RSL15 Antenna Design Guideline

DN05137/D

INTRODUCTION

This document explains the design of the RSL15 EVB antenna, designed for use with the RSL15 Evaluation and Development Board (RSL15−EVB) with the RSL15 QFN (NCH−RSL15−512−101Q40−ACG).

The antenna is an L−shaped quarter wavelength design, sometimes referred to as a bent whip antenna. This shape is simple to design and easy to integrate into a PCB layout. In addition, the planner structure allows a low profile and cost−effective approach, making this design advantageous.

A simulated antenna design is shown in this document for demonstration purposes. This antenna is part of the RSL15 Evaluation and Development Board, and is used as a reference. The performance of PCB−based antennas is dependent on dielectric type and thickness; in this exercise during sensitivity simulations, the laminate thicknesses are kept the same as RSL15 EVB PCB board. The PCB dielectric thickness effects are not part of the sensitivity simulated design.

RSL15 REFERENCE ANTENNA: LAYOUT AND SIMULATIONS

Key Points:

- The feed line is a 50−Ω trace on the top conductor layer and is a coplanar waveguide implementation.
- The 50 Ω port is referenced to the top conductor layer and there is no ground under the antenna.
- The four−conductor layers are stitched together near the feed line with through−holes.
- There are ground stubs on two sides of the antenna at a specific distance to accommodate SMT components and connectors.
- No impedance−matching components or matching features are simulated.
- The dielectric material is FR4 with K = 4.6

PCB Stack−Up and RSL15 Reference Antenna Layout

The reference antenna layout is illustrated in Figure 1; the 50−Ω feed line and 50−Ω port are highlighted in Figure 2. The antenna dimensions in the reference layout are used as starting references in the sensitivity simulations.

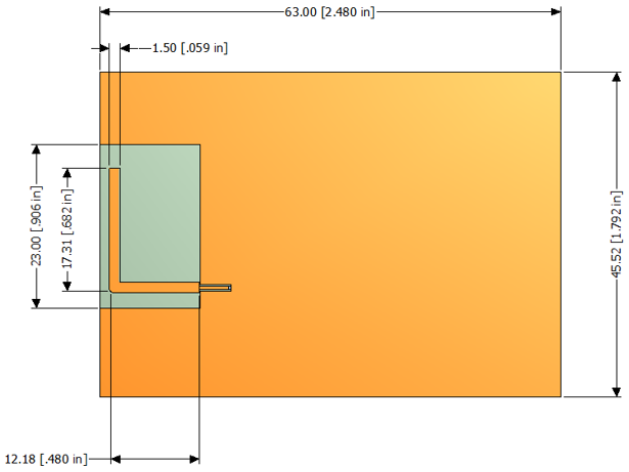

Figure 1. Reference Antenna Layout from RSL15 EVB

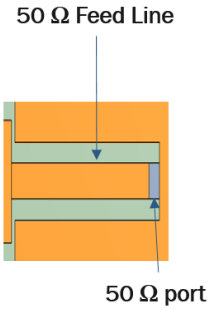

Figure 2. 50−Ω Feed Line and Port

The stack−up consists of four conductor layers, as illustrated in Figure 3:

- Copper thickness 0.020 mm
- Finished board: thickness 1.58 mm
- Dielectric material: FR4, k = 4.6

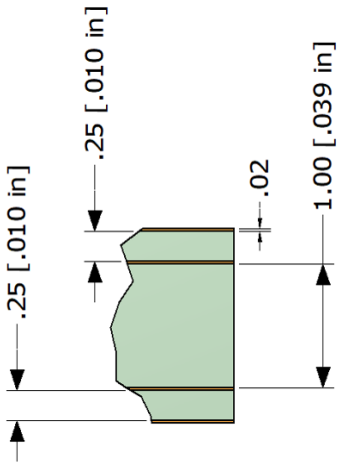

Figure 3. Stack−up

Reference Layout Return Loss (S11)

This section provides the following graphical resources regarding return loss:

- Return Loss Parameter Plot (Figure 4)
- Return Loss Chart (Figure 5)

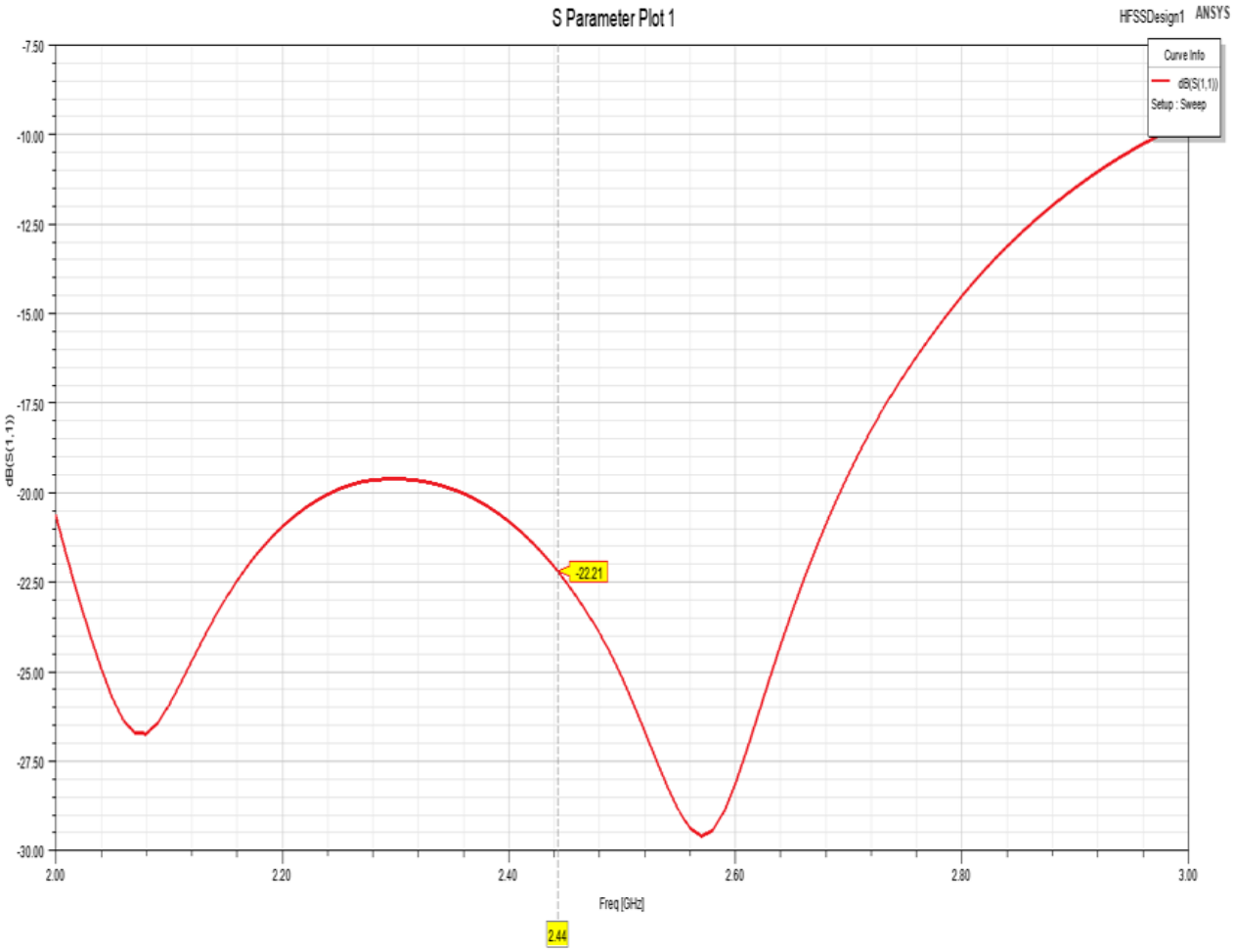

Figure 4. Return Loss Parameter Plot

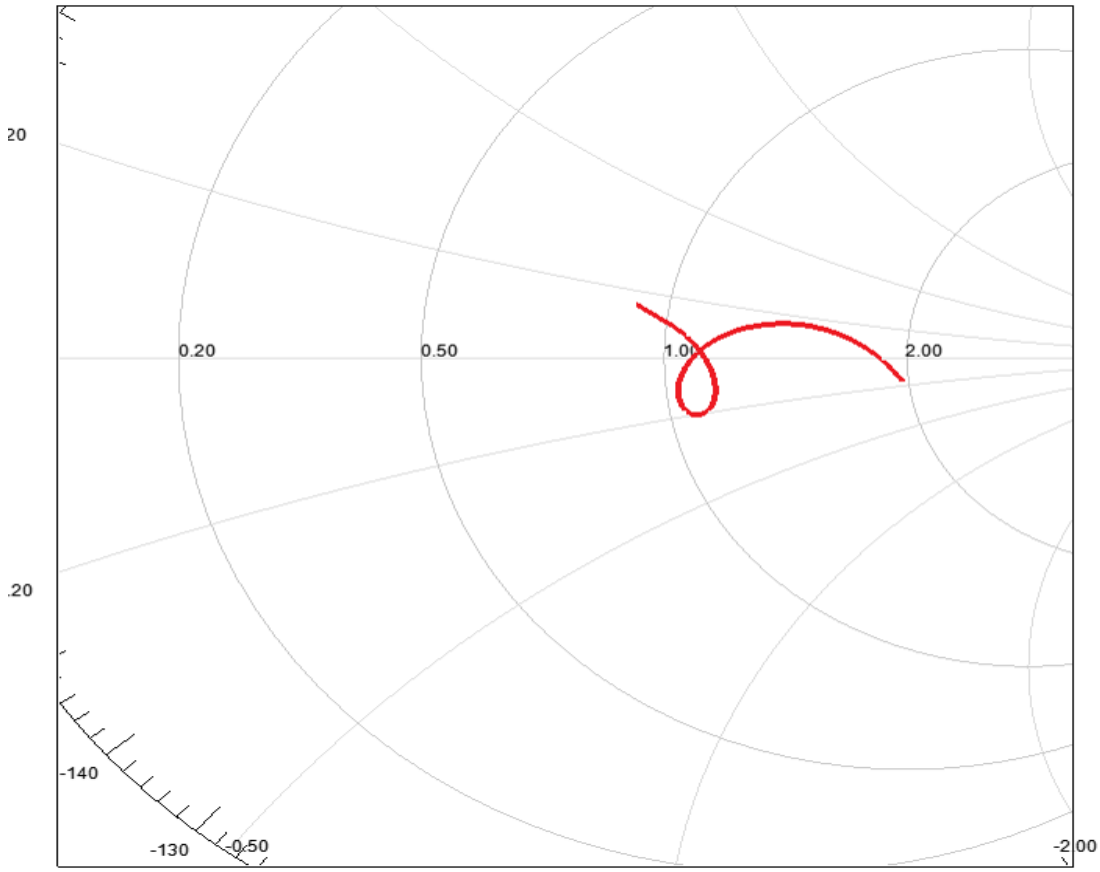

Figure 5. Return Loss Chart

Radiation Pattern with Scale

This section provides the following graphical representations of the radiation pattern:

- Radiation Pattern Gain Plot (Figure 6)
- Radiation Pattern Gain Plot with RSL15 Reference Antenna Layout (Figure 7)

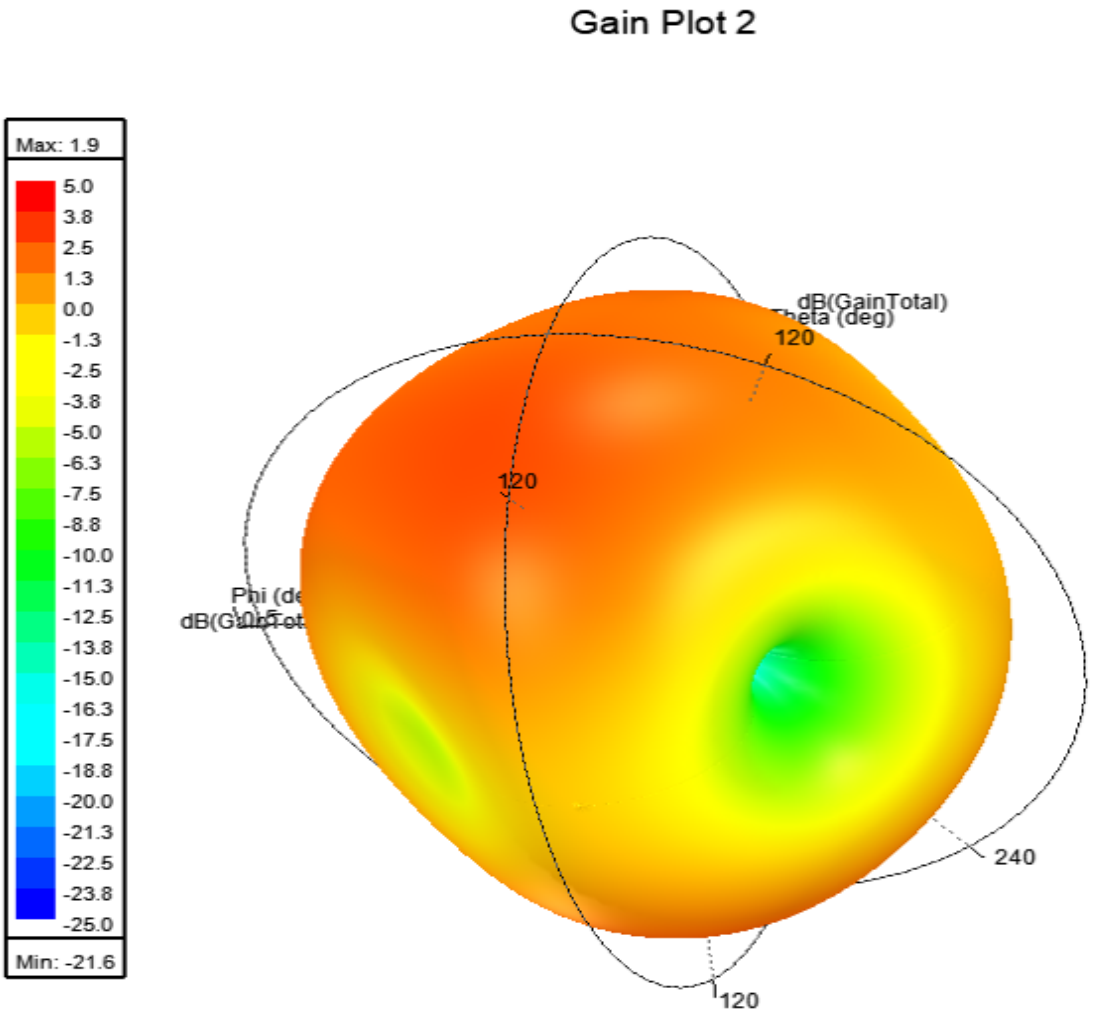

Figure 6. Radiation Pattern Gain Plot

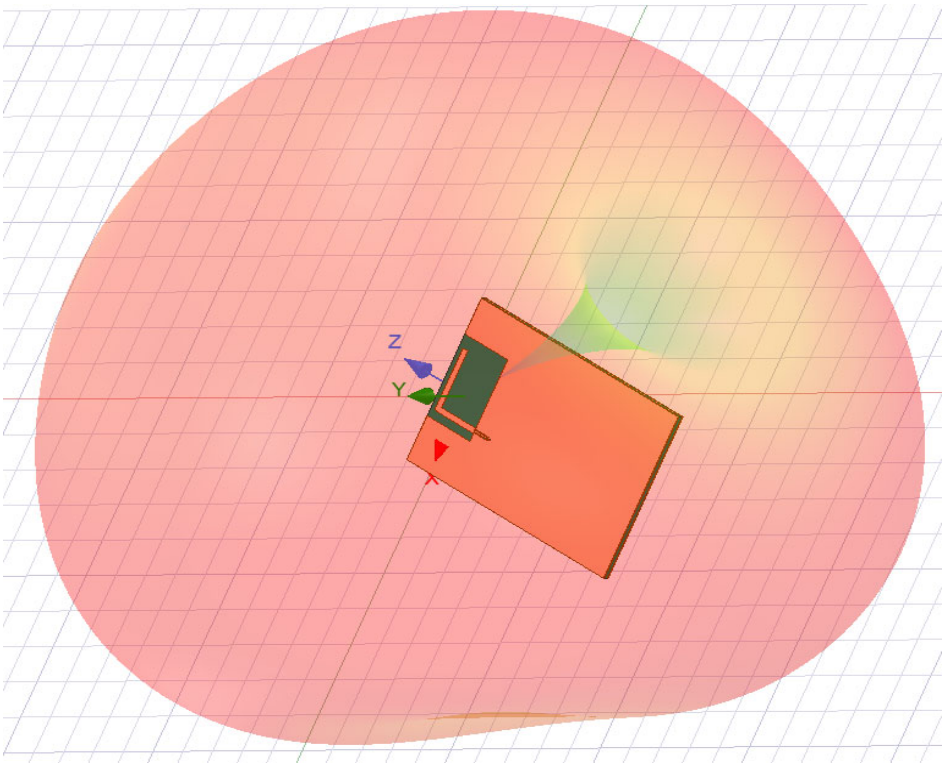

Figure 7. Radiation Pattern Gain Plot with RSL15 Reference Antenna Layout

Patterns Phi and Theta Plots

This section provides the following graphical resources for Phi and Theta plots:

- Realized Phi Gain Plot (Figure 8)
- Realized Theta Gain Plot (Figure 9)

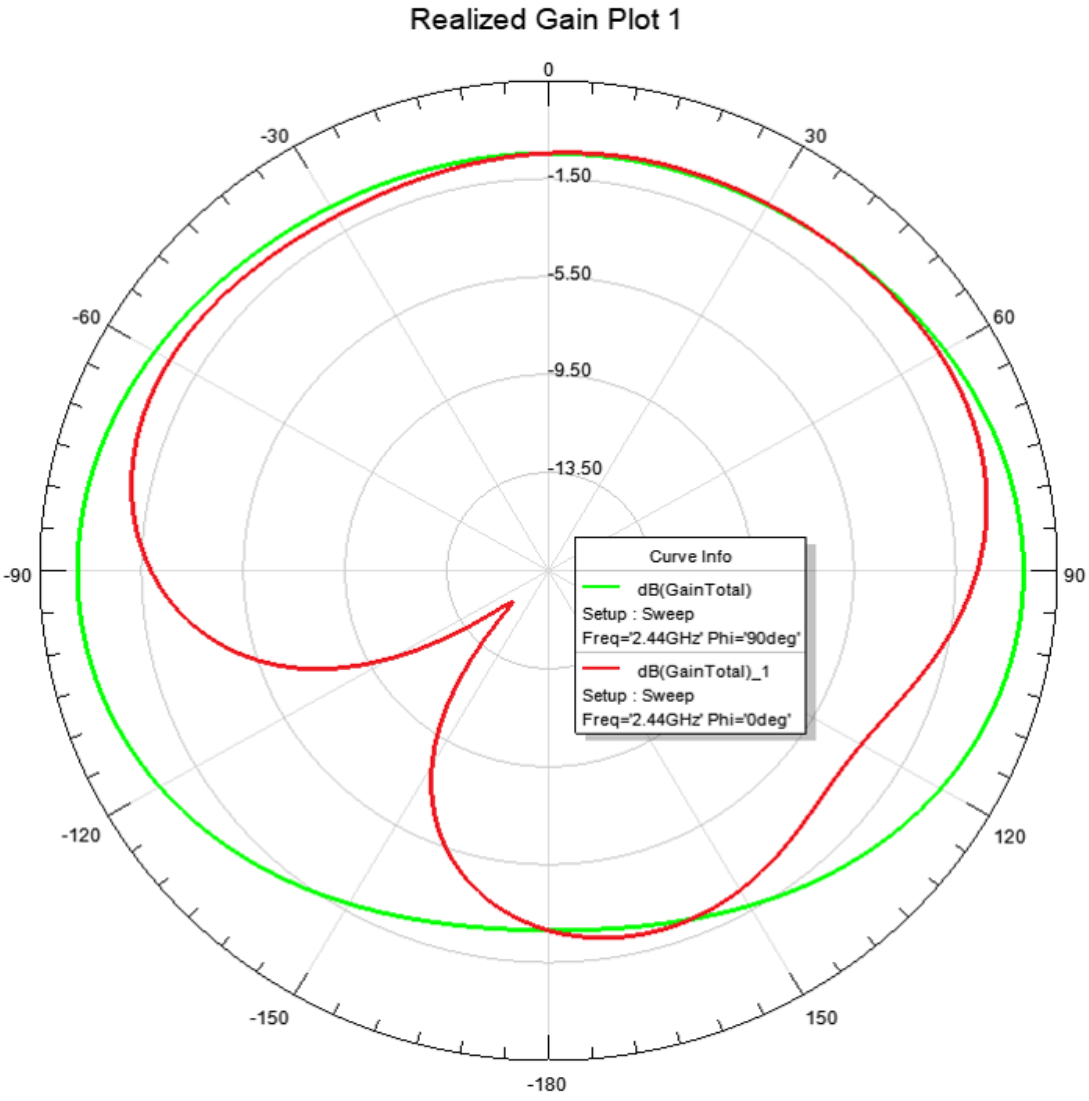

Figure 8. Realized Phi Gain Plot

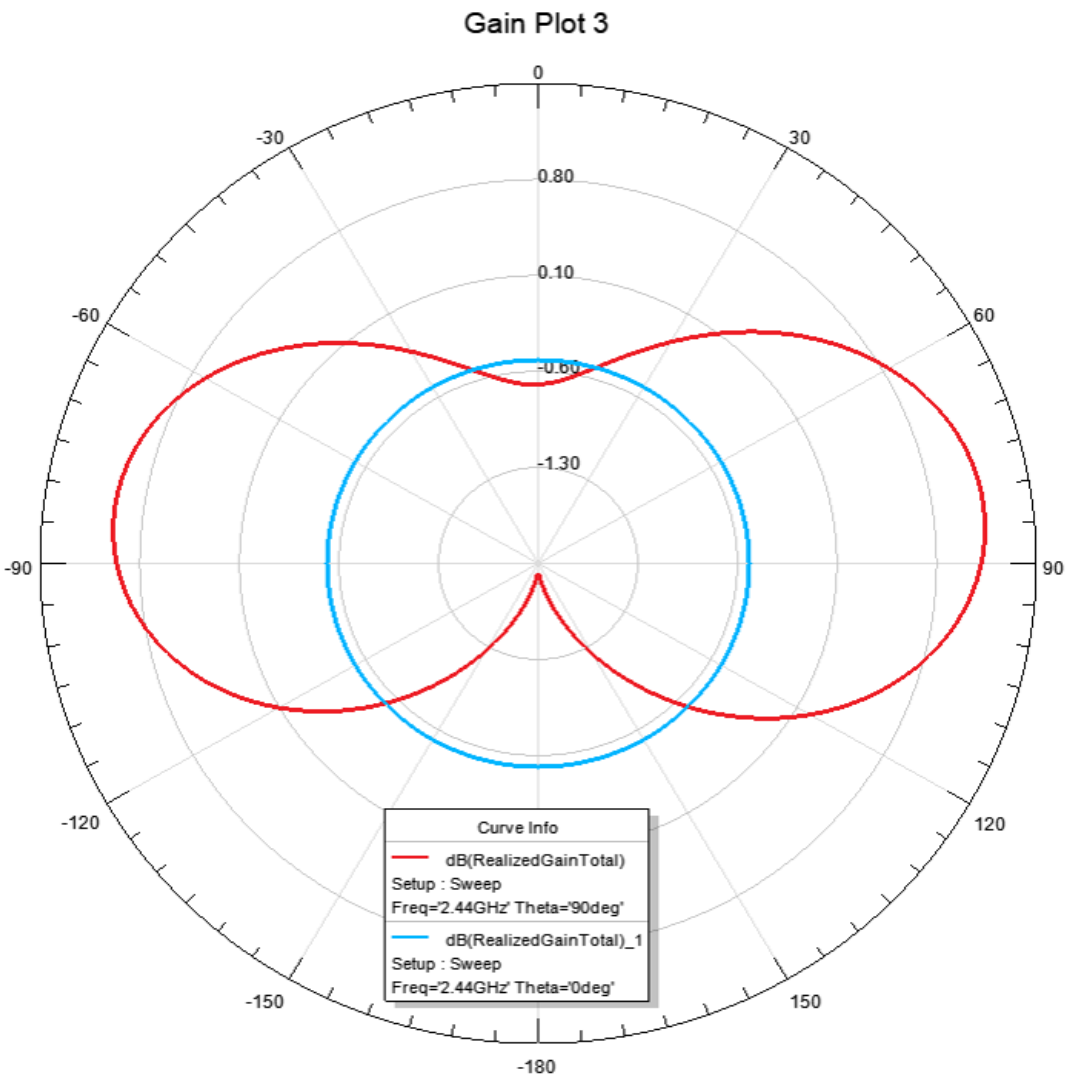

Figure 9. Realized Theta Gain Plot

Sensitivity Simulations

In this section, the antenna dimensions from the previous section are used as a reference. The following four dimensions are changed, and return loss is simulated:

- The ground length is `(pcb_h)`.
- The air gap around the antenna is `(gap_w)`.
- The length of the horizontal antenna trace is `(trace_l)`.
- The height of the antenna trace is `(trace_h)`.

One dimension is changed per iteration, while the other three dimensions are kept as in the RSL15 reference antenna layout. The PCB stack is kept fixed, and the dimensions are the same as in the reference design.

Simulation Variables

Figure 10 shows the simulation variables as they relate to the RSL15 reference antenna layout.

Table 1 details the set of dimensions used for Return Loss (S11) simulations, with values in the second column.

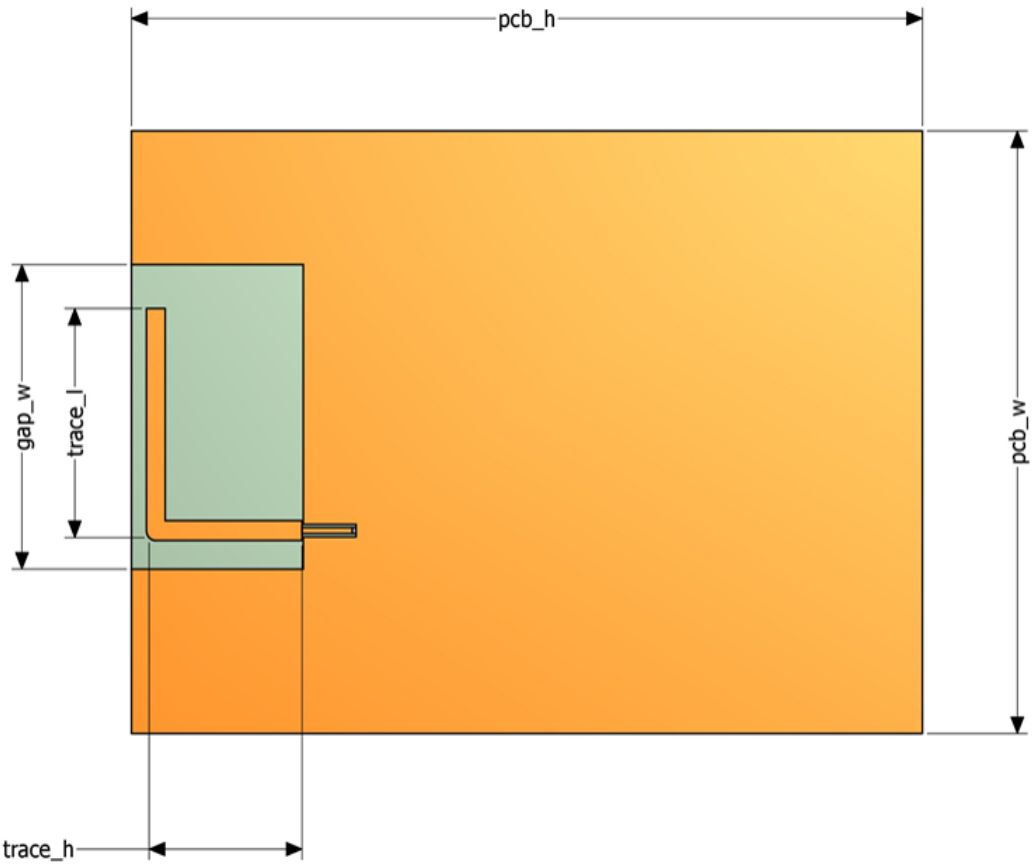

Figure 10. Simulation Variables in RSL15 Reference Antenna Layout

Table 1. SIMULATION VARIABLES

Dimension (Variable)	Values Simulated
pcb_h	35 mm, 45 mm, 55 mm, 65 mm, 75 mm
gap_w	21 mm, 23 mm, 25 mm, 27 mm
trace_l	13 mm, 14 mm, 15 mm, 16 mm, 17 mm, 18 mm, 19 mm, 20 mm
trace_h	9 mm, 10.5 mm, 11.5 mm, 12.5 mm

Return Loss (S11) – Gap around the Antenna (Variable gap_w)

This section provides the following graphical resources regarding the gap around the antenna (gap_w):

- gap_w Parameter Plot (Figure 11)
- gap_w Parameter Chart (Figure 12)

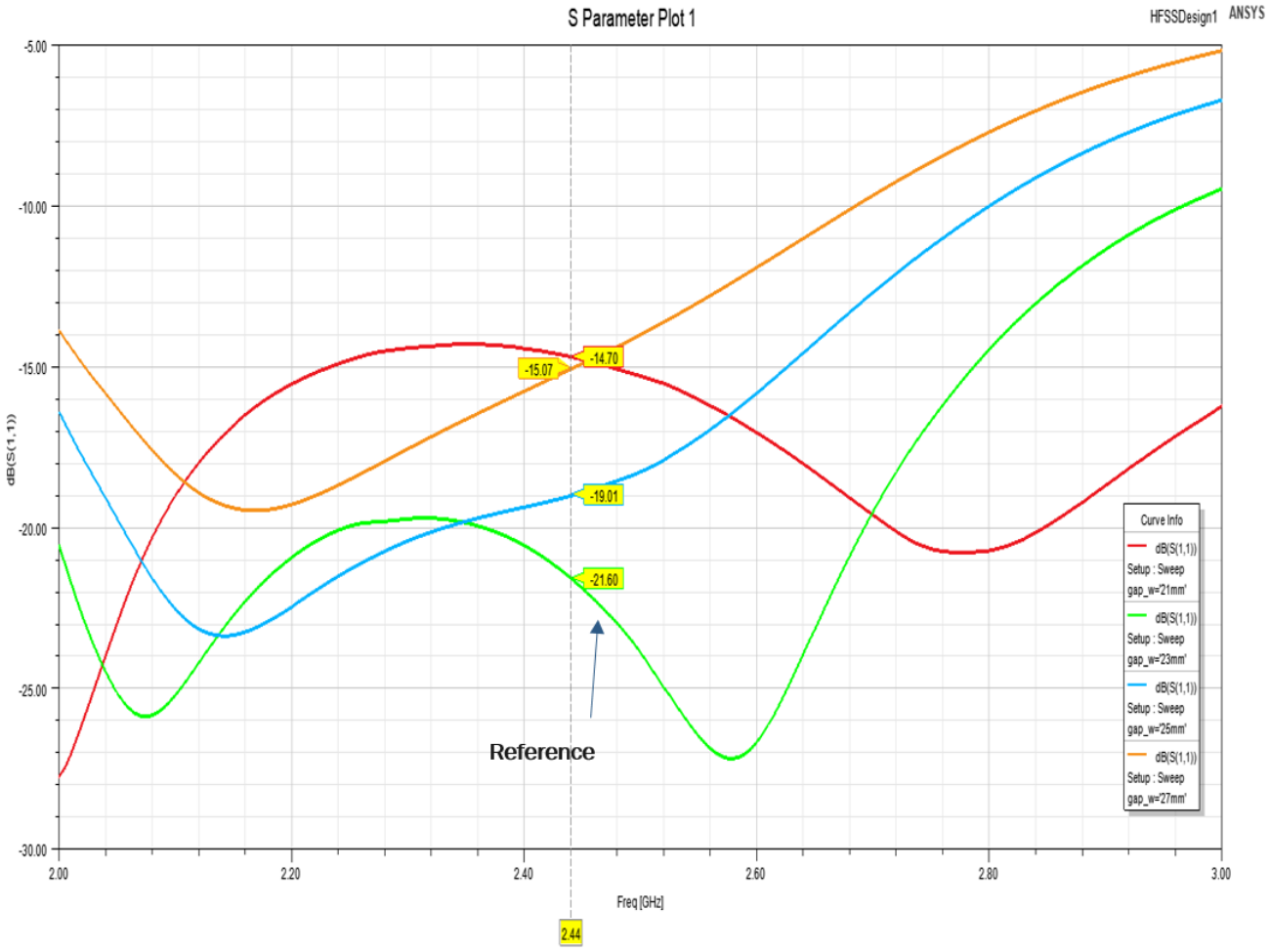

Figure 11. gap_w Parameter Plot

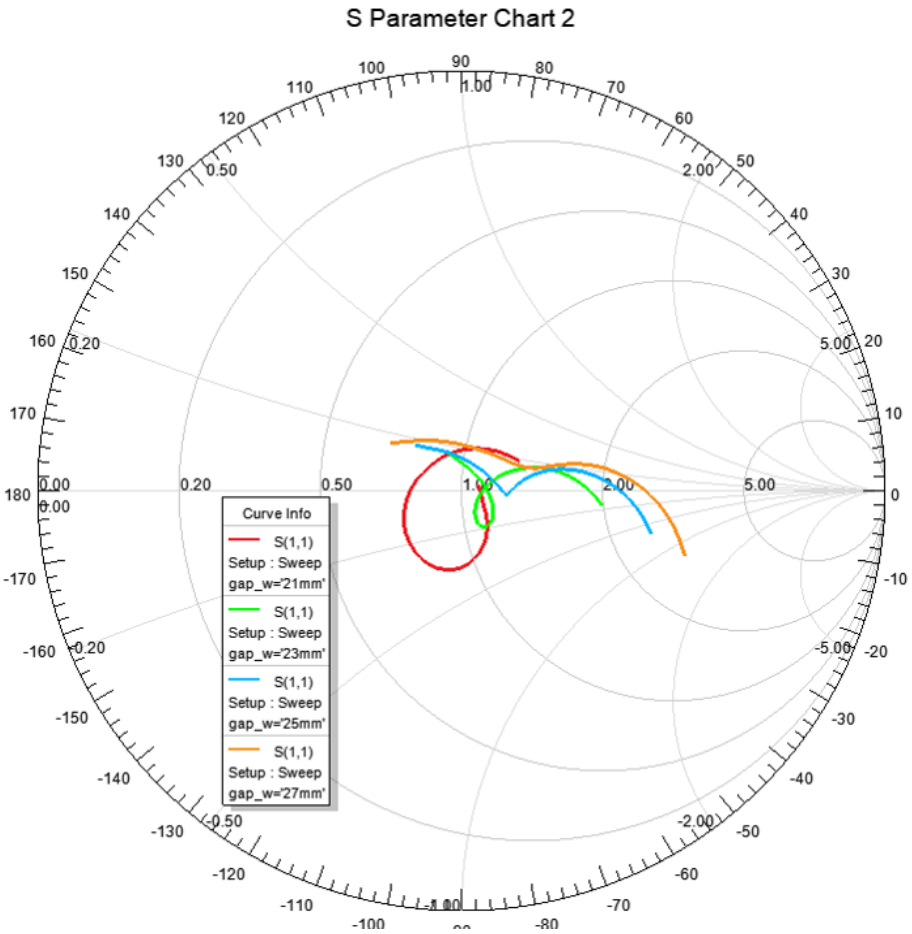

Figure 12. gap_w Parameter Chart

Return Loss (S11) – Trace Length (Variable trace_l)

This section provides the following graphical resources for the trace length (trace_l):

- trace_l Parameter Plot (Figure 13)
- trace_l Parameter Chart (Figure 14)

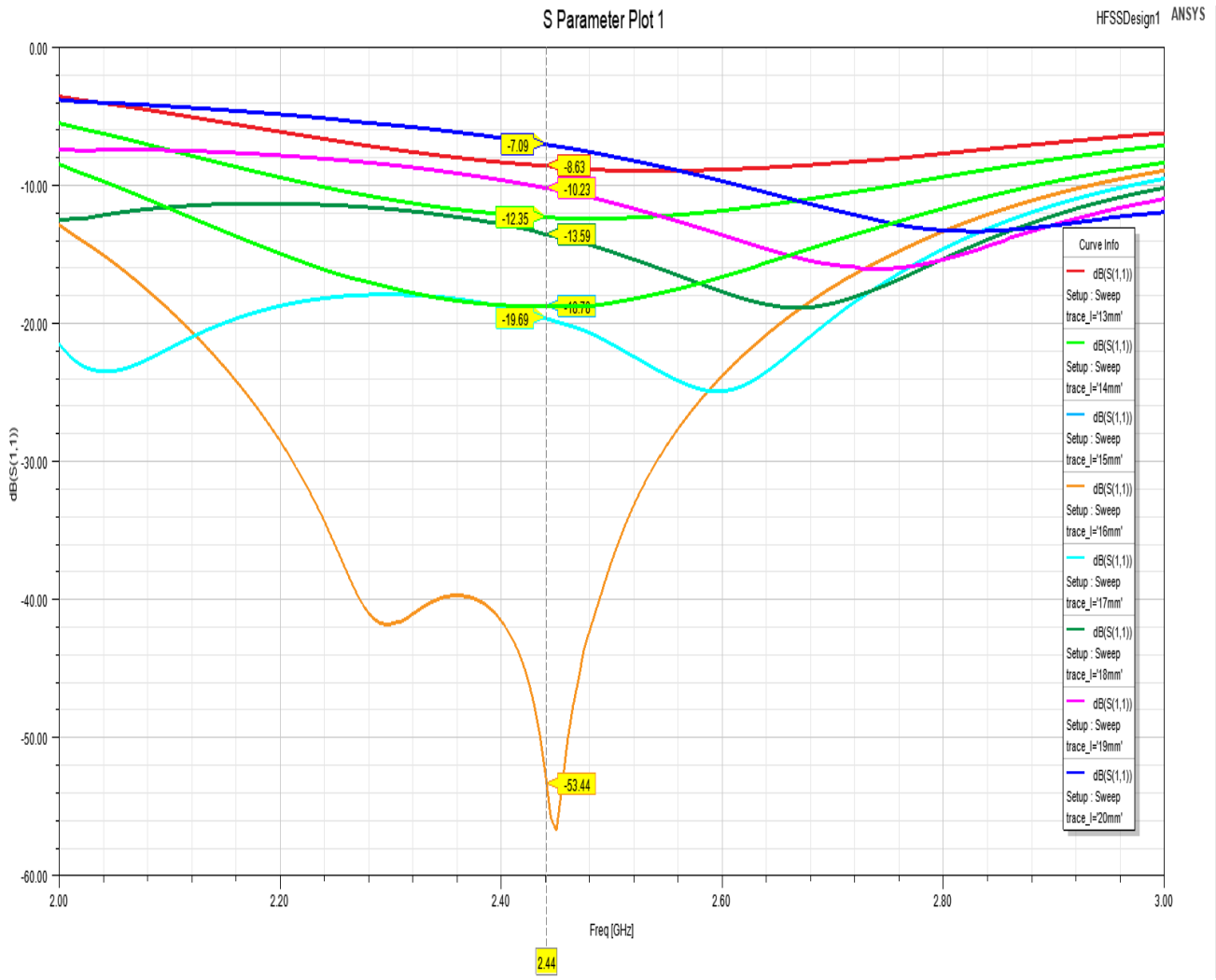

Figure 13. trace_l Parameter Plot

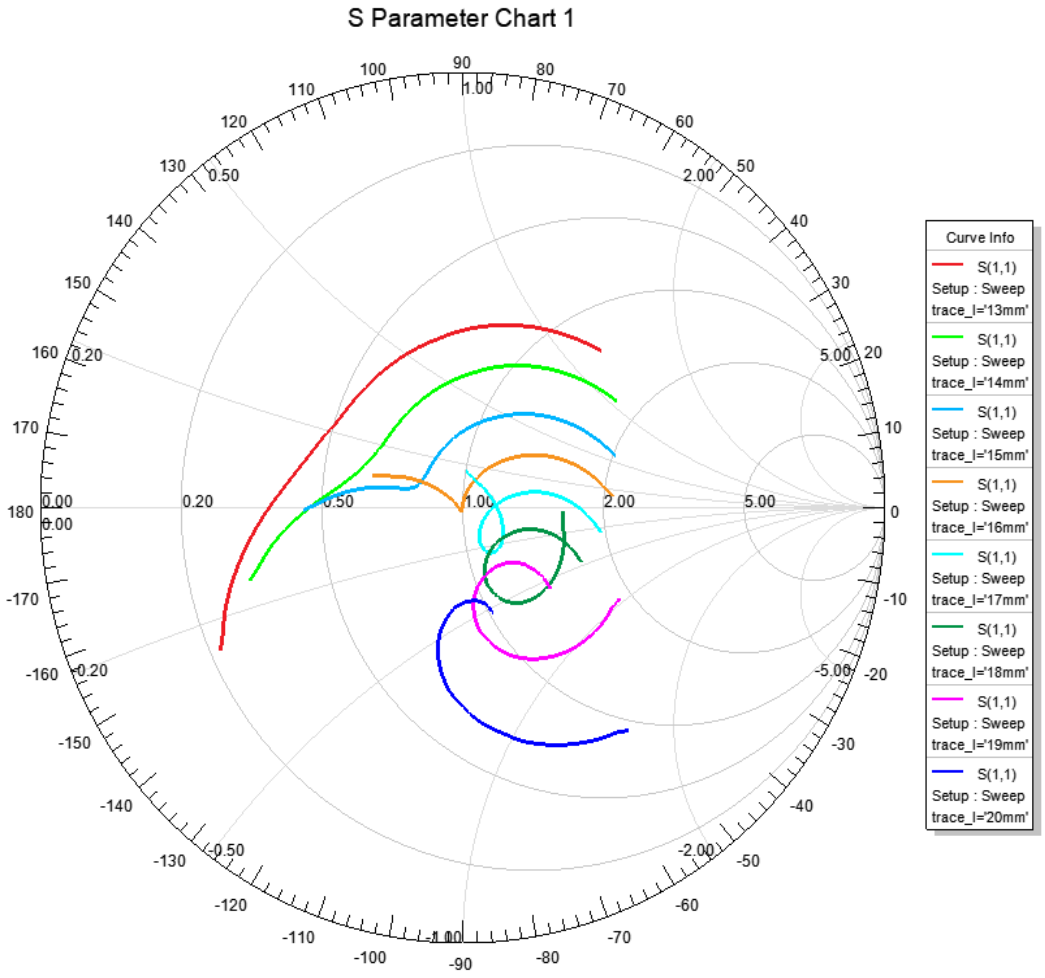

Figure 14. trace_l Parameter Chart

Return Loss (S11) – Trace Height (Variable trace_h)

This section provides the following graphical resources regarding trace height (trace_h):

- trace_h Parameter Plot (Figure 15)
- trace_h Parameter Chart (Figure 16)

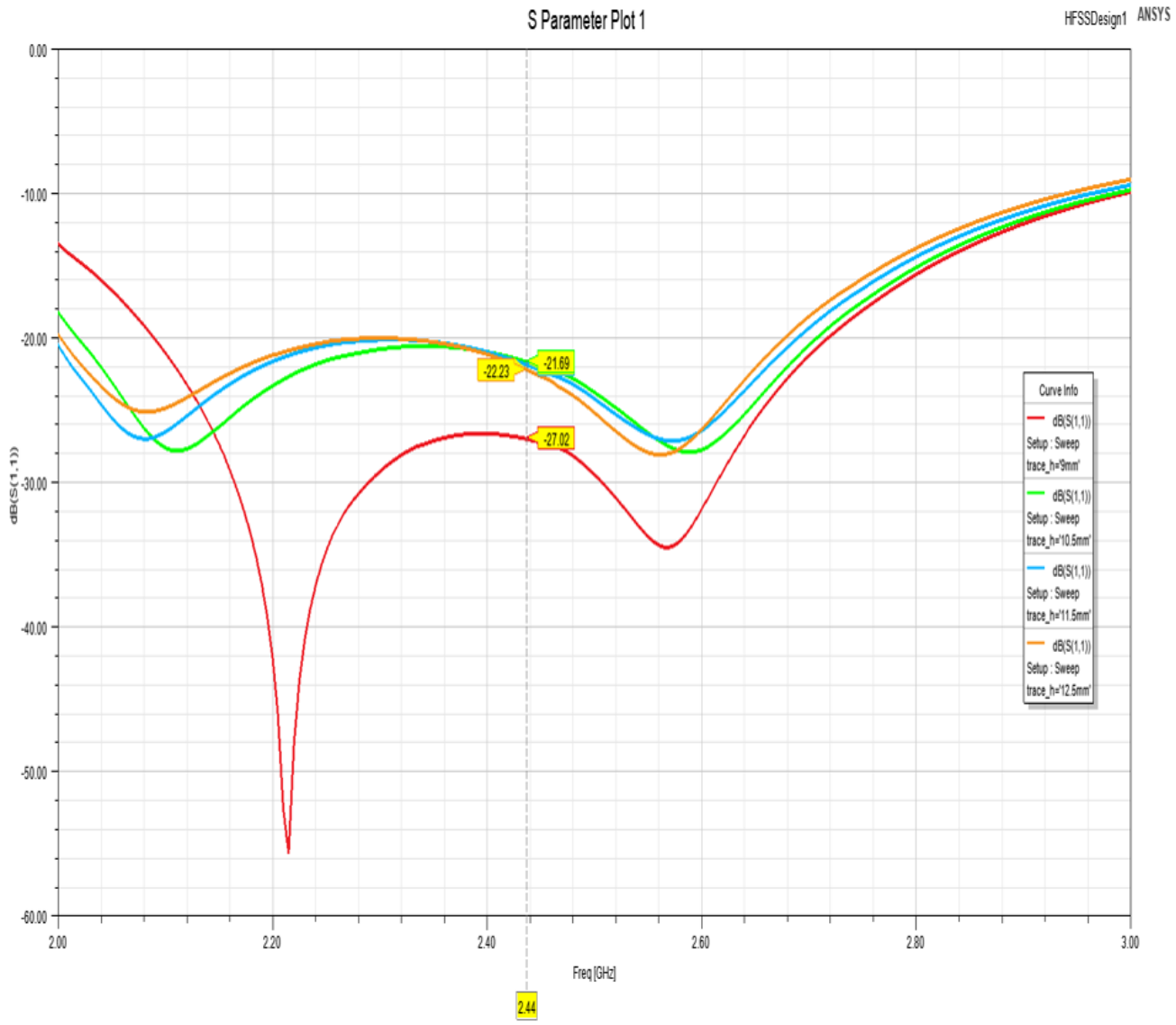

Figure 15. trace_h Parameter Plot

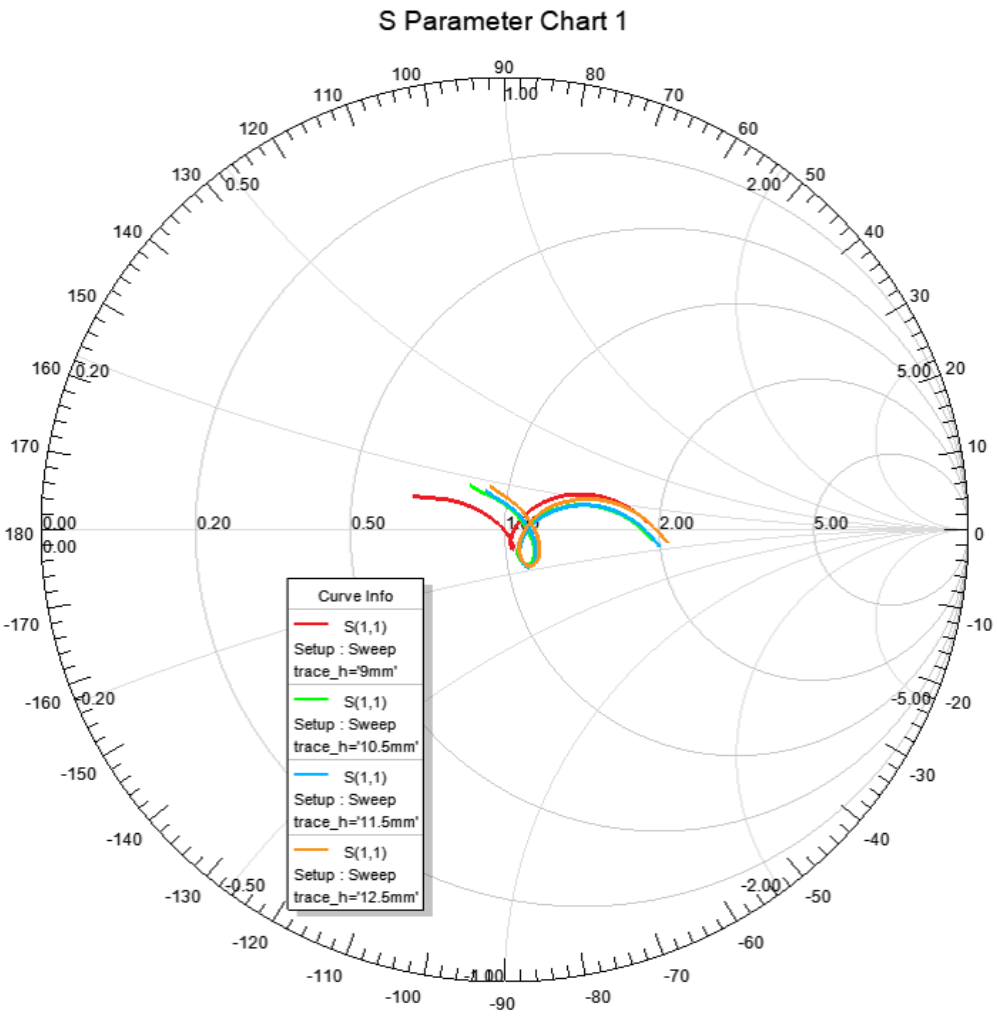

Figure 16. trace_h Parameter Chart

Return Loss (S11) – PCB Length (Variable pcb_h)

This section provides the following graphical resources regarding PCB length (pcb_h):

- pcb_h Parameter Plot (Figure 17)
- pcb_h Parameter Chart (Figure 18)

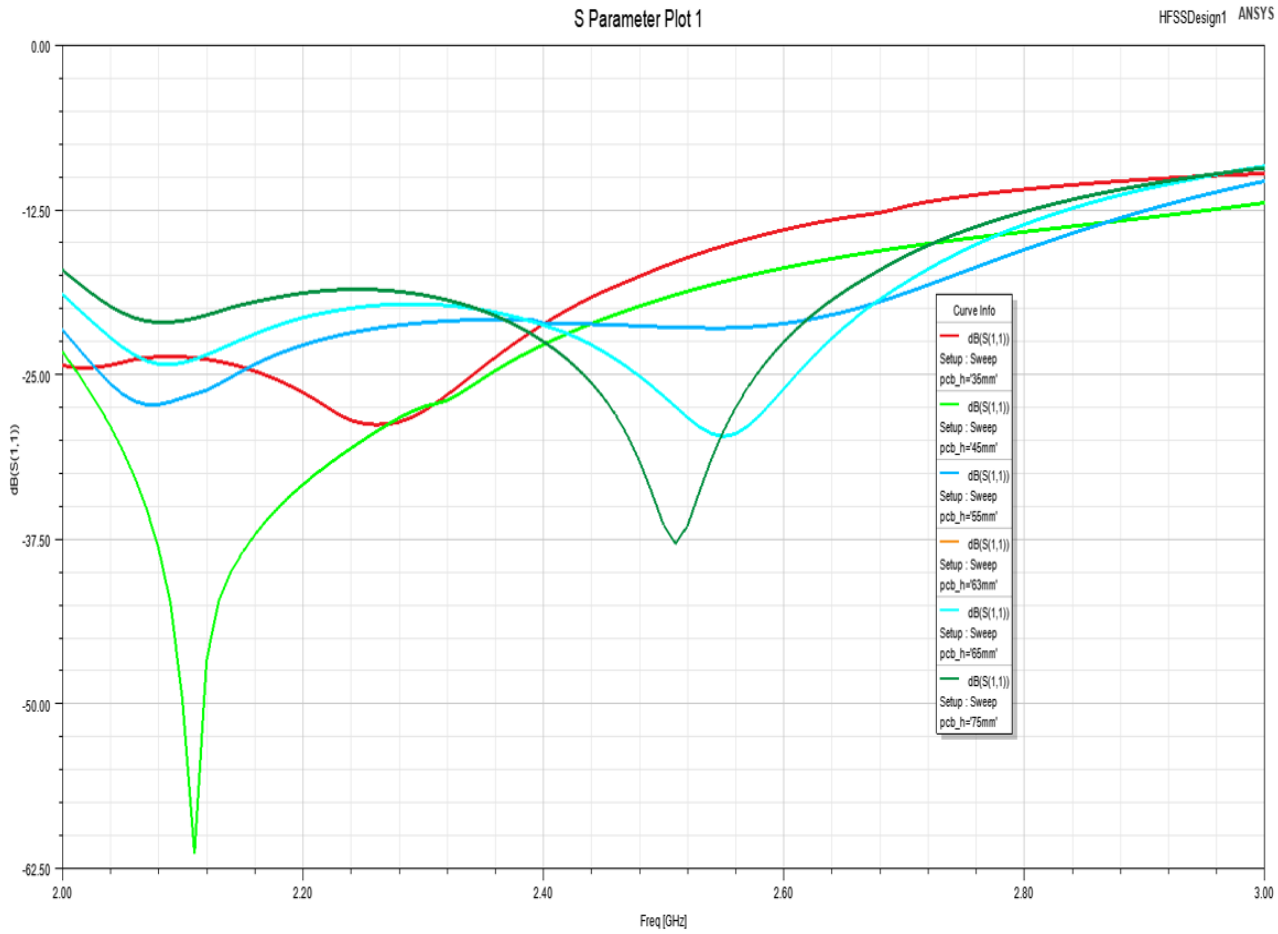

Figure 17. pcb_h Parameter Plot

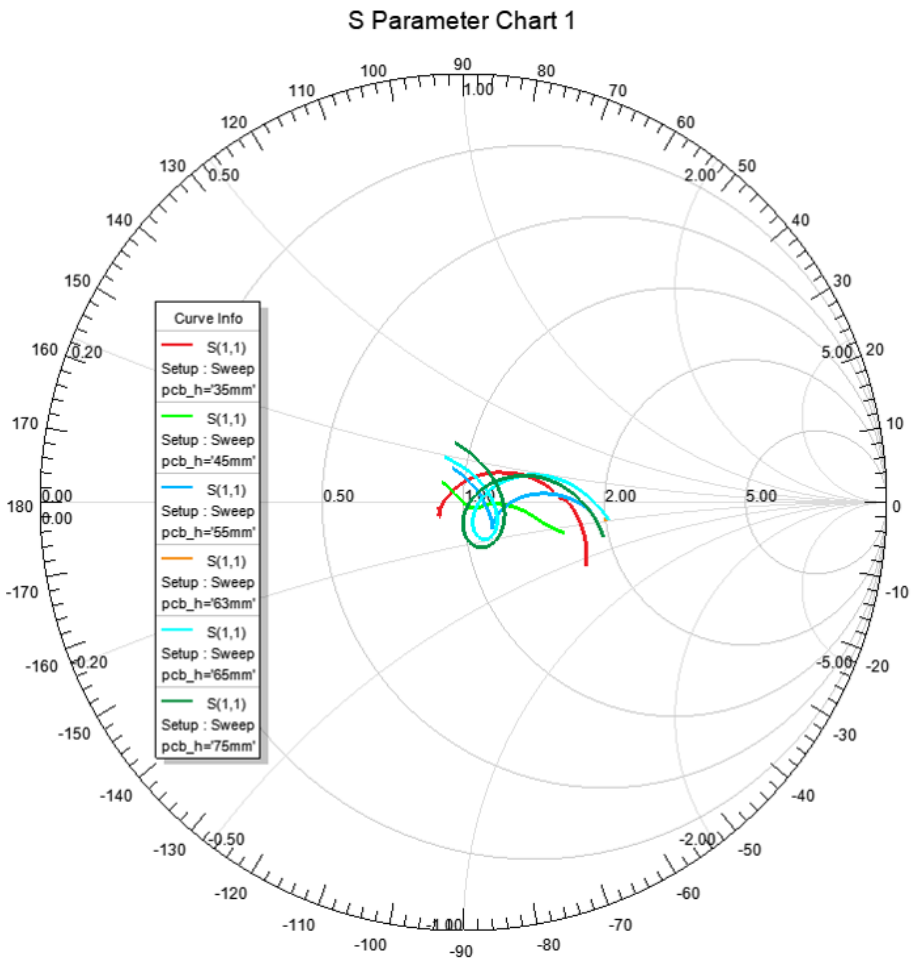

Figure 18. pcb_h Parameter Chart

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