# ELECTRONICALLY CONFIGURABLE ANTENNAS

(Group I)

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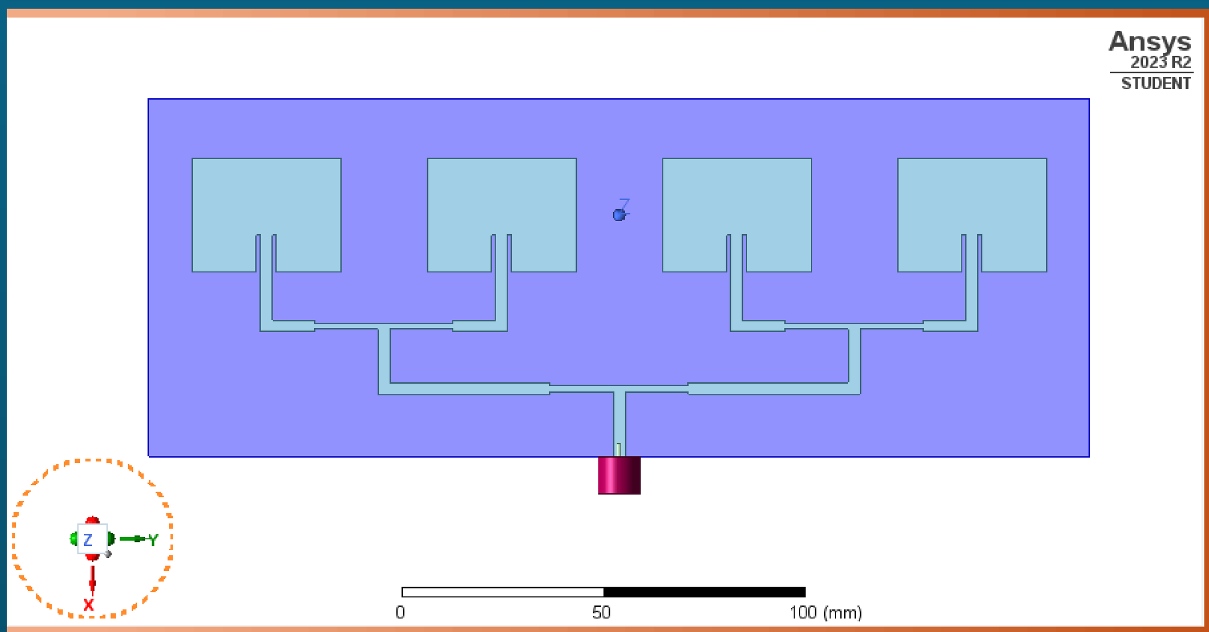
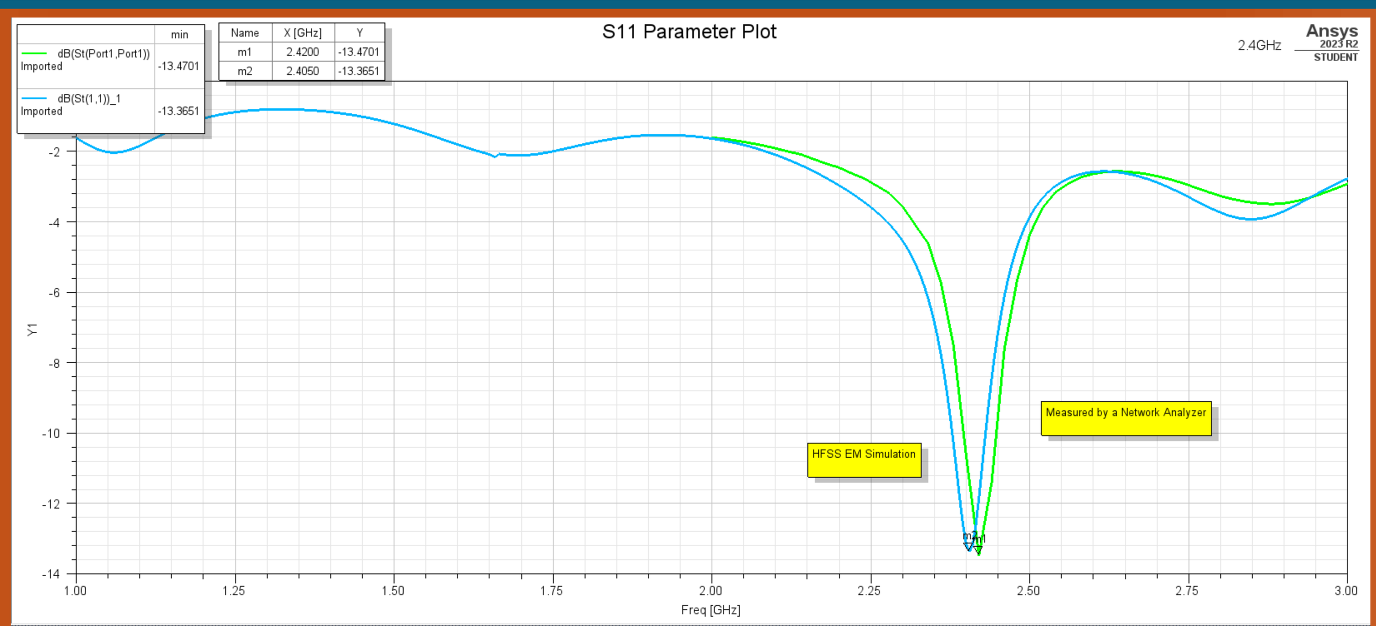
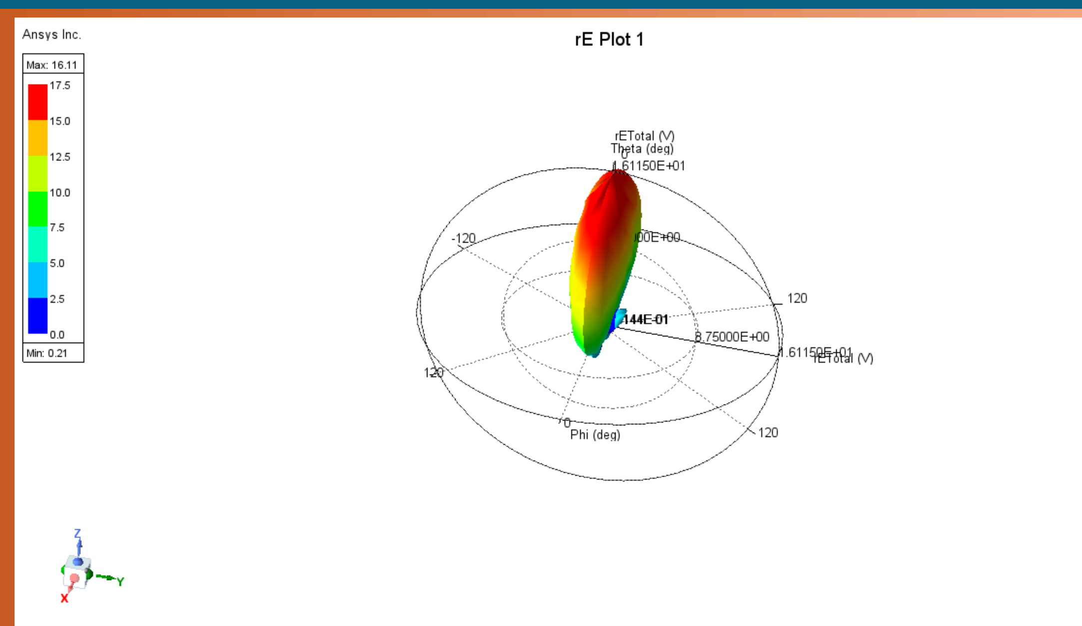
## INTRODUCTION AND APPLICATION AREAS

This project aims to improve the functionality and effectiveness of communication networks by utilizing modern techniques including patch antennas with switchable parts that use PIN diodes for switching. These antennas were designed to have directional radiation patterns, low profiles, and ease of integration with electronic systems. Their adaptability for phased array configurations can be used in various applications, such as wireless communication and radar systems. These antennas can dynamically adjust their radiation patterns in real time, ensuring optimal signal reception and transmission. In crowded urban environments or areas with high interference, these antennas can intelligently focus their signals, improving coverage and data rates.

## ANTENNA DESIGN AND SIMULATION




| | |
|---|---|
| $\varepsilon_r$ | 4.3 |
| $f_o$ | 2.4GHz |
| $h$ | 1.55mm |
| $\lambda_o$ | 12cm |

$$W = \frac{c}{2 * f_o}\sqrt{\frac{2}{\varepsilon_r + 1}} = 38mm$$

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\sqrt{\left(1 + 12\left(\frac{h}{W}\right)\right)}^{-1} = 4.27$$

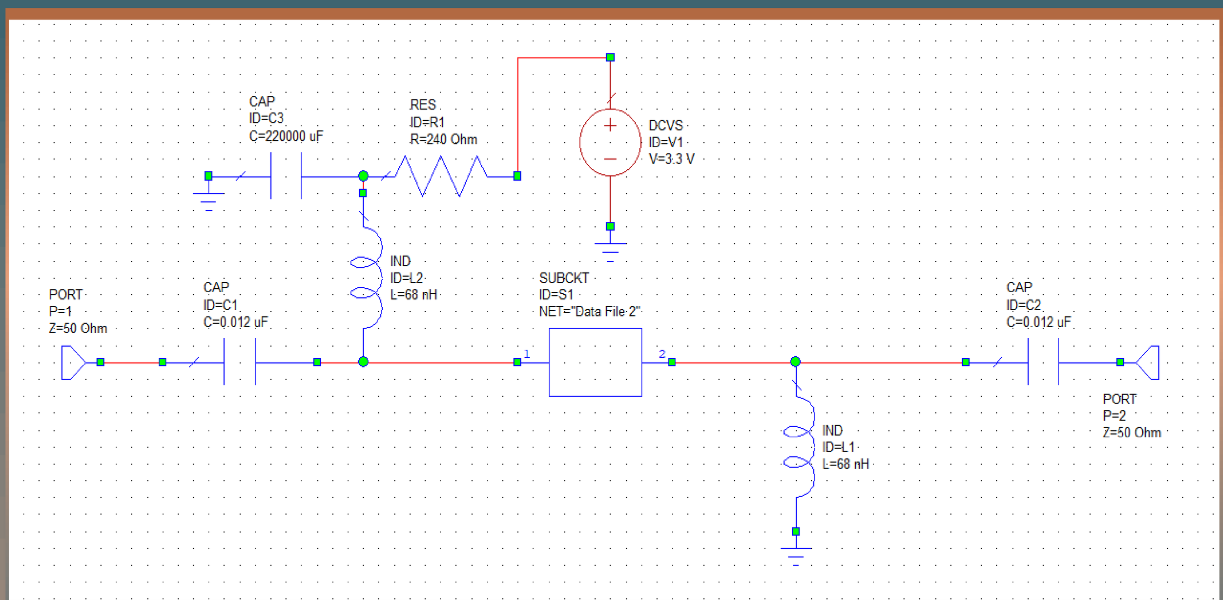
$$\Delta L = h * (0.412) * \frac{(\varepsilon_{eff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{eff} - 0.258)(\frac{W}{h} + 0.8)} = 0.73mm$$

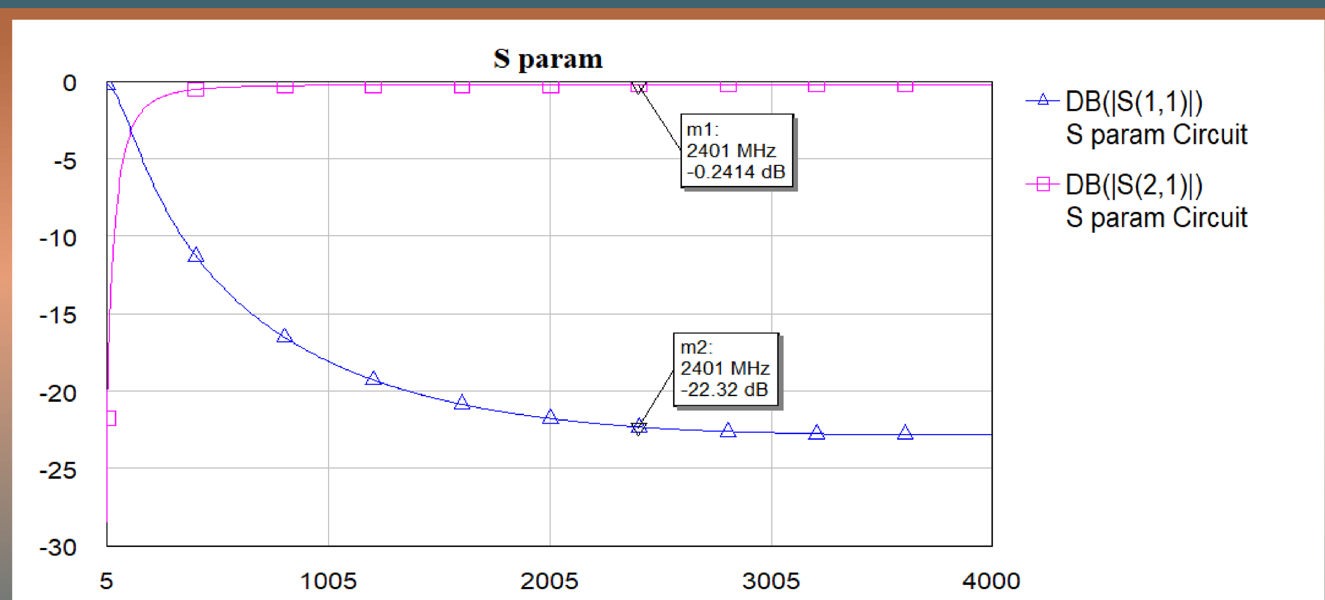
$$L_{eff} = \frac{c}{2 * f_o * \sqrt{\varepsilon_{eff}}} = 3.03cm$$

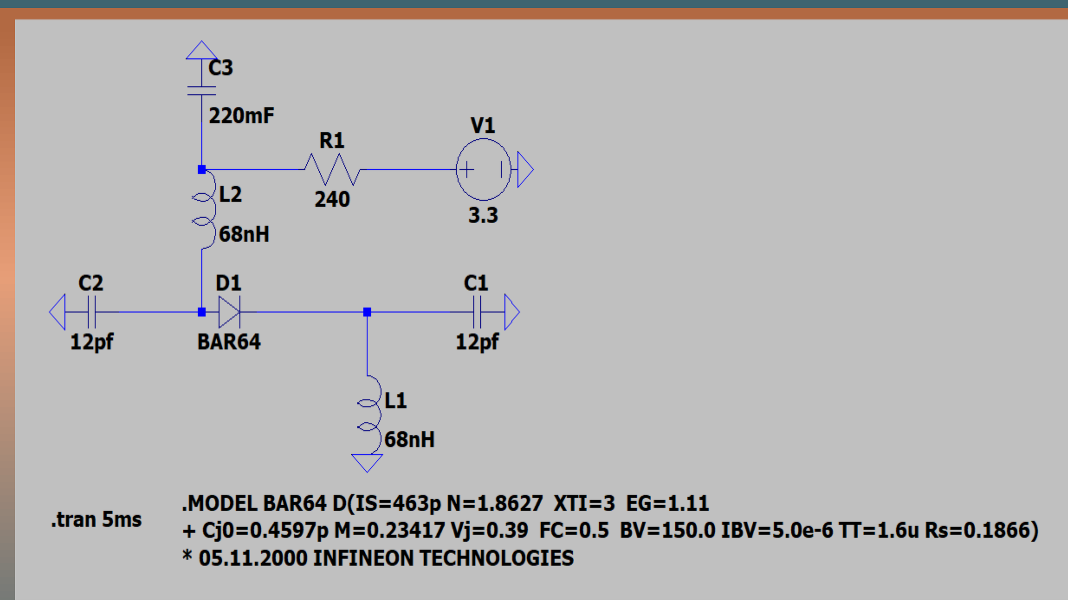
$$L = L_{eff} - 2 * \Delta L = 29.4mm$$

The locations of array antennas are placed by $\lambda/2$ *which is* $6cm$.

## SWITCHING CIRCUIT DESIGN AND SIMULATION

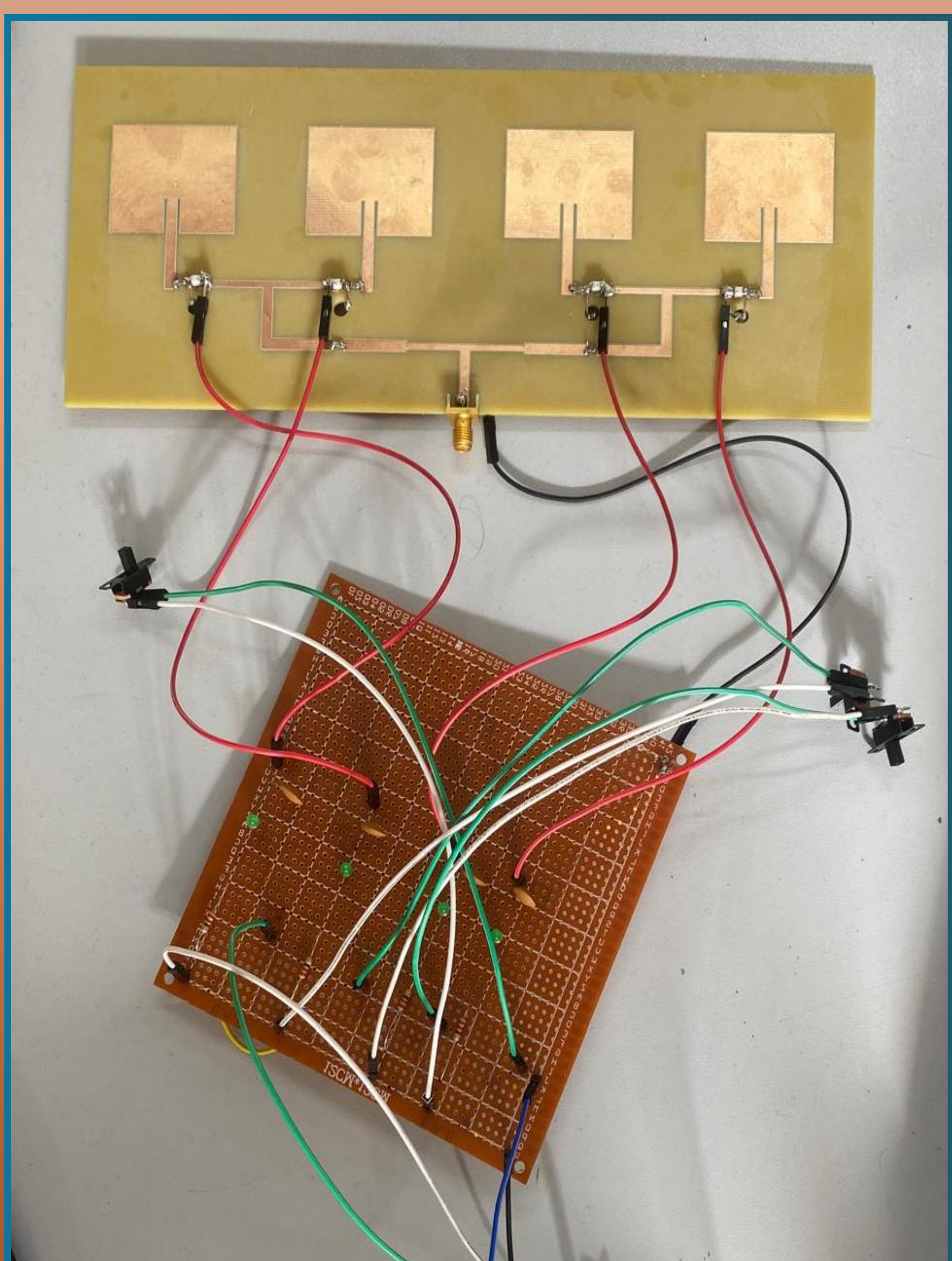


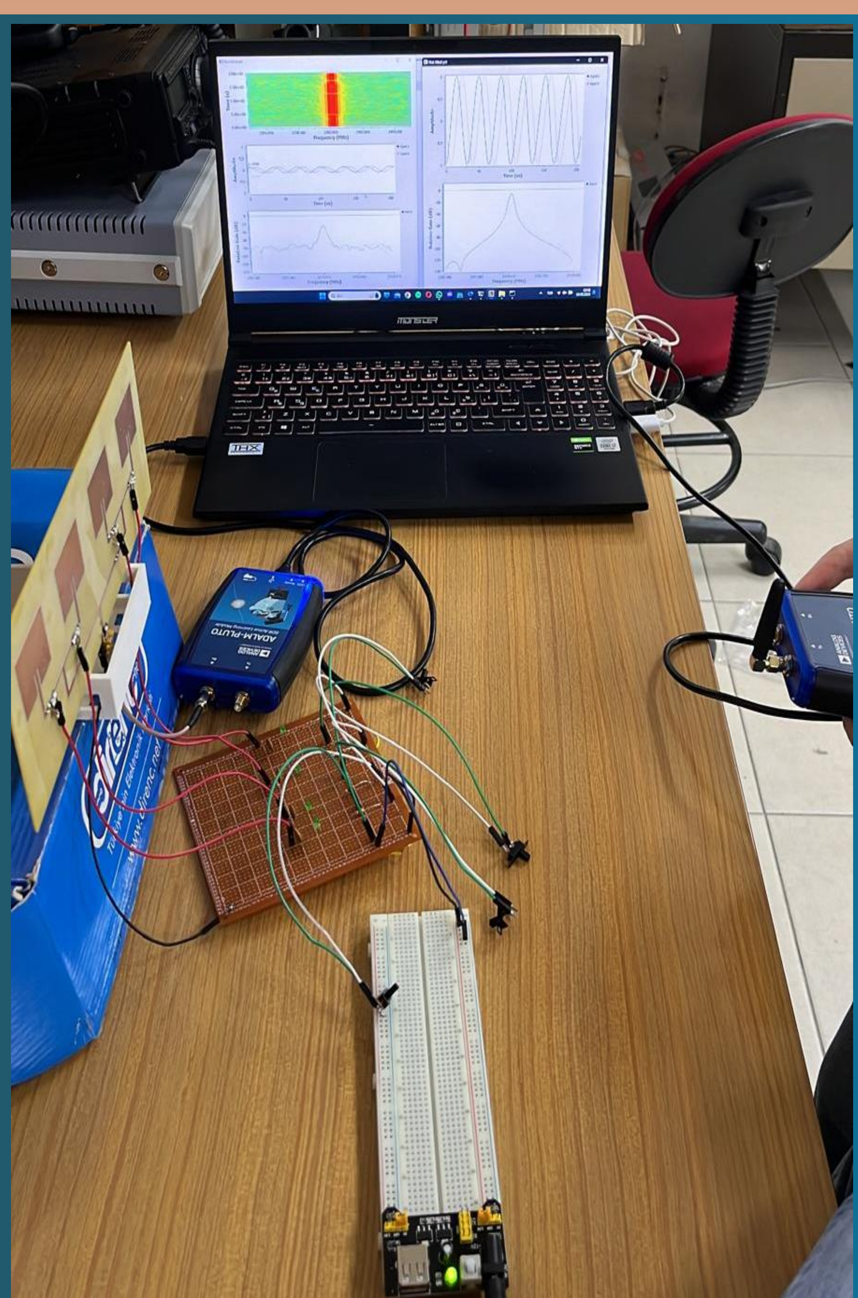



- **Forward Voltage Gain:** When we examine the S21 parameter values of the circuits we designed, we can observe that there are quite good values in the desired frequency band.
- **Biasing Circuit:** The consideration of DC biasing parameters ensures that the pin diode operates effectively, exhibiting behaviors such as current-controlled resistance and high impedance for RF signals as intended.
- **Simplicity:** The simplicity of the design, achieved by using minimal components without the need for a complex structure typical of switch types, indicates high manufacturability.
- **S11 Performance:** When we examine the signal reflection coefficient of the circuit, we observe that it exhibits behavior compatible with the antenna, allowing us to attain the desired values.

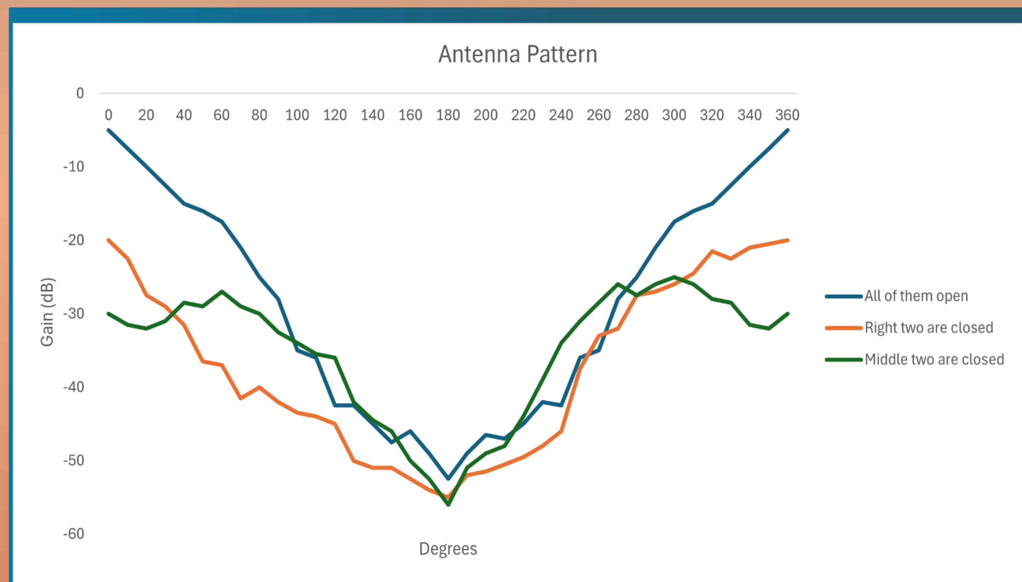
## FABRICATED ANTENNA & CIRCUIT

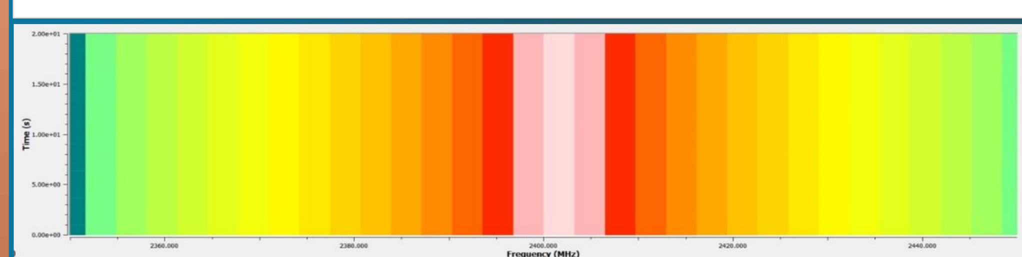




| | |
|---|---|
| MA4P7452F-1072 | Pin Diode |
| 12pF | DC Block and Input Matching |
| 220nF | RF Bypass |
| 12pF | DC Block and Output Matching |
| 68nH | RF Choke |
| 68nH | DC Return |
| 240 Ohm | DC Bias |
| $2V_{DC}$ | Green LED |

## ANTENNA RADIATION PATTERN TEST



- 30° behind the antenna (120°), the signal cannot be received anymore. Thus, this point is our maxima point.
- This antenna radiation pattern test is made by using the GNU Radio. ADALM-PLUTO SDR is integrated for the test.
- Waterfall Sink shows how the received signal by ADALM-PLUTO changes over time. Stability and consistency of the signal can be monitored.

## ACKNOWLEDGEMENTS

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