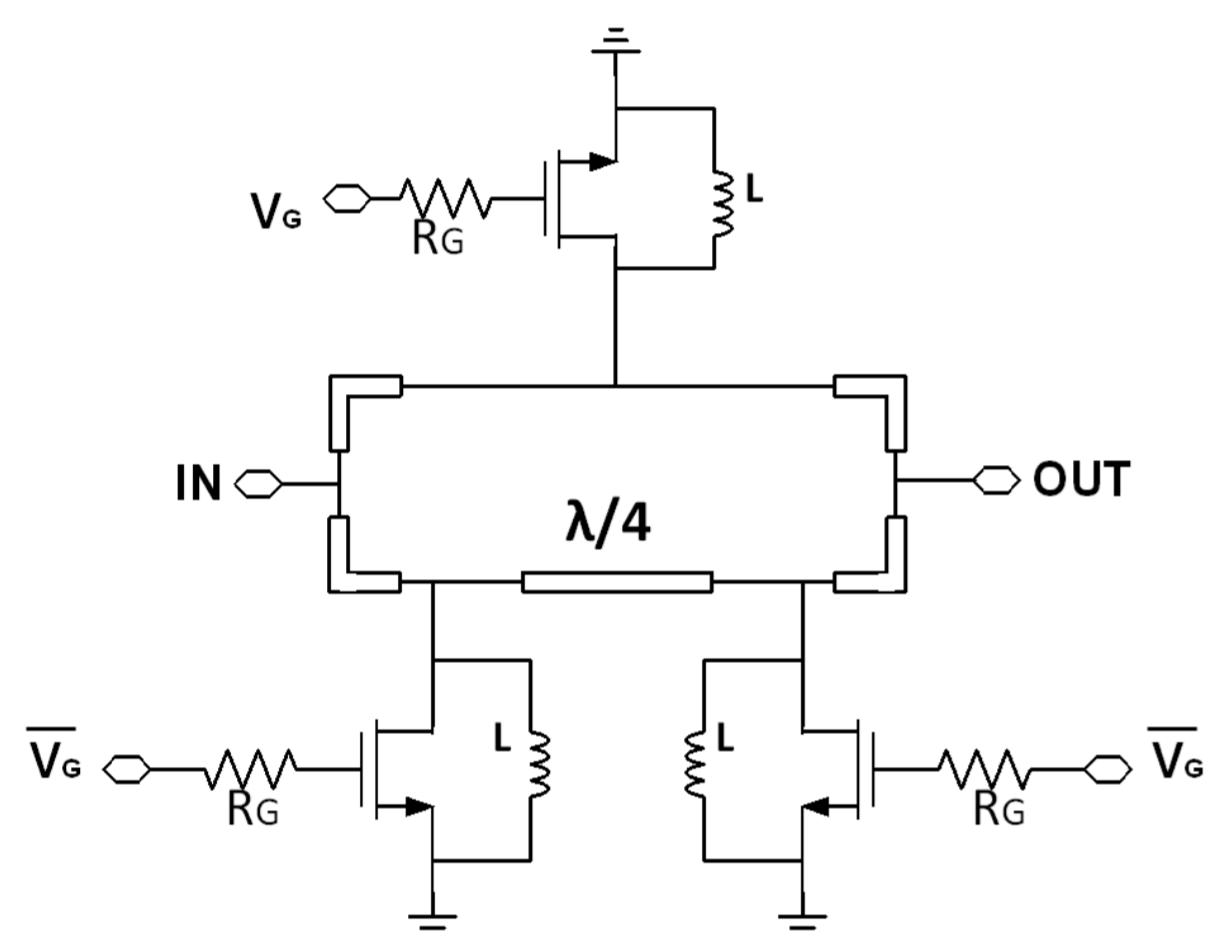


Figure 4. Circuit schematic of 90 degree switched-line phase shifter.

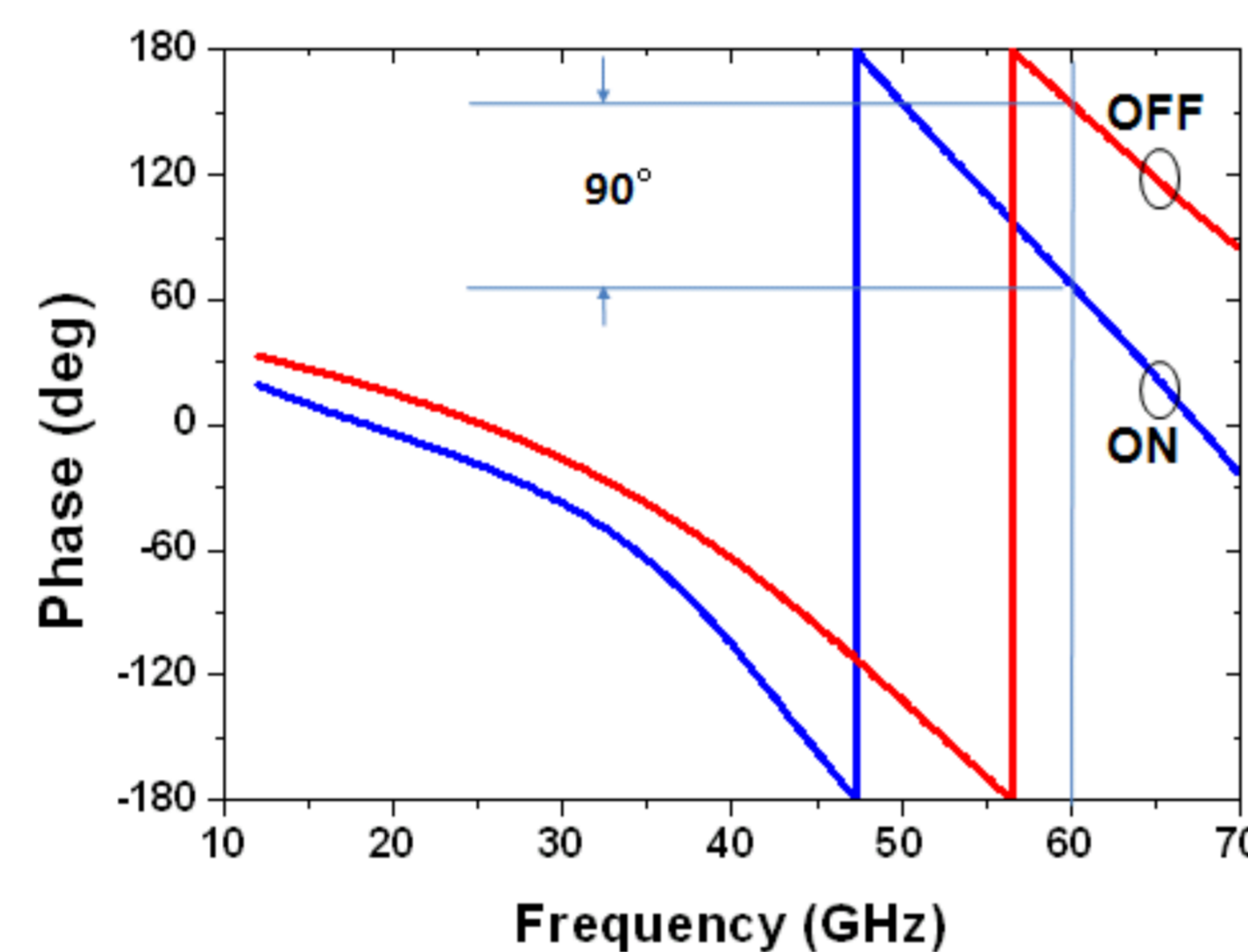


Fig. 5. 90 degree switched-line phase shifter characteristics for ON and OFF states.

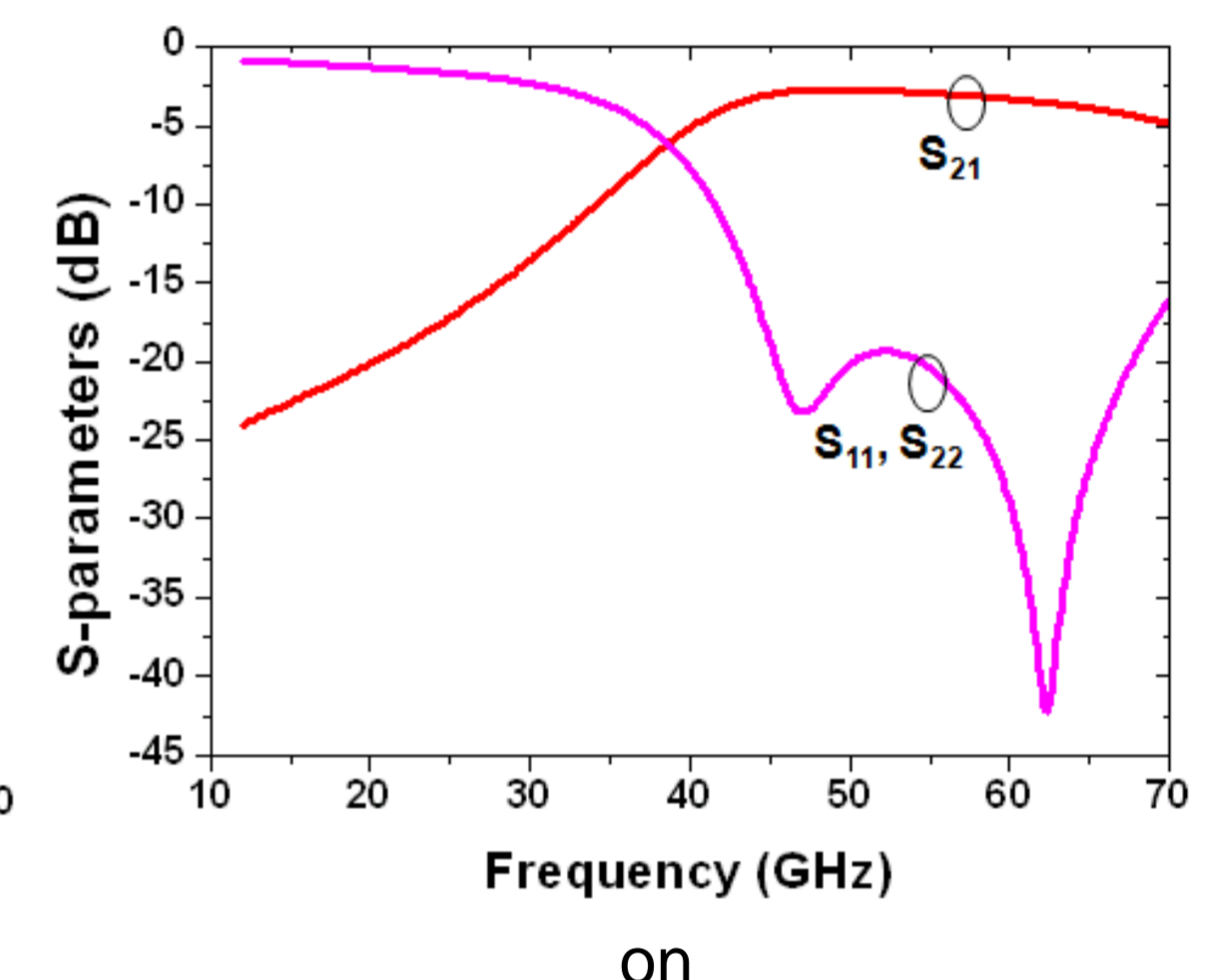
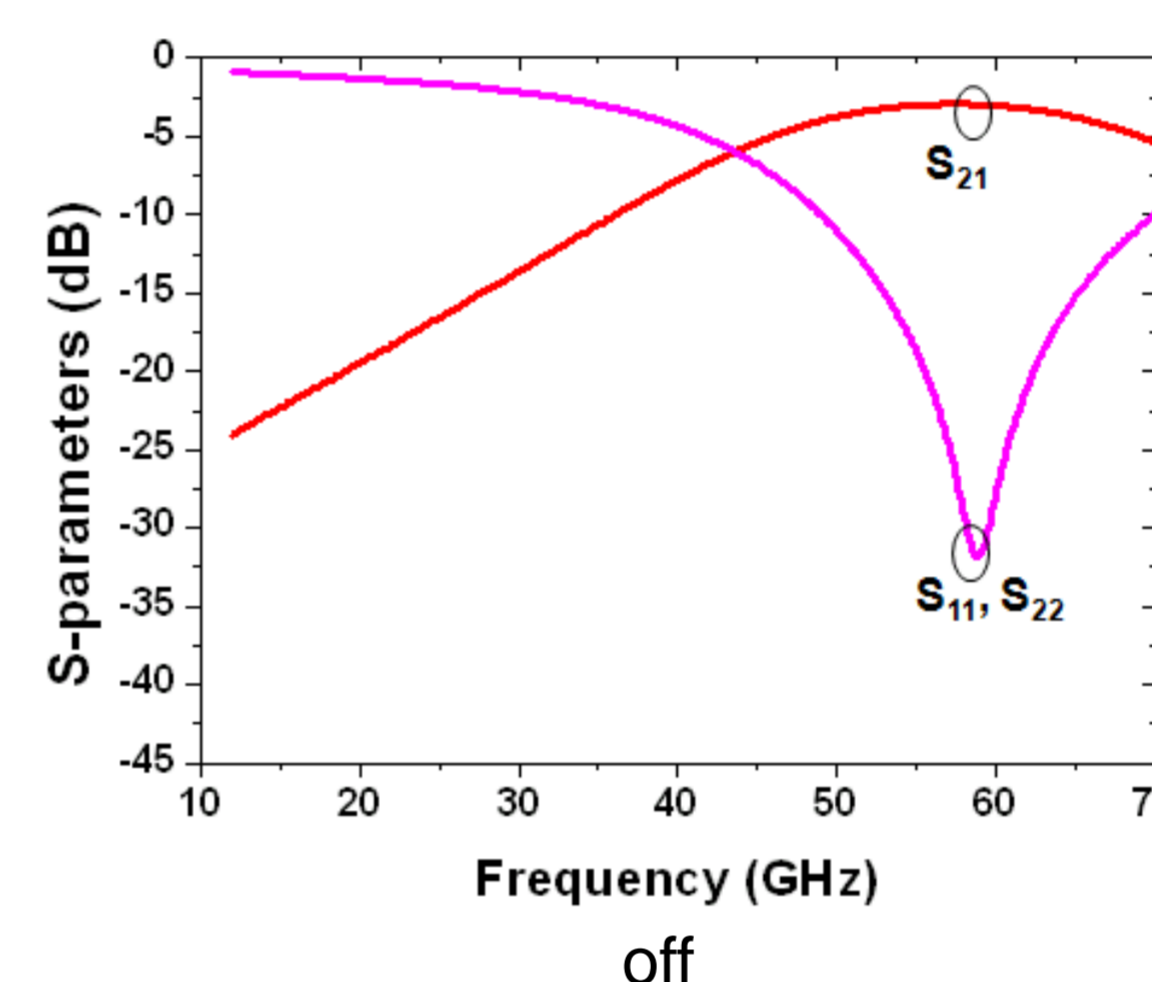


Fig. 6. S-parameters of 90 degree switched-line phase shifter for ON and OFF states.

IV. 4-bit Phase Shifter

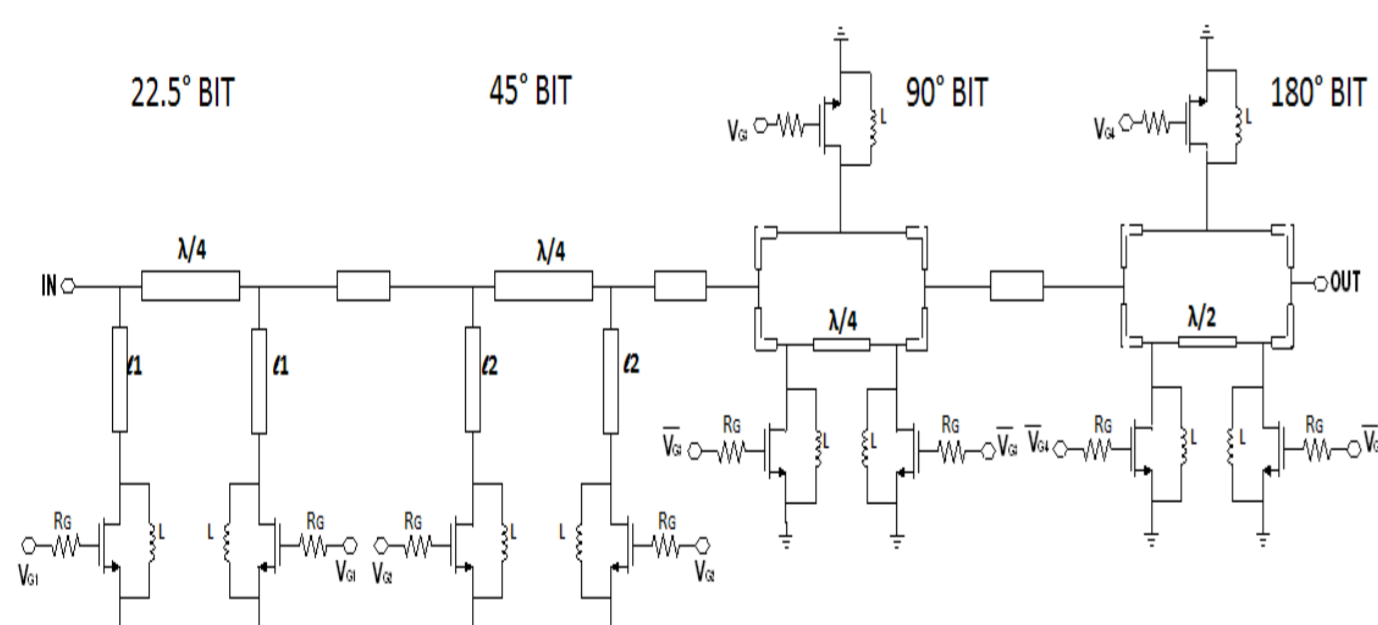


Figure 7. Circuit schematic of 4-bit phase shifter.

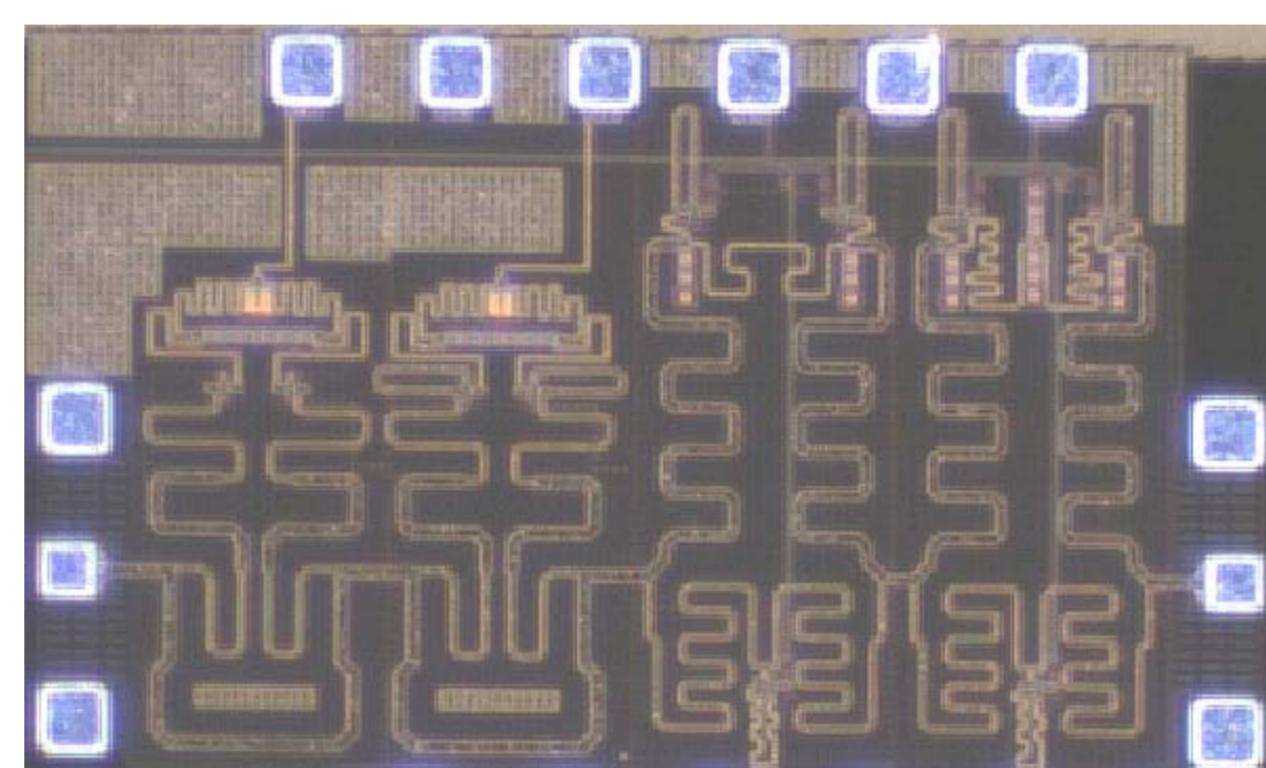
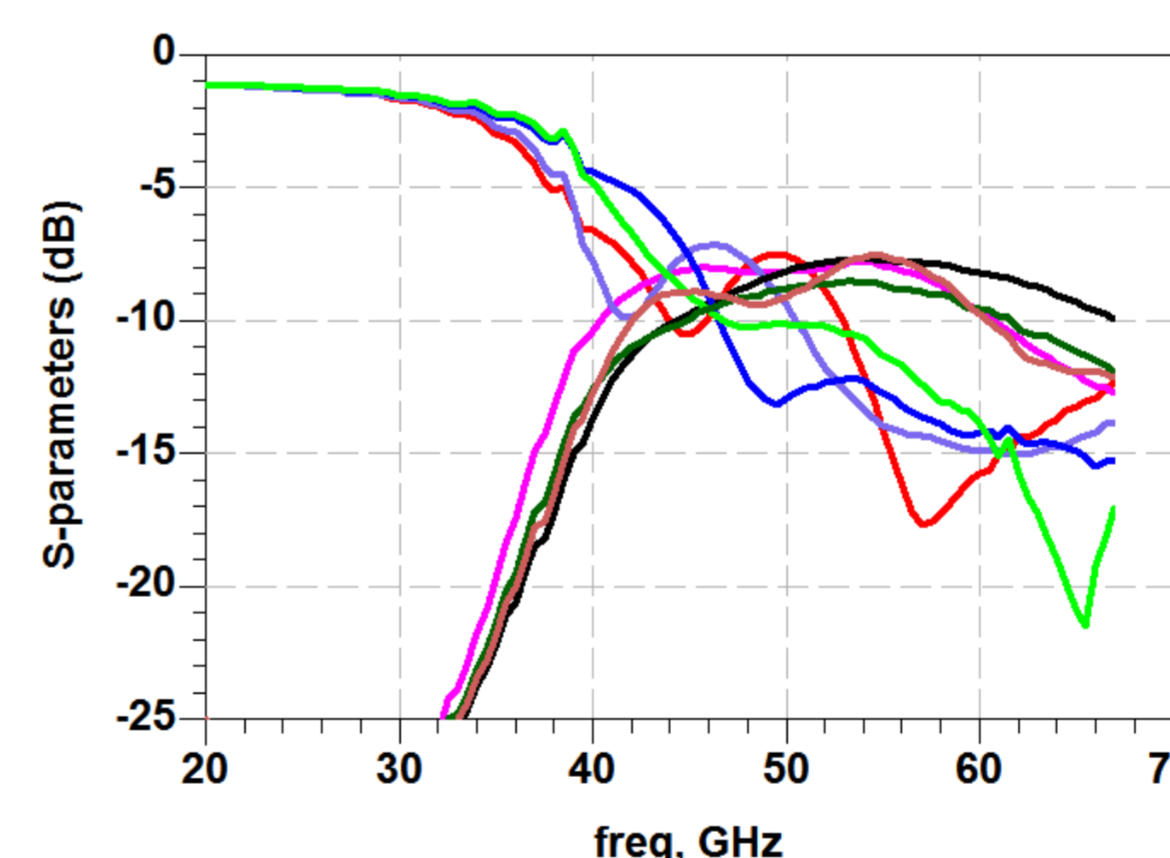
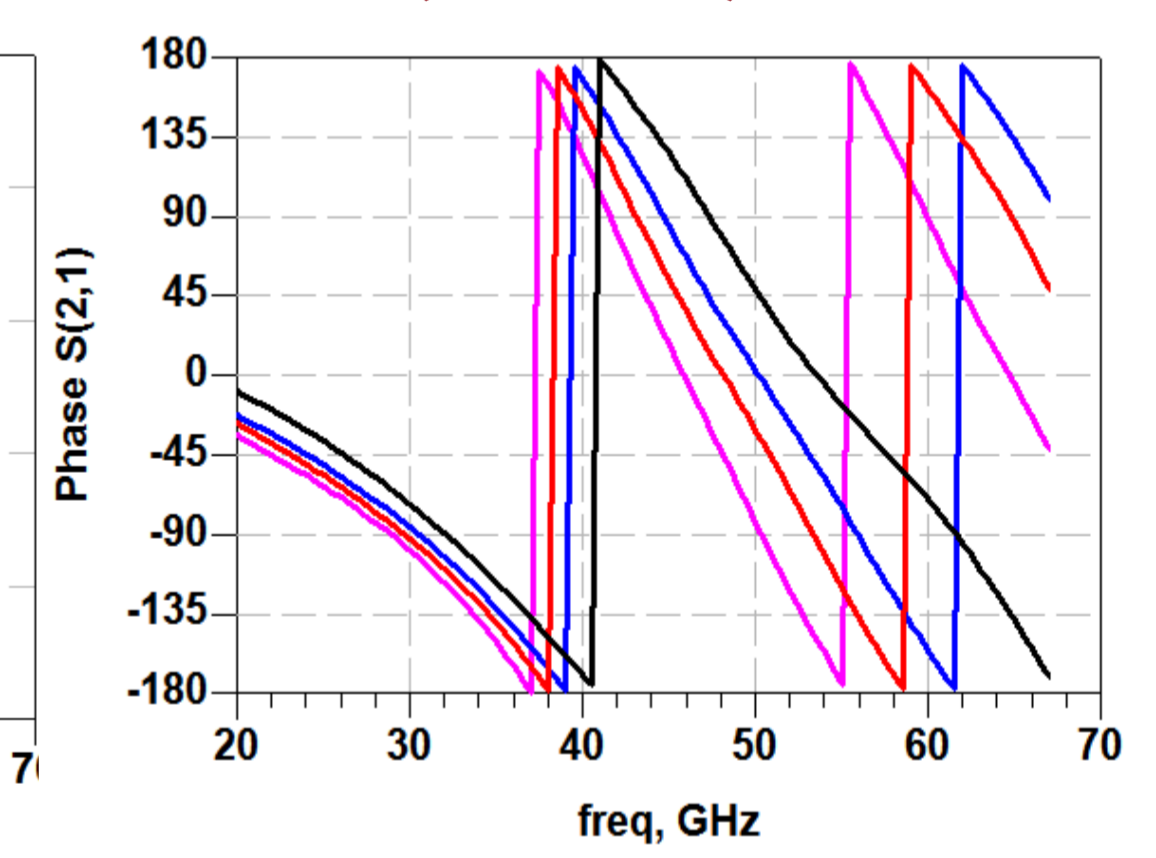


Fig. 8. Photograph of the 4-bit phase shifter fabricated using Dongbu Hitek 0.13um RFCMOS process. Size is 1230×730 μm^2 .

V. Measured results (2-bit)



(a)



(b)

Fig. 9. Measured results of the 2-bit (90 and 180 degree) phase shifter, (a) insertion loss, (b) phase shifting characteristics.

VI. Conclusions

Initial phase shifter for 60 GHz phase array application was successfully designed and fabricated using Dongbu Hitek 0.13um RFCMOS process. The measured data measured on-wafer up to 67 GHz using Agilent E8361A PNA shows promising results. In the future, the following revision will be done: 1) including the effect of measurement pad, 2) correct less than design phase shifting values, 3) reducing the chip size, 4) phase re-design and achieving improved results using 90nm CMOS process.

Acknowledgement

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References

- [1] R. V. Garver, "Broad-band diode phase shifter" IEEE Trans. Microwave Theory Tech, vol. MTT-20, pp. 314-323, May 1972.
- [2] H. A. Atwater, "Circuit Design of the Loaded-Line Phase Shifter" IEEE Transactions on Microwave Theory and Tech., vol. MTT-33, no. 7, July, 1985.