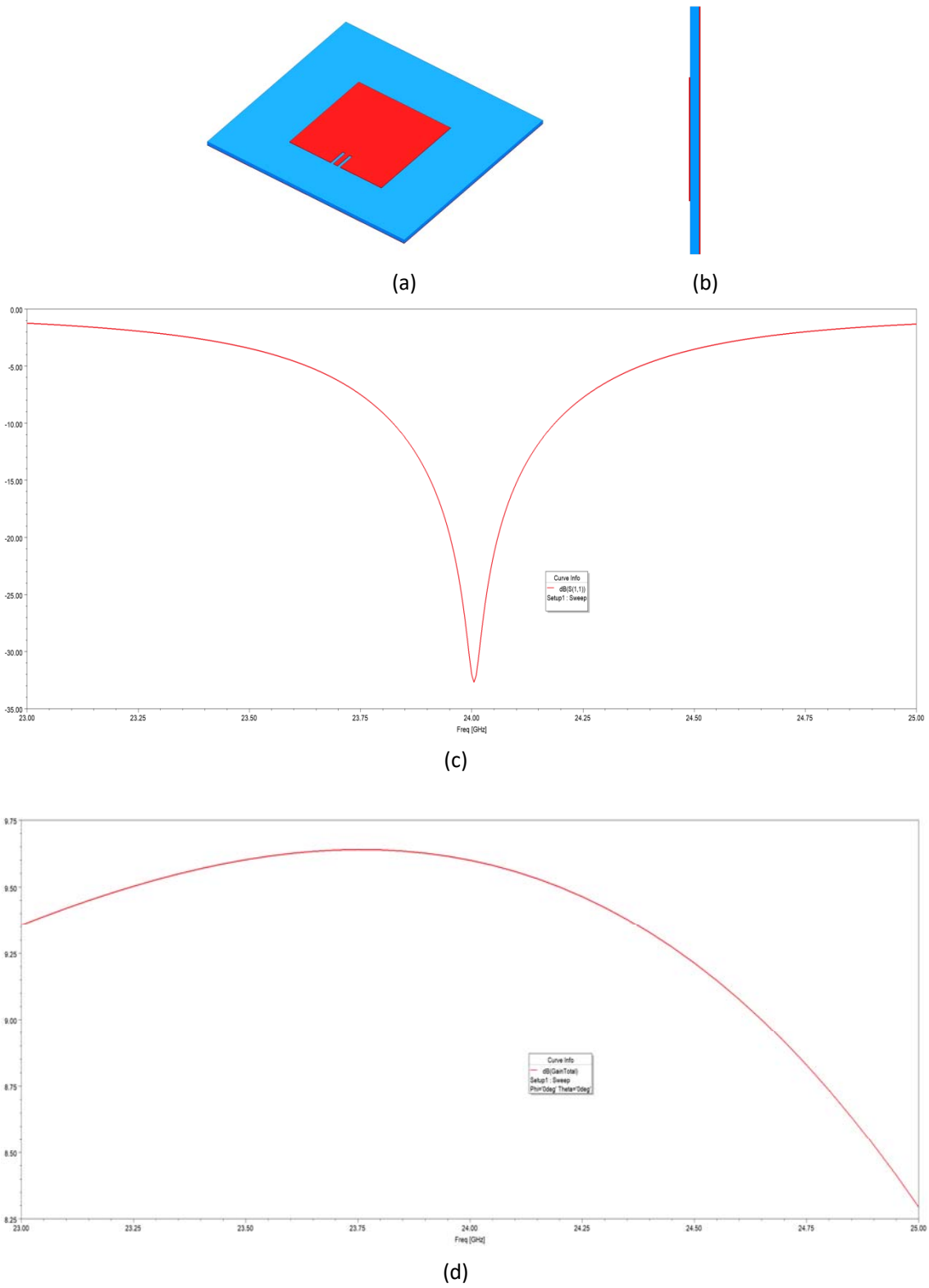
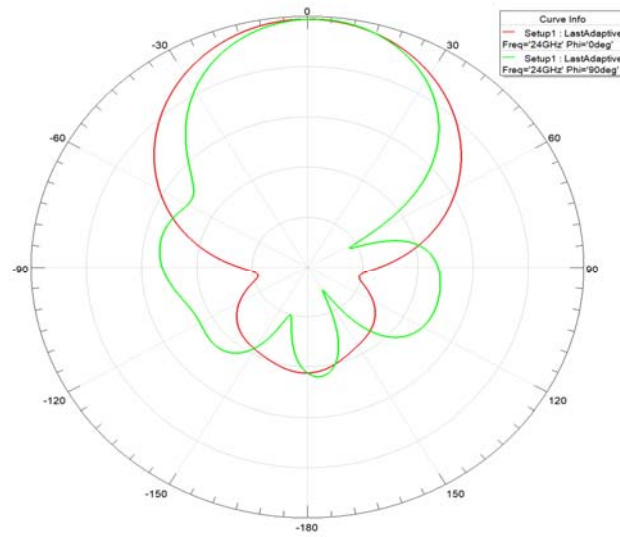


The supplementary file contains screenshots of the simulation models and results, presented in a manner that directly corresponds to the figures in the manuscript.

Figure 1





(e)

Figure 1. Antenna unit structure and simulated results. (a) Front side view of the antenna unit, (b) Side view of the antenna unit, (c) S_{11} (d) gain of the antenna unit, (e) Radiation pattern of the antenna at 24 GHz xoz plane and yoz plane.

Figure 2

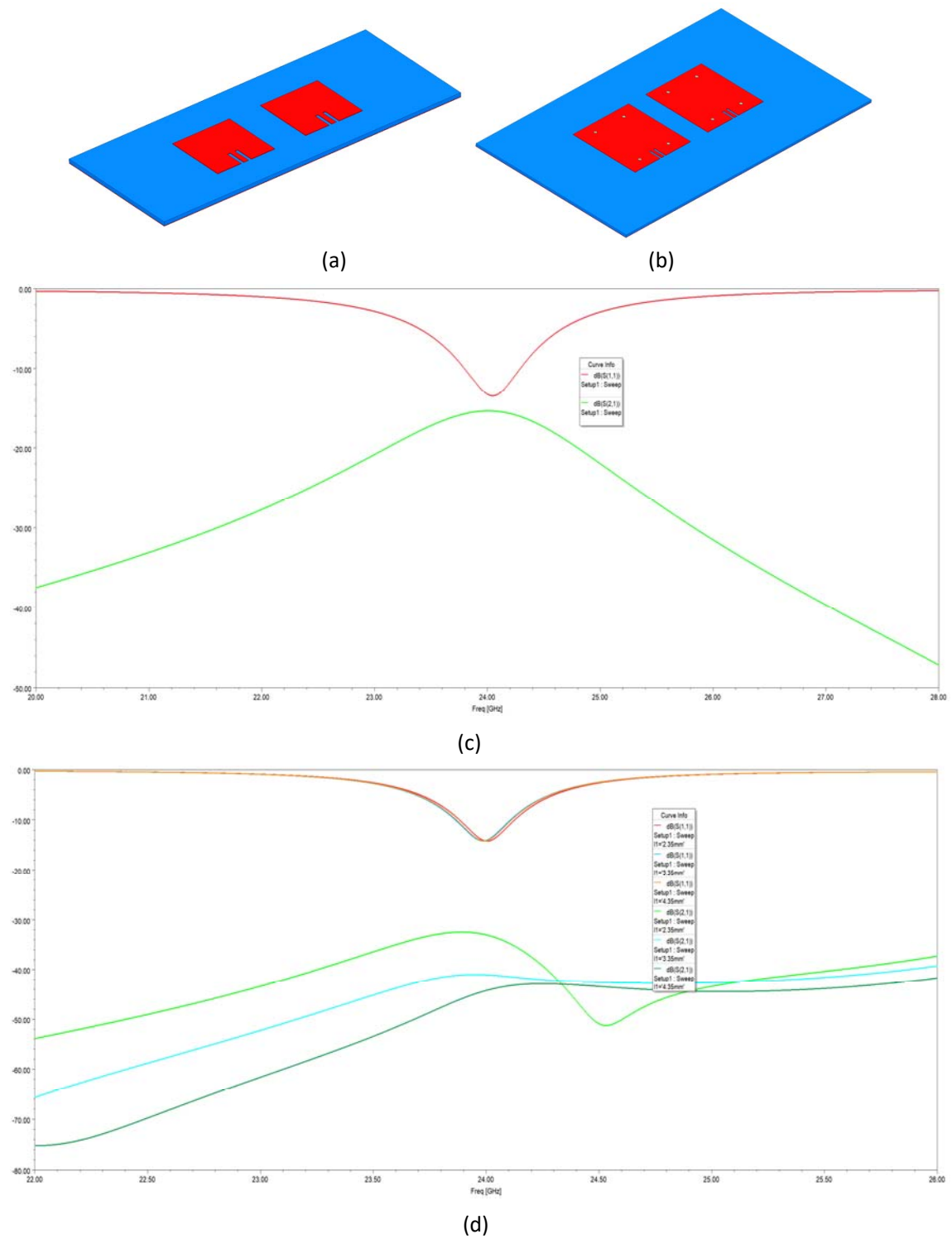


Figure 2. The structural diagrams of 1x2 array antenna without the four metal cylinders (reference antenna) and with them loaded (designed antenna), along with their simulated S-parameter results. (a) Reference antenna, (b) Designed antenna, (c) S-parameters of reference antenna, (d) S-parameters of the designed antenna.

Figure 3

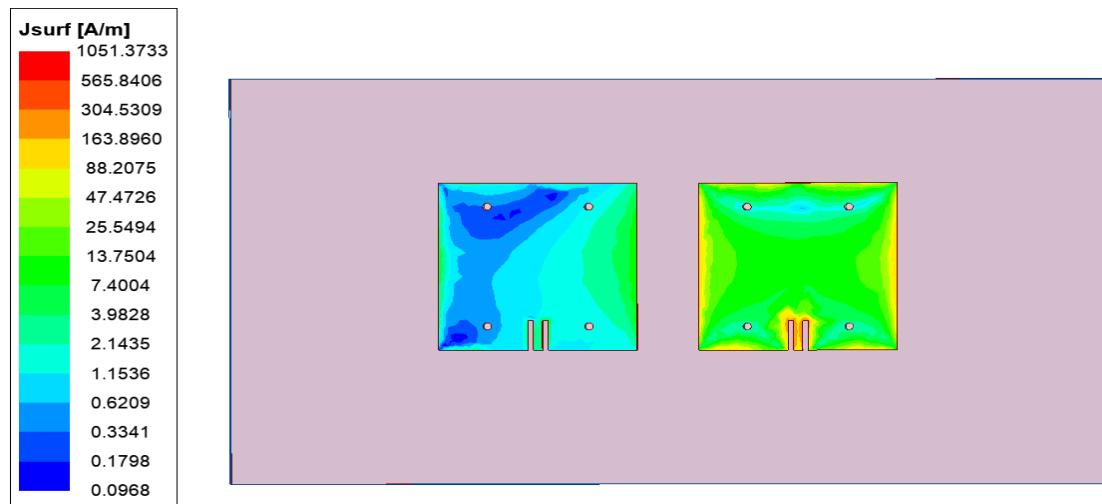


Figure 3. Current distribution of the two antennas.

Figure 4

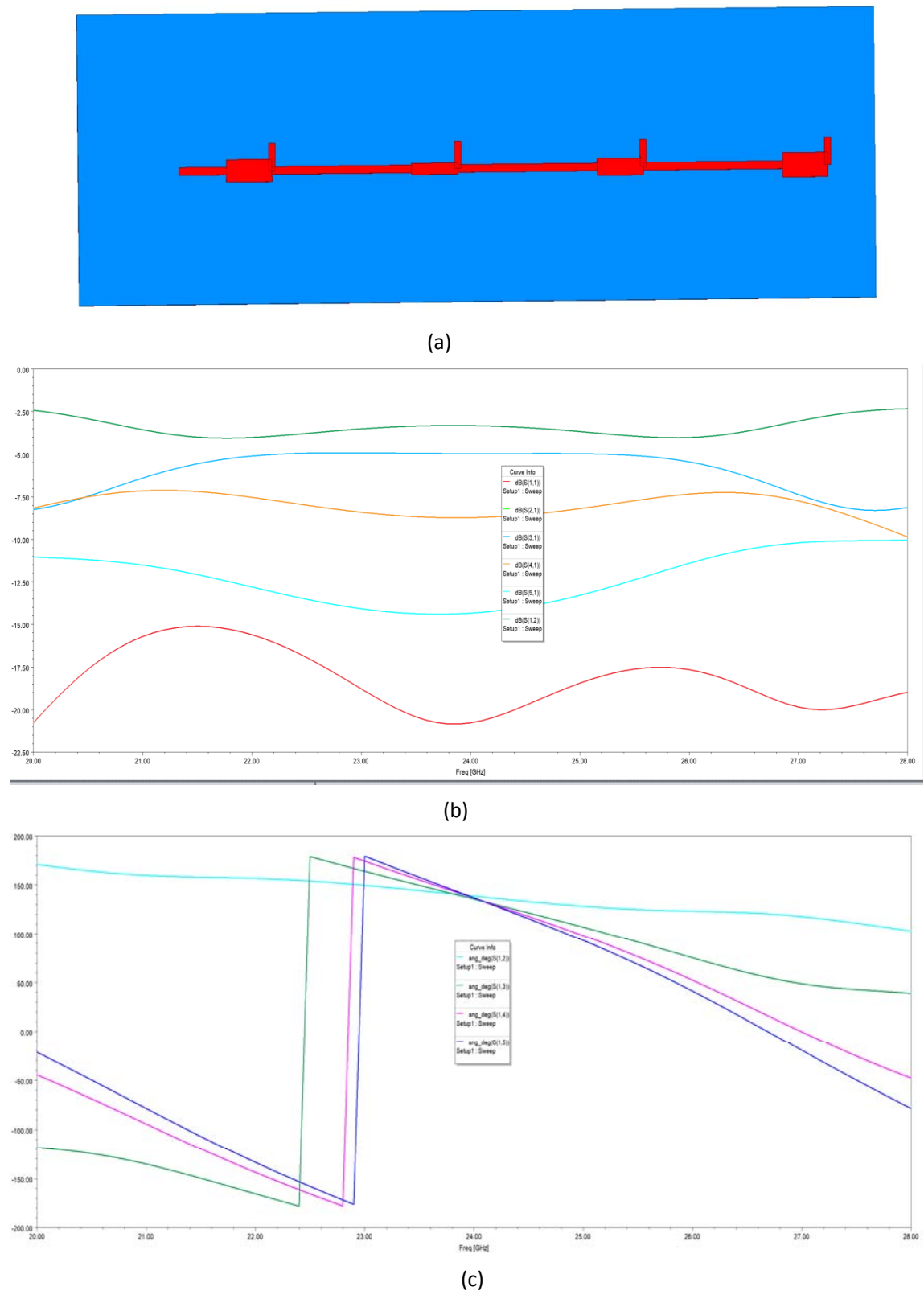


Figure 4. Structural of the feeding network and its results. (a) Structural, (b) Amplitudes, (c) Phase.

Figure 5

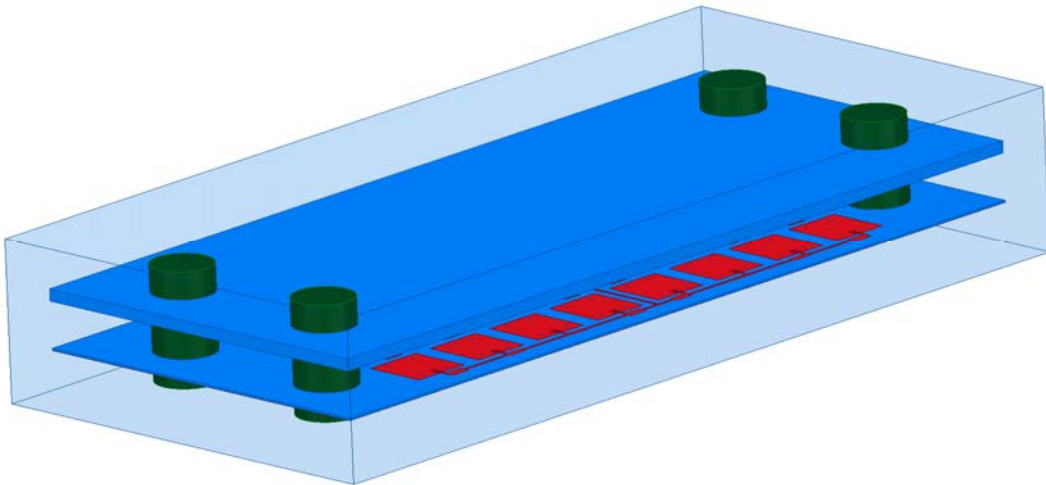


Figure 5. Dimensions of the 4x8 array antenna.

Figure 6

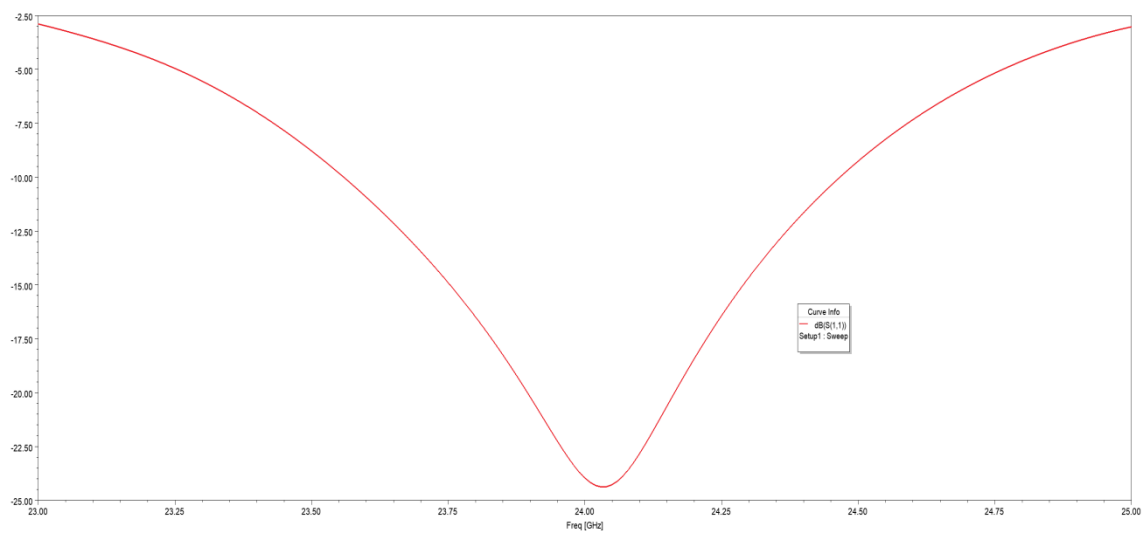
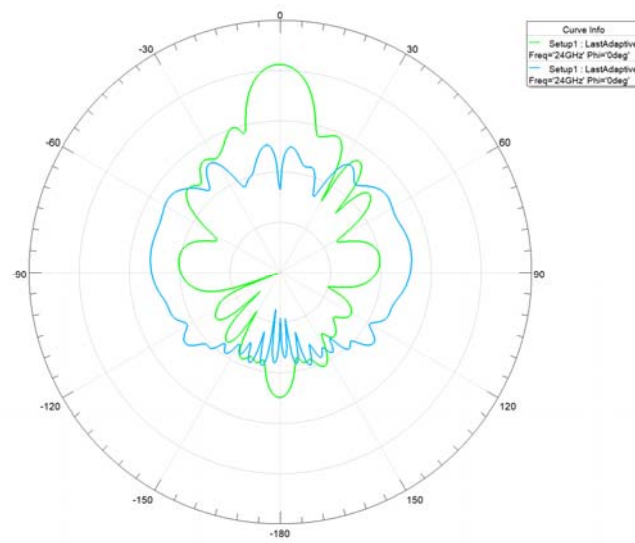
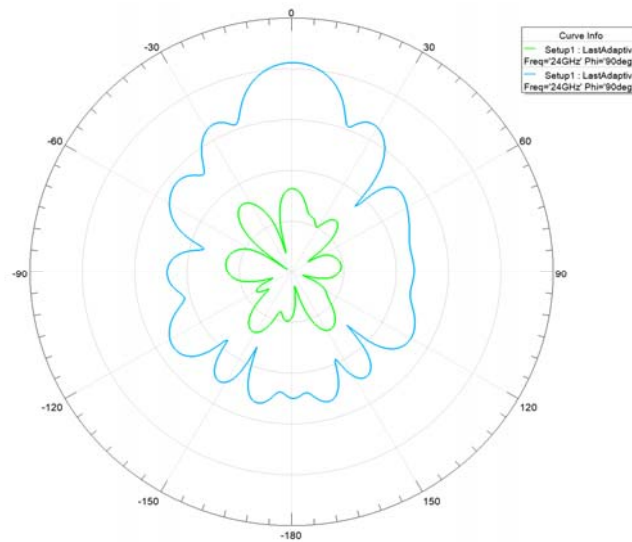


Figure 6. Photo of the fabricated antenna S11.

Figure 7



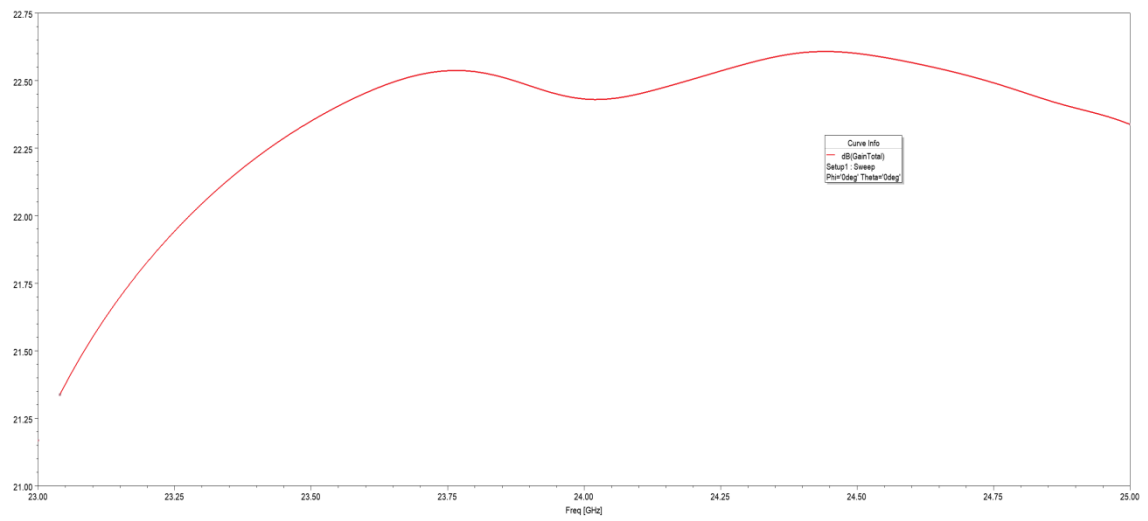
(a)



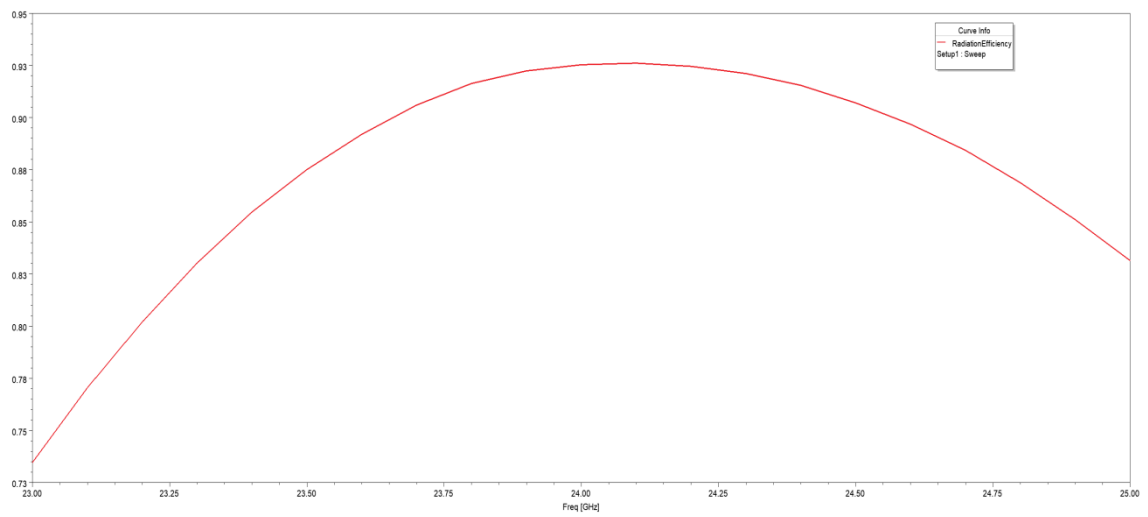
(b)

Figure 7. Radiation pattern of array antenna at 24 GHz. (a) xoz plane, (b) yoz plane.

Figure 8



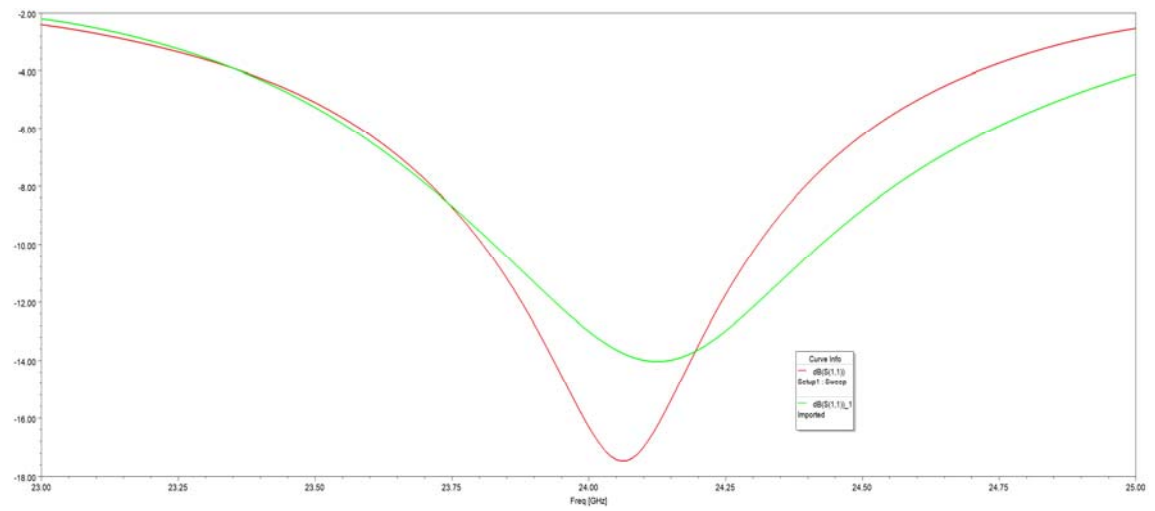
(a)



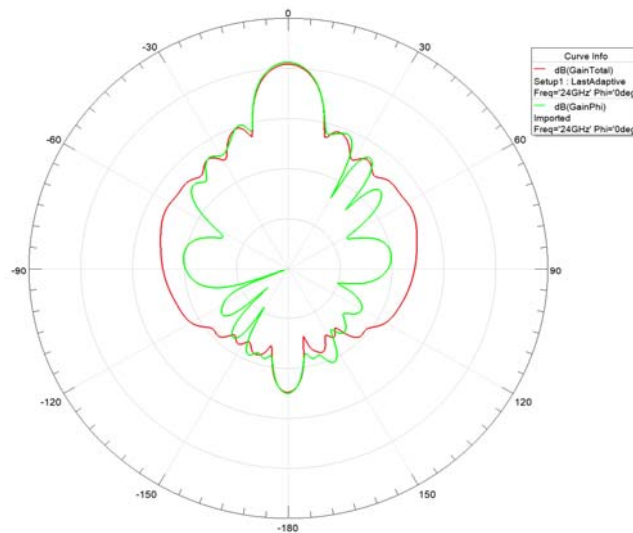
(b)

Figure 8. Gain and efficiency of array antenna. (a) Gain VS frequency, (b) Radiation efficiency VS frequency.

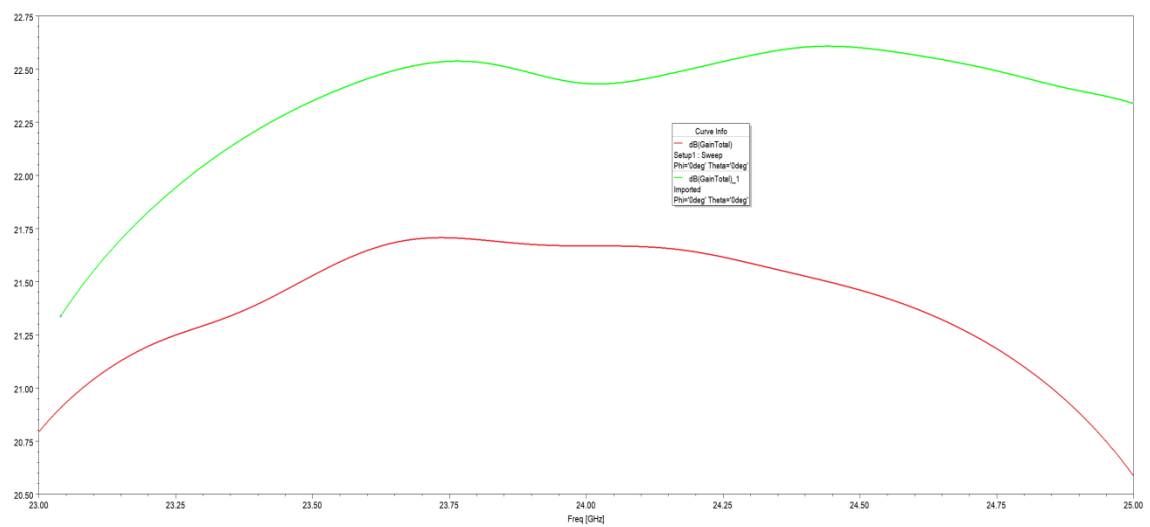
Figure 9



(a)



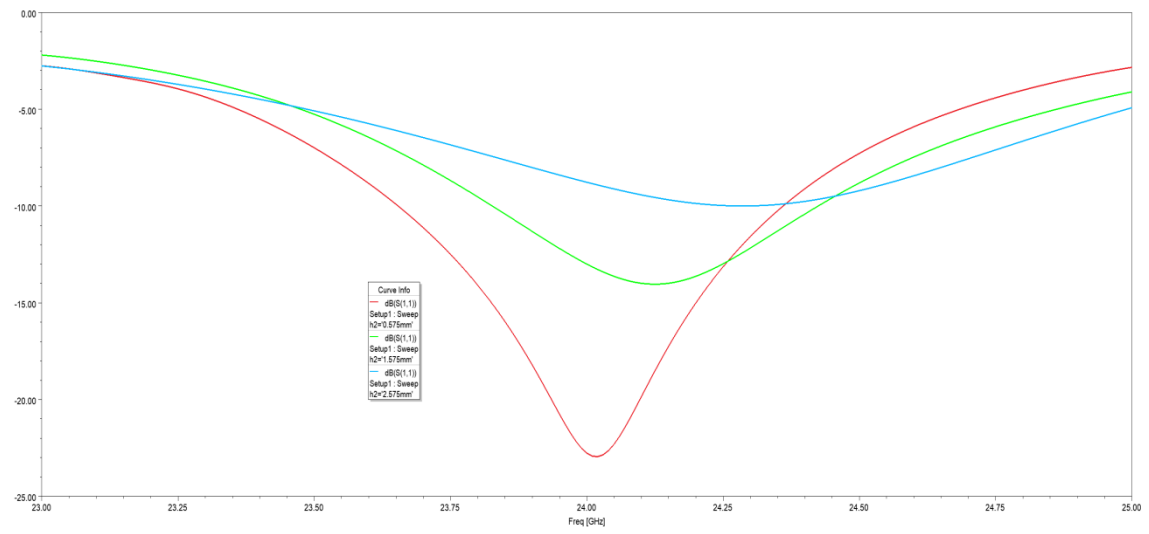
(b)



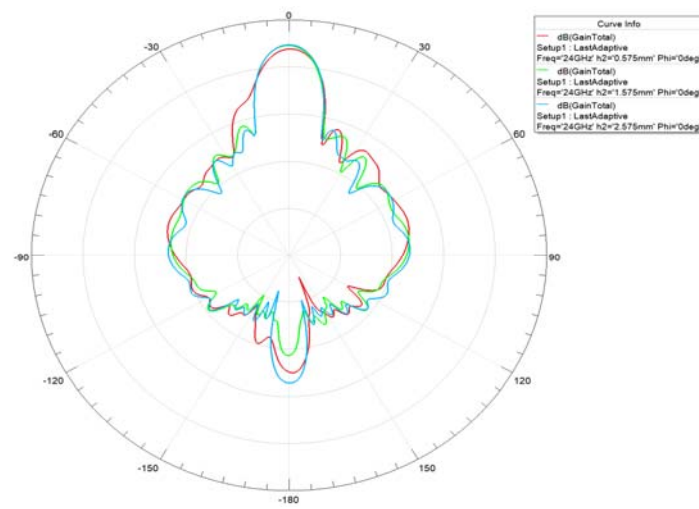
(c)

Figure 9. Comparison of simulation results between the superstrate layer array antenna and reference array antenna. (a) S11 , (b) Radiation pattern, (c) Gain vs frequency.

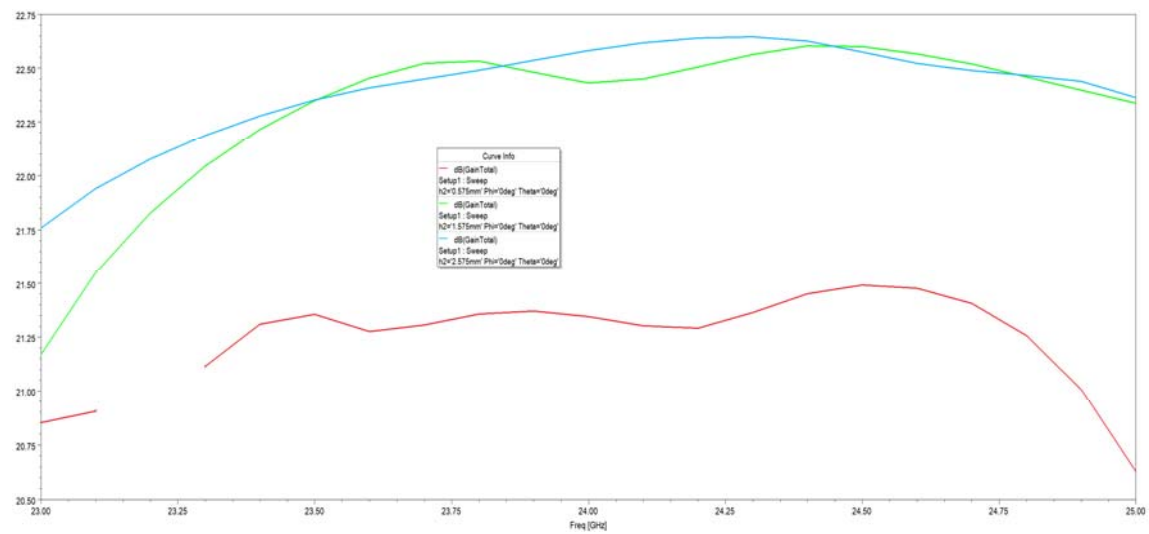
Figure 10



(a)



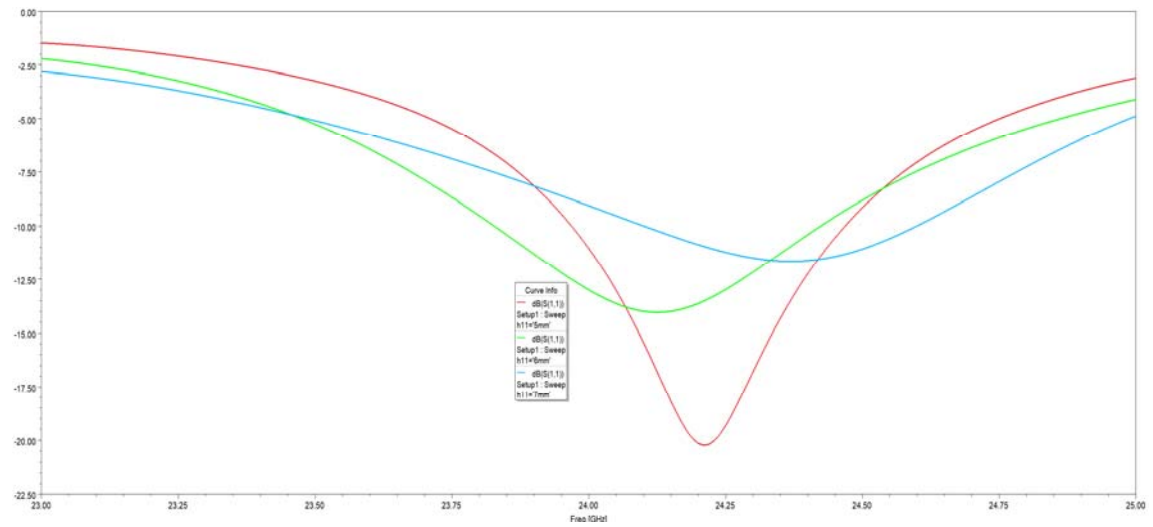
(b)



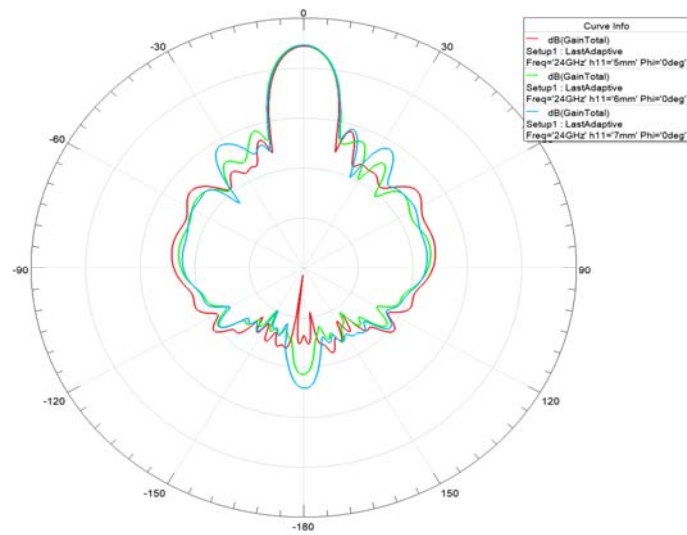
(c)

Figure 10. Simulation results of superstrate layer array antenna with thickness. (a) S11, (b) Radiation pattern, (c) Gain vs frequency.

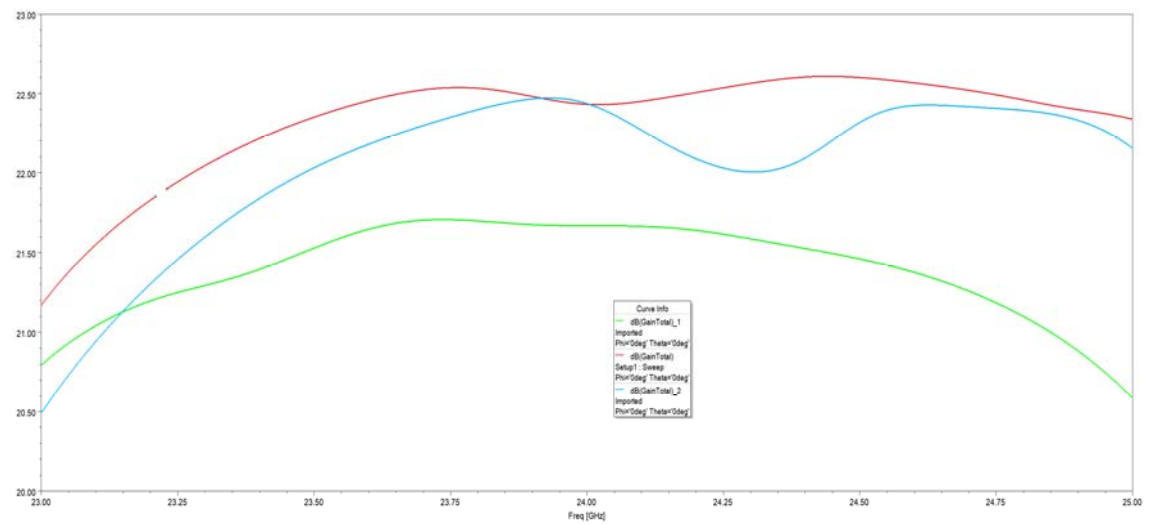
Figure 11



(a)



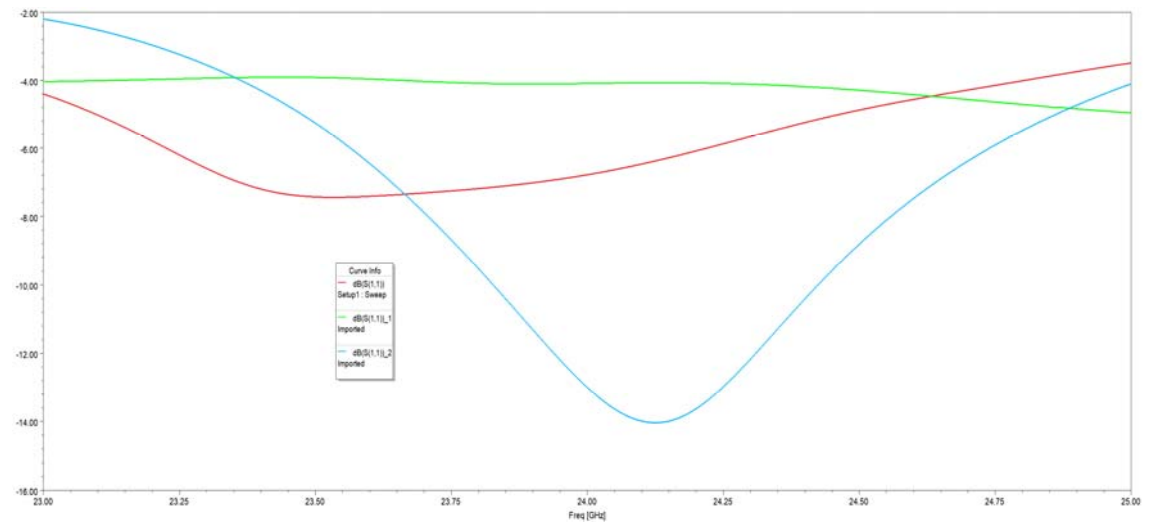
(b)



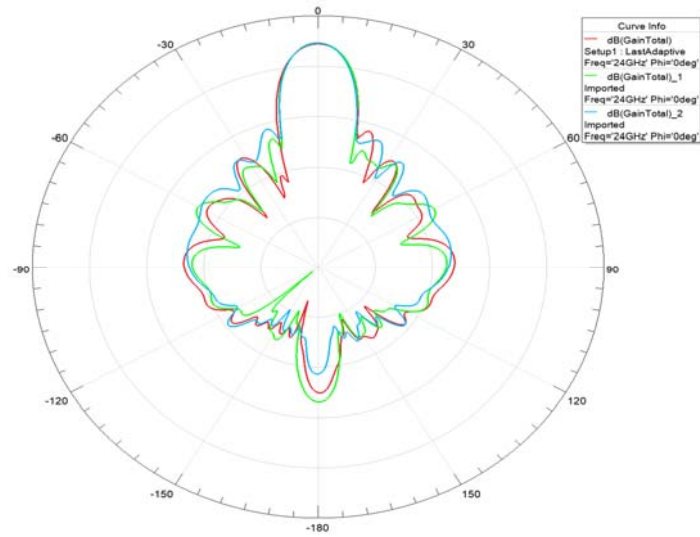
(c)

Figure 11. Simulation results of superstrate layer array antenna with distance. (a) S11 , (b) Radiation pattern, (c) Gain vs frequency.

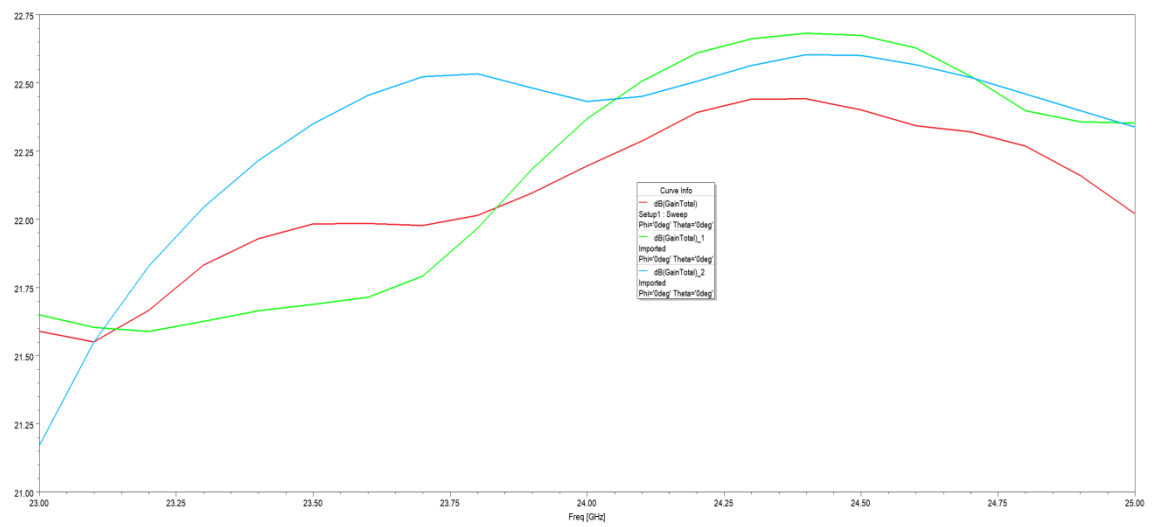
Figure 12



(a)



(b)



(c)

Figure 12. Simulation results of superstrate layer array antenna with dielectric constant. (a) S11, (b) Radiation pattern, (c) Gain vs frequency.

Figure 13

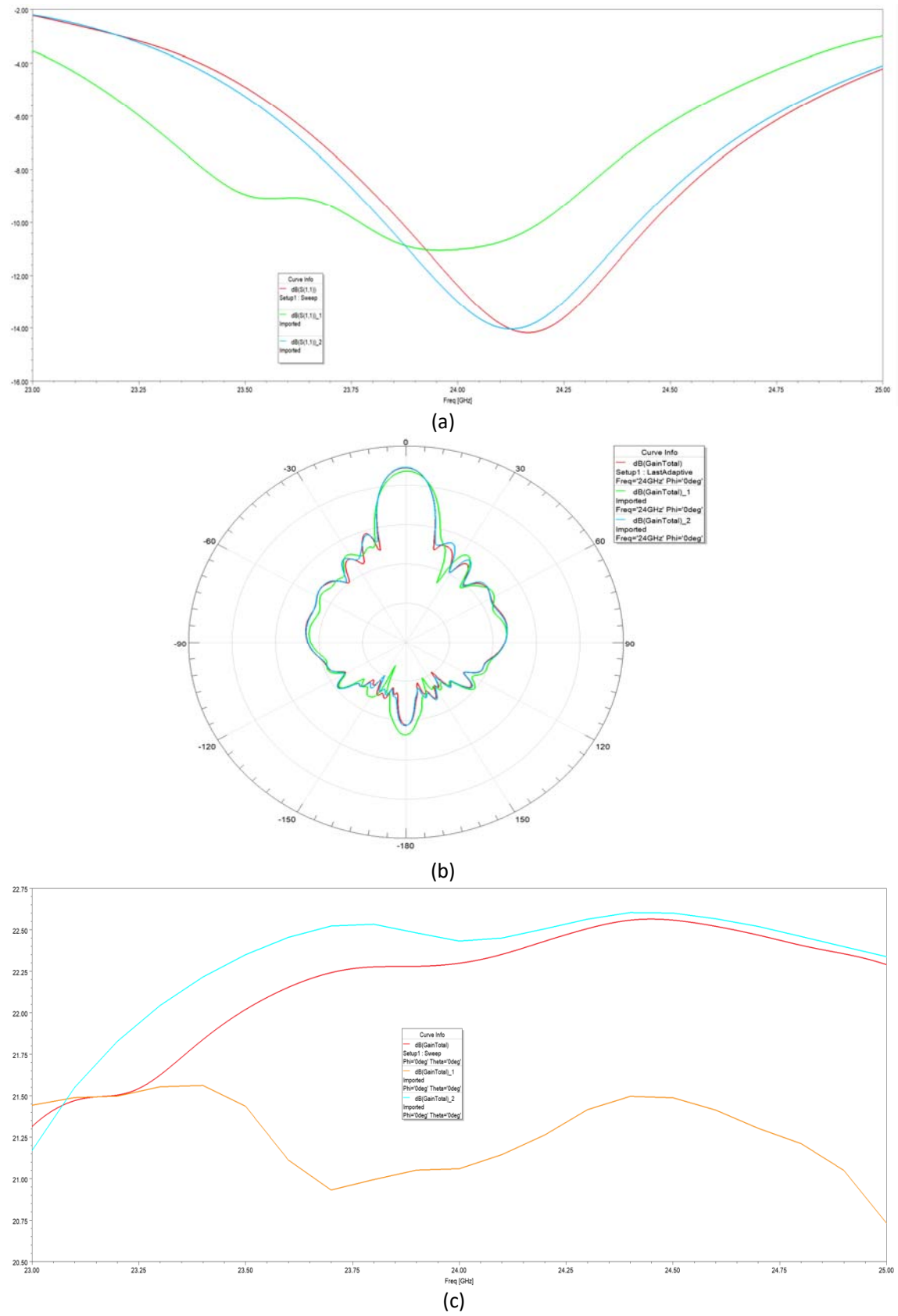


Figure 13. Simulation results of superstrate layer array antenna with dielectric loss. (a) S11, (b) Radiation pattern, (c) Gain vs frequency.