Hamid A. Hassan

+92-348-5126330,+92-317-5268878 | engr_hamid11@yahoo.com | linkedin.com/in/rfmwel | github.com/tet10hhn

Education

Tampere University of Technology Finland
M.Eng, Electrical Engineering, 68/120 ECTS (AI, Photonics, 5G, loT, Cloud, Satellite, LTE (4G, 6G) *Aug.19 – 21*

Högskolan i Gävle Sweden
MSc Electronics Telecommunications (Microwave I& II, RF measurements, Cellular, Antenna, Stochastic) *Aug.11 – Apr 15*

University of Engineering and Technology, Taxila Pakistan
BSc Electronics Engineering (VLSI, Analog Circuits I & II, Digital Image/signal processing, digital design) *Aug. 04 – Aug 09*

Experience

Freelance Technical Writer, (RF/PCB Designer, loT Solutions architect, Antennas Designer July 2021 –
Freelancer.com, Upwork, Linkedin *Islamabad, P*

- Completed successful reports on the following topics: 1): Cognitive Radio Networks, Toplogies, Architectures and Simulations Based Analysis of CRNs, in NS3, Net-Sim and MATLAB. 2) Deep Learning Techniques For Predictive Maintenance In Industry 4.0 (75 pages). 3): Wireless Sensor Networks: Multi-Hop Transmissions using Evolutionary Algorithm, LEACH, MODLEACH, HEED, TEEN PEGASIS (65 pages), 4) Principal Component Analysis (PCA) Machine Learning 5): Amazon PESTEL SWOT Analysis.
- 6): 5G, 6G Wireless and Satellite Communication Advances.
- 7): Responsible Business Case Study, Ford Motors, (sustainable value creation, circular economy, Human Rights and Ethics) 8) OLE Button Feasibility Study 9) Writing 4 scientific Papers on 5G, loT, RF design and Artificial Intelligence, Deep Learning and Machine Learning
- Low Noise Amplifier Design AT 2.4 GHz using BFG520, ATF55143 Transistors. from Stability, Biasing circuit, Source and Load Reflection coefficient, and input/output matching network design in Agilent ADS .
- Dual Band Slotted Patch Antenna design in CST Studio Suite, Antenna Magnus, and Altair Feko at 26.73 and 36.7 GHz frequencies for 5G Mobile applications (5G band n261 for Base Stations).

Research Associate (RF Engineer) July 2022 – March 23
Institute of Space Technology *Islamabad, Pakistan.*

- Design of a wide-band ELINT/SIGINT system i.e. satellite-based broadband receiver/antenna system for Estimation of Direction of Arrival (DoA) of RF and Radar Emitters including Vivaldi Array Antenna Design from 2-12 GHz (UWB) with dual polarization and beam-forming networks (6-bit Schiffman/coupled line phase shifters design in AWR Design Environment and 4*1 power divider/combiner design in ADS). mm-wave antenna array design i.e. 4*4 patch array antenna design in HFSS, 1*10 Vivaldi array design in HFSS/FeKo and dipole array design in HFSS.
- Wide-band component design for RF Front-end, such as UWB Filters, Broadband matching networks, UWB Low-Noise Amplifier, down-conversion and implementation of direction finding algorithms (MUSIC, ESPRIT) in digital signal processing base-band chain in FPGA.
- Simulation of LEO satellite orbits earth centered in Ansys STK, range vs azimuth and elevation angle calculations, Path loss simulations in MATLAB, excel sheet formation for complete link budget analysis, including losses, antenna pointing loss, polarization mismatch, atmospheric, rain loss, path loss for satellite communications.

Research Assistant May 2018 – Sep 2018
UC Louvain *Louvain-La-Neuve, Belgium*

- Research study of Commercial Automotive MIMO FMCW radar chips (in SiGe BiCMOS) at 24-77 GHz, with emphasis on mixer (Active, passive) and transceiver architectures such as low IF, zero IF architectures, focus point is on RF test and measurement of the components such as filters, mixers, and Amplifiers using standard RF test equipment i.e. filters S21, S11, and mixers conversion loss measurements.
- Machine learning techniques in ADAS (Autonomous driving assist systems) such as regression, clustering, localization, and classification (LSTM) based object tracking problems for Automotive millimeter-wave radar, with focus on conducting laboratory tests on RF equipment such as VNA, Spectrum Analyzer, PNA-X, power meter etc.

Radio Frequency Designer/Assistant Manager (Full-time) Apr. 2016 – July 2017

National Electronics Complex of Pakistan *Islamabad, PK*

- Test and measurements of Planar RF Filters design and Amplifiers (LNA, HPA) using RF test measurement such as VNA, Spectrum analyzer, power meter and couplers, design and Simulation components in Agilent ADS, transceiver front-end components, and antenna simulations. Transmitter architectures, phased array radar, power combining research and design (spatial/radial).
- Working with cameras, surveillance projects, Bill of materials, networking equipment, passive IR/microwave (dual tech) sensors for IDS (intrusion detection systems), install access management system and fiber optics distribution.

Thesis Researcher Aug 2014 – May 2015

Högskolan i Gävle *Sweden*

- *Fabrication, RF test & measurements, Synthesis, Design & size reduction analysis of micro strip hairpin band pass filters using coupled resonators.*
- Synthesis, analysis & design of high-Q filters with improved selectivity, analysis of inter-resonator spacing for desired coupling, return loss, and out of band attenuation with transmission zeroes.
- FR4 is used for PCB and fabrication is done using LPKF protomat and measurements with state-of-the art VNA/Spectrum Analyzer. SMR/FBAR, micro-machining methods and RF MEMS acoustic resonators, ceramics are researched for on-chip integration and miniaturization .

Antenna Design Projects 2010-to-Date

Masters Training, Previous Experiences Gavle, (Sweden), Tampere, (Finland), LLN, (Belgium), Islamabad, (Pakistan).

- I can work with following Antenna designs in Antenna Magnus, CST, Feko and HFSS. Printed Micro-Strip Fed Yagi-Uda Dipole Array, Triangular Edge-Fed patch antenna (LRR (76-77 GHz), Automotive), M-by-N Rectangular Patch Array with Corporate Feed, Circularly polarized, (square/truncated/rectangular/elliptically/resonant), series/edge inset-fed patch arrays, measurements, synthesis,& design.
- Synthesis of arrays: Linear traveling-wave slotted wave-guide array, Cavity backed slotted antenna array, Wire-grid array & printed multi-layer dipole array, planar bow-tie automotive array, Log Periodic Dipole Array (LPDA), LPDA with square boom.
- Dielectric based antennas, mono-pole, Printed loop and spiral antennas with many modes, self matched normal mode helix antenna, Stacked rectangular broadband patch with V-slot. Other antennas i can design as per specification, from scratch or using synthesis software's such as Feko/Magnus from application areas, Aeronautical, Automotive, Cellular, ISM, loT, Immarsat, Nautical, Public Broadcast, Radar bands, smart devices and Mobile Communications and custom specifications. Library synthesis experience of rectangular/circular/ single rigid/double rigid/elliptical wave-guides.
- RF Projects given in Projects Sections, Writing 4 scientific Papers on 5G, loT, RF design and Machine Learning.

Scientific papers, Unpublished

- Paper: Network Slicing, SDN, NFV in 5G and Machine learning, An Overview. *In Progress. Keywords: NOX, openflow, OpenvSwitch, Machine learning, Python (Submission, Jan '23)*
- Paper: A Survey on Wireless Communications for Internet-of-Things (Architecture, Enablers, literature review). *Sent to a conference. Keywords: LoRaWAN, SigFox, Zigbee, NB-loT, Python (Submission. Jan '23)*
- Paper: V2V, V2X communications in 5G and beyond, a tutorial overview.*In Progress. Keywords: DSRC, 820.11p, Computer vision (Dec '22)*
- Paper: Planar filter synthesis based design and analysis (RF Hairpin Filters)*Published on Semantic Scholar: To be Submitted to a conference: Jan 23. Tech: Agilent ADS, MATLAB, AWR Microwave office.*
- Paper: Two-Conductor Transmission Lines *Submission: Jan 2023.*
- Paper: Polarization and diversity analysis: A measurement based approach *To be Submitted: Jan 23.*

Projects

Privacy & Security in loT and 5G | *(MQTT, CoAP, TLS, DoS)* June 2020 – SEP 2020

- Privacy and cyber security risks in 5G and Internet-of-things using Wireless technologies (LoRaWAN, SigFox, NB-loT, and web interface, application protocols, network security and cloud implementation) (August '20).

Sensing and control of assistive exoskeletons | *Pro-Engineer, Arduino,force/pressure sensors,Git* May 2013 – Nov 2013

- The design of assistive exoskeleton for the lower limb support of elderly patients for medical applications, starting from human gait and biomedical analysis, force, pressure sensors, accelerometers, linear actuators for joint actuation and control of system using Arduino. The prototype was designed in Pro-Engineer, manufactured and presented (March '13)

loT, Analog, RF design and characterization. | *End-to End radar simulators in MATLAB with Ancortek SDR*

- Understanding of LTE, 4G, 5G, MAC layer design, Mobile cell site design, radio cell design and optimization. Design of low noise voltage regulator, VCO, and PLL for high frequency transmitters and receivers. Modeling & RF characterization of LDMOS transistors for base station power amplifier applications.
  Wireless loT covering LoRaWAN, SigFox, NB-loT, and web interface, application protocols, network security and cloud implementation.
  RF amplifiers design (LNA, HPA), load pull, hybrid coupler, power splitter/combiners, diode mixers & transistor oscillators design.
  Differential, multistage amplifiers, current mirrors, inductors, capacitors in Cadence, mixers, phase detectors, CPPLL, filters in ADS and MEMS sensors and socially assistive robotics applications using deep learning and sensor fusion.
  Advanced receiver/transmitter architectures, IQ imbalance, DC offset, Wide-band A/D conversion, Non-linearity methods, Direct/wide-band IF sampling, Behavior modeling, Digital Pre-Distortion, Multi-rate signal processing, Radio filter transceiver simulation & synthesis expertise.

Test and measurement of RF Equipment (VNA, SA, Oscilloscope). | *Filter, mixer, amplifier, oscillator measurements*

- Strong RF measurements and Instruments experience through hands-on of State-of-the art Spectrum Analyzer, VNA, PNA-X, Isolator, circulator, directional coupler, attenuator, signal generators, signal quality analyzers for Bit-error rate testing (BERT) for collecting metrics such as packet loss, latency and jitter, throughput testing, IIP3 and IIP2 measurements and measurements such as Active passive components, Mixers conversion loss and frequency offset measurements, Load pull simulations and Passive Inter-modulation measurements.

- Multi-hop Wireless Sensor Networks using Algorithms in MATLAB such as LEACH, MOD-LEACH, DEEC, TEEN, PEGASIS, Evolutionary (Genetic) Algorithms. Deep Learning for Predictive Maintenance using loT in Industry 4.0.

- Cognitive-Radio Wireless Sensor Networks simulations using NS-3, NS-3 module development such as LENA, NR, LTE, Cognitive (CRE-NS3), Throughput, delay, latency, power transmit conrorl, rate control plots, using Wi-Fi, BLE, 5g, Video, audio, multiple nodes/topology creation, simulation based analysis, future trends and challenges .

Technical Skills

Languages: Python, C/C++, JavaScript
RF Simulation/PCB design Tools:Agilent ADS, AWR Microwave Office, Ansys STK, Genesys, Ansoft HFSS, CST, Altair FeKo, COMSOL Multiphysics, LabVIEW, MATLAB, Cadence Virtuoso, FPGA, Vivado, Verilog, Xilinx, Spartan
PCB DesignTools:Altium, Cadence Allegro, Mentor Graphics PADS, Eagle, Kicad, Cadece OrCad.
Developer Tools: Git, Docker, AWS, Google Cloud Platform, VS Code, PyCharm, KeiluVision, chadder,ARM-R(scheduler(RM), WCET, feasibility analysis
Python Libraries: Pandas, NumPy, Matplotlib, SKlearn, Keras, Open CV

HAMID ALI HASSAN

36 YEARS OLD RF FILTER/AMPIFIER, MIXER, VCO DESIGNER FOR MM-WAVE, 5G, RAADR, SATELLITE/INTERNET-OF-THINGS DEVELOPER

PROFILE INFO

An expert passive circuits designer (RF filters, antenna arrays), MM-WAVE, ELINT/SIGINT satellite system developer, RF Front end skilled (LNA, HPA, MIXER, VCOs, radio/wireless networks developer (4G, 5G, 6G), with skills in SDR, Cognitive Radio Networks, assisted with skills in internet-of-things development, MQTT, COAP, DoS, AWS, LoRaWAN, SigFox, Zigbee, NB-IoT, Git, Dockers, Containers, Keiluvision, Vivado, FPGA DEVELOMENT, SDN, NFV, Openflow.DPD, Zero-IF, LOwIF, IoT clusutering protocols, LEACH, MODLEACH, PEGASIS, CRN simulations in NS-3 and NETSIM.

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Email
engr_hamid11@yahoo.com

Address
VPO Saghri, Jand Attock

PERSONAL SKILLS

- ADS, Momentum, HFSS, CST, FeKo, Antenna Magnus, MATLAB, AWR Microwave Office, Comsol
- C++, python (ANACONDA, AI/ML frameworks), NS3, NETSIM,
- Office suite, CANVA ADOBE, corel
- ANSYS STK for link budget simulations & satellite orbits dynamics with MATLAB.
- Brand and Content creation (Linkedin)
- Expert Level Technical report writer, canva designer. IoT solutions developer .
- PCB Design: Altium, Allegro, Eagle, Kicad, PADS, MULTI-LAYER PCB Design.

LANGUAGE SKILLS

English 95%

Swedish 50%

REFERENCE

MR. KHAWAR NAEEM
TECHNICAL SALES ENGINEEER, WESTERMO AB, VASTERAS, SWEDEN
+46-728-652220

MS. MARIA RUOKONEN
TAMPERE UNIVERSITY / TEAM COACHING SPECIALIST
+358-40-4377138

LOT NICHE: AWS-LOT, MQTT,BLUETOOTH, WI-FI, 802.11N, 802.15.4, CAN-SERIAL COMMUNICATION, ETHERNET, DOCKERS, CONTAINERS, NODE.JS

WORK EXPERIENCE

EXPERT TECHNICAL WRITER (LOT/RF SOLUTION DEVELOPER)
UPWORK, INC. MARCH 22 ONWARDS (CURRENT)

JULY 2022 – FEB 2023
RESEARCH ASSOCIATE (RF ENGINEER)
INSTITUTE OF SPACE TECHNOLOGY, ISB, PK.

- ELINT/ SIGINT System Design. RFFE, Antenna, DoA Estimation of Radar Emitters
- RF Front-end (LNA, filter, HPA, VCO) design
- Gained experience in UWB (2-12 GHz) RFFE, Array Antenna and Signal processing (MUSIC, ESPIRIT in MATLAB, ADS, HFSS/CST, ANTENNA MAGNUS, FEKO.

MAY 2018 – SEP 2018
RESEARCH ASSISTANT (RF DESIGNER)
UCLOUVAIN BELGIUM, LLN, 1348.

- MIMO FMCW Radar chip Research in SiGe, BiCMOS at 24, 76-77 GHz Automotive radar .
- Microstrip filter/Mixer measurements on VNA, SA, Singly/doubly balanced. ML/AI for ADAS driver assist cars, regression, clustering, classification, SVM, KNN, ANN, DNN, Deep Learning.

APR 2016 – JULY 2017
RF DESIGNER, ASSISTANT MANAGER
NESCOM, NATIONAL ELECTRONICS COMPLEX OF PAK, ISB, PAKISTAN

- RF Filters, transmitters, amplifiers, radar design. IoT system deployment, IR/MW (Dual tech) sensors for IDS/Access control system.
- Got extensive training in PCB, IoT, RF design.

MY EDUCATION

AUG 2004 – MAY 2009
BACHELOR OF SCIENCE IN ELECTRONICS ENGG, UNIVERSITY OF ENGG & TECHNOLOGY, TAXILA, PK

- Graduated in BSC Electronics Engineering.

AUG 2011 – MAY 2015
MSC ELECTRONICS TELECOMMUNICATIONS UNIVERSITY OF GAVLE, SWEDEN

- Graduated in MSC in RF & Microwave Design, Active/passive components design.

AUG 2019 – AUG 2021
MENG ELECTRICAL ENGINEERING (RF/WIRELESS) TAMPERE UNIVERSITY OF TECHNOLOGY, FINLAND

- Obtained 70/120 ECTS in Advanced wireless communications (5G, 4G, IoT, IoT for wireless, cloud, radar, photonics, C++ and RF circuits.

PROFILE INFO

I am an expert level filters and antenna designer, with in depth skills in filter synthesis and antenna arrays synthesis and simulations in software's such as Nuhertz and Genesys for filter synthesis, Antenna Magnus, CST and HFSS-FeKo for antenna synthesis. I am expert in measurements in VNA, Spectrum analyser, and filter, mixer, amplifiers, antenna measurements.

I studied MSc Electronics-telecom from Högskolan i Gävle, Sweden and Studied 68/120 credits from Tampere University Finland, major in RF & Wireless Communications.

HAMID A. HASSAN

36 YEARS OLD WITH 10 YEARS EXPERIENCED FILTERS-ANTENNA DEISGNER, MICROWAVE-CELLULAR EXPERT FOR MMWAVE, LOT, EMBEDDED, 5G, SATELLITE & RADAR APPLICATIONS.

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+92-317-5268878, 0348-5126330

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Address
VPO Saghri, Jand Attock

RECIPIENT

HOLLIE WEBER, CIS ELECTRONICS ENGINEERING, ANTENNA RF ENGINEER, REMOTE, EUROPEAN RECRUITMENT.

DATE: 12TH ARPIL 2023

RELEVENT SKILLS

EXPERT LEVEL: ADS, HFSS, VNA, SPECTRUM ANALYZER, CST, ANTENNA MAGNUS, NUHERTZ, GNESYS (FILTERS), ALTAIR FEKO, VIVADO..INTEL FPGA.

MEDIUM LEVEL: COMSOL MULTIPHYSICS, FPGA, RTOS, LOT, MQTT, COAP, AWS, CLOUD, DOCKERS, LORAWAN, SIGFOX, NB-LOT, FPGA-VHDL VIRTUALIZATON.

MASTER THESIS

FABRICATION, RF TEST & MEASUREMENTS, SYNTHESIS, DESIGN & SIZE REDUCTION ANALYSIS OF MICRO STRIP HAIRPIN BAND PASS FILTERS USING COUPLED RESONATORS. SYNTHESIS, ANALYSIS & DESIGN OF HIGH-Q FILTERS WITH IMPROVED SELECTIVITY, ANALYSIS OF INTER-RESONATOR SPACING FOR DESIRED COUPLING, RETURN LOSS, AND OUT OF BAND ATTENUATION WITH TRANSMISSION ZEROES.

COVER LETTER

Dear HOLLIE WEBER:

I am excited to submit my application for the **ANTENNA RF ENGINEER, REMOTE, AT CIS ELECTRONICS ENGINEERING,/EUROPEAN RECRUITMENT.**

As a Master's student in Electrical Engineering with a focus on antennas and wireless communications, I am confident that I possess the skills, knowledge and experience that make me a strong candidate for the role.

As a student who is pursuing a Master's degree in Electrical Engineering, with major in RF and wireless communications (4G, 5G, LTE, cloud, Internet-of-things for wireless communications), I have developed an expert level skillset in active and passive components design, expert level skillset in RF measurements and instruments technology at centre of RF measurements and instruments at Högskolan i Gävle,Sweden. Through my years of education, I have developed an in-depth understanding of Electromagnetic Theory, Antenna Theory and Antenna Practice. I have also acquired hands-on experience with EM & circuit simulators such as CST and Optenni Lab, as well as with antenna measurements using VNA and chamber. My academic and research experience have provided me with the skills and knowledge required to excel in Device modelling and simulations, as well as in the analysis of technical publications.

In addition to my technical skills, I possess excellent communication skills in English, and I am a team player with the ability to work effectively in an international team. I am eager to learn from senior experts in the field and I am confident that this internship will help me to develop my skills and competences in the mobile industry.

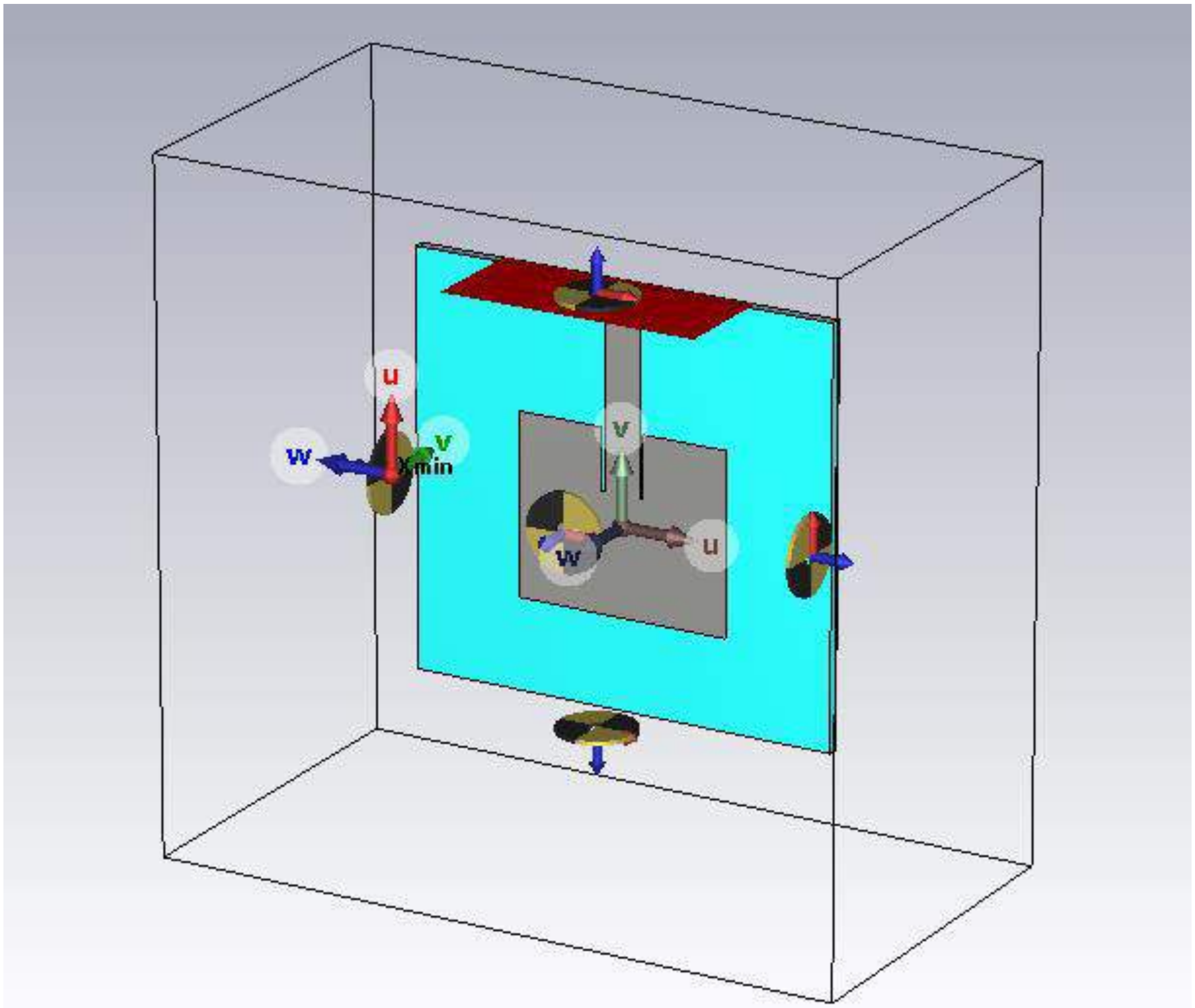
I am particularly drawn to the opportunity to work as ANTENNA RF ENGINEEAR AT CIS ELECTRONICS ENGINEERING, as high Tech Solution provider, a globally competitive organization in Electronics, FPGA and PCB design solutions providers, RF and MM-WAVE solutions, wireless Iot, RF and Microwave Design solutions and leader in Global RF Electronics, Microwave and Wireless Solution Providers. I am confident that the working environment and the mentorship from senior experts will provide me with the exposure and experience necessary to excel in my career. I am available to start the internship in May and I am excited about the opportunity to contribute my skills and knowledge to MCIS ELECTRONICS TEASM team as an EXPERT Antenn/RF Engineer (MILLIMETERWAVE/ Medium-High Frequency).

Thank you for considering my application. I am looking forward to hearing from you.

Yours faithfully,
Hamid A. Hassan

hamid A. hassan

5G Antenna Design for 25 GHz center Frequency (Patch Antenna with Feed inset from edge of patch).



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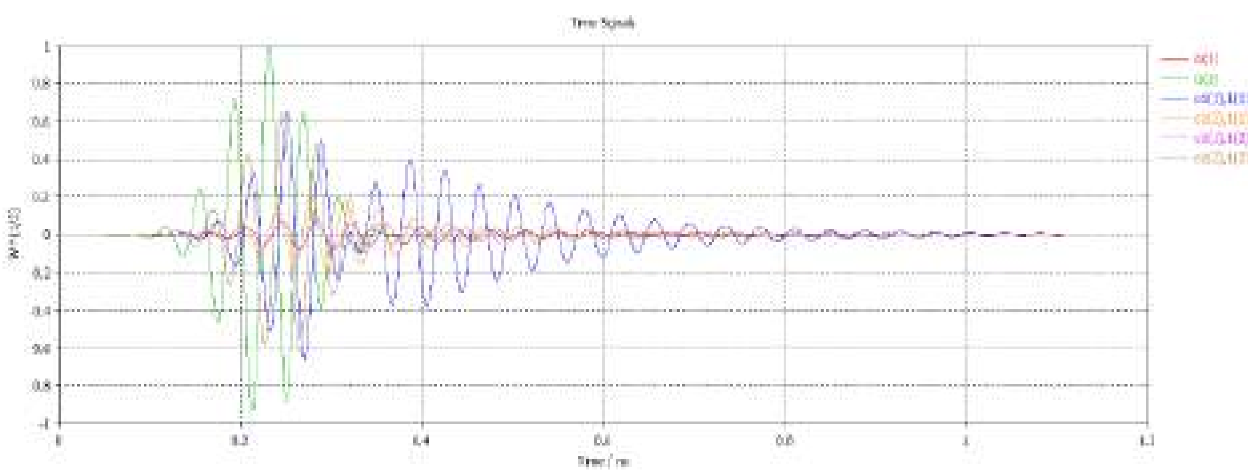

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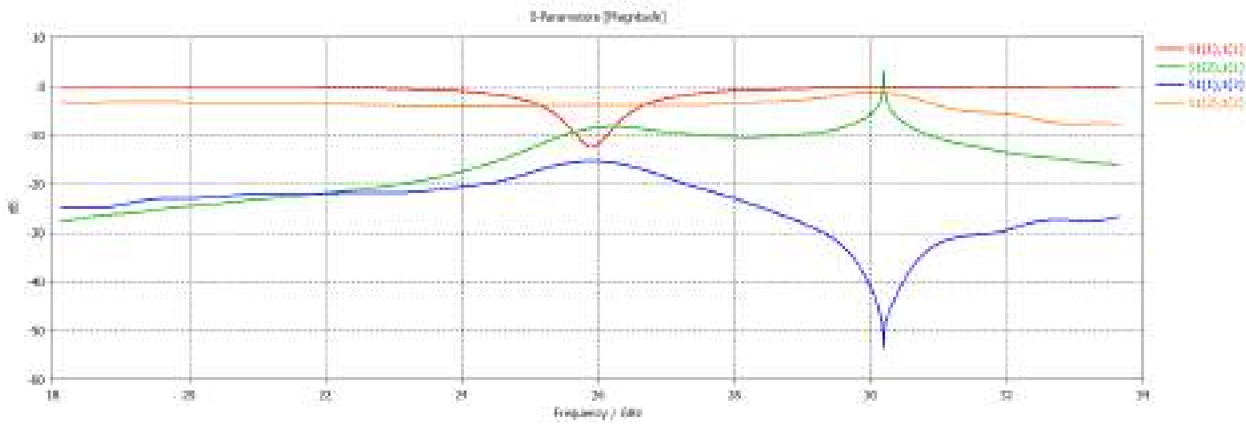

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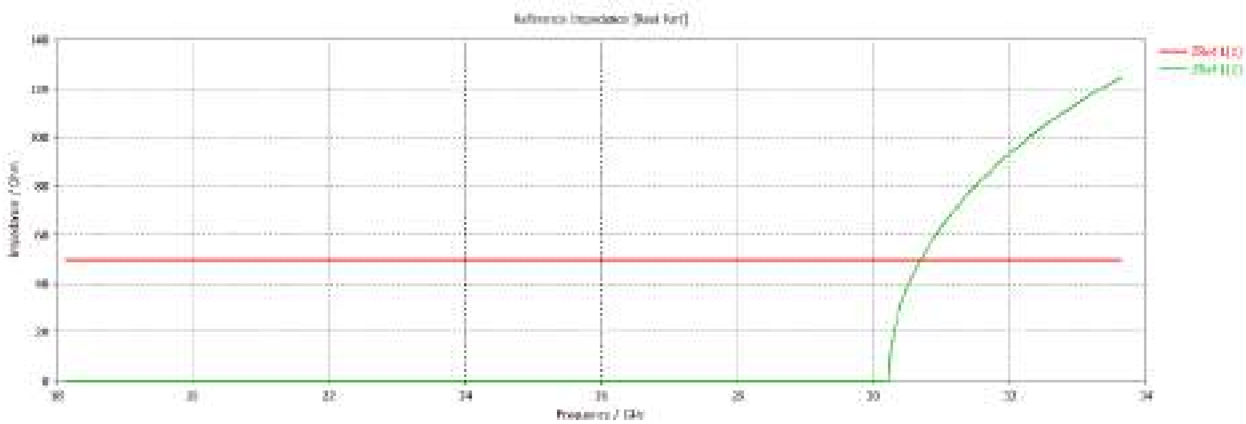

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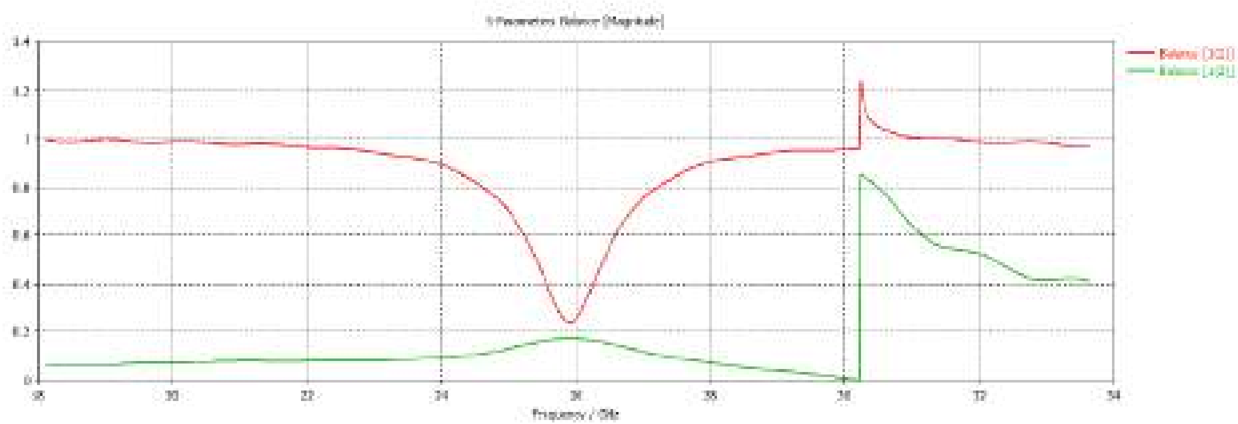
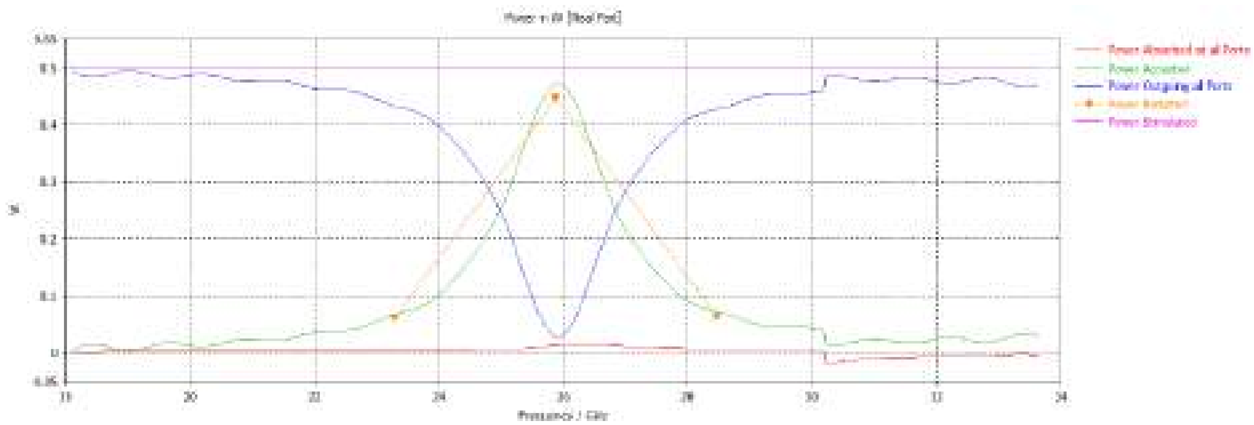
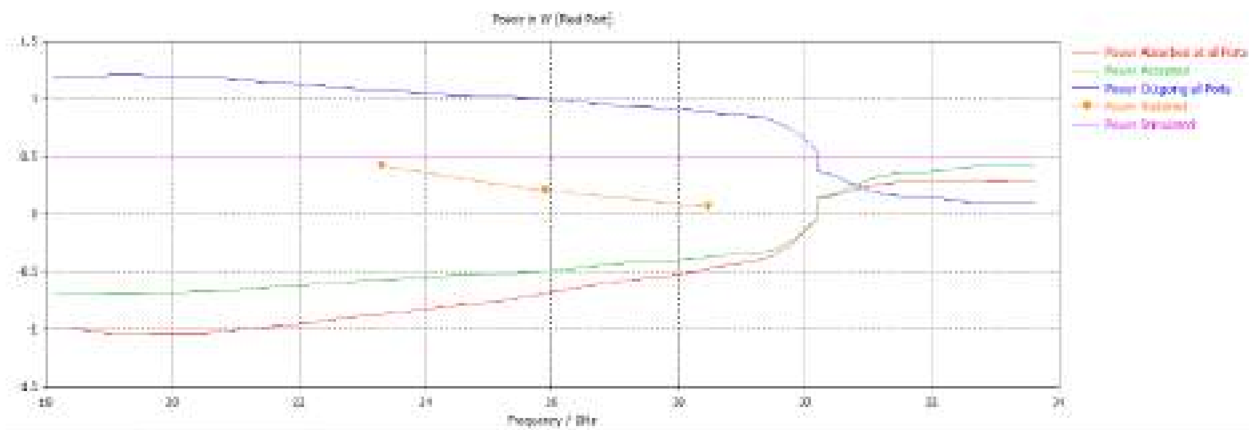


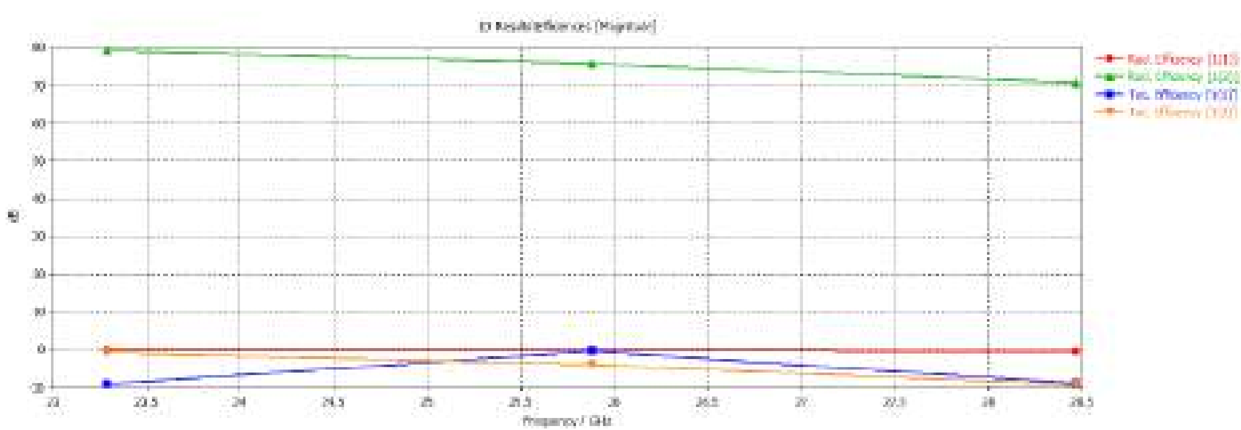
Excitations [1(1)]:



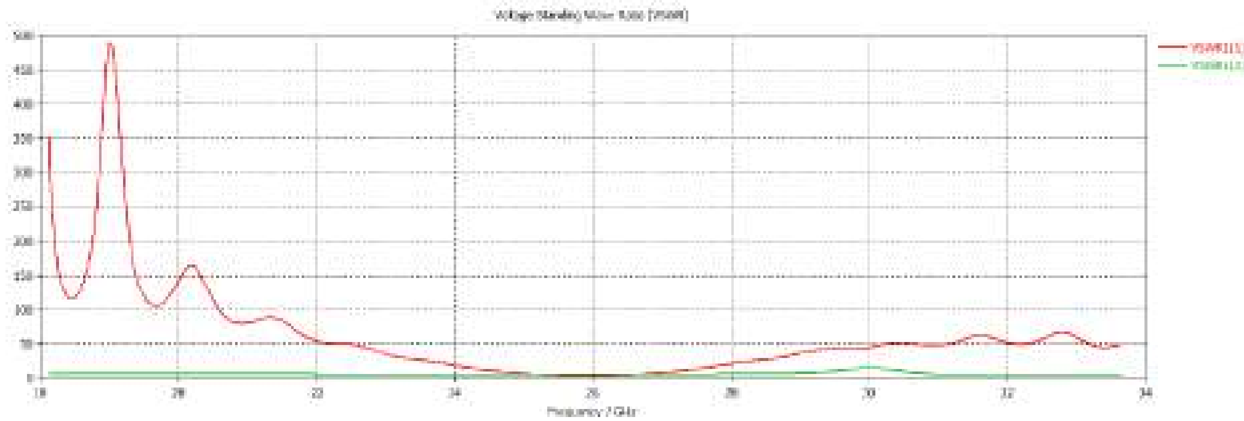
Excitations [1(2)]:



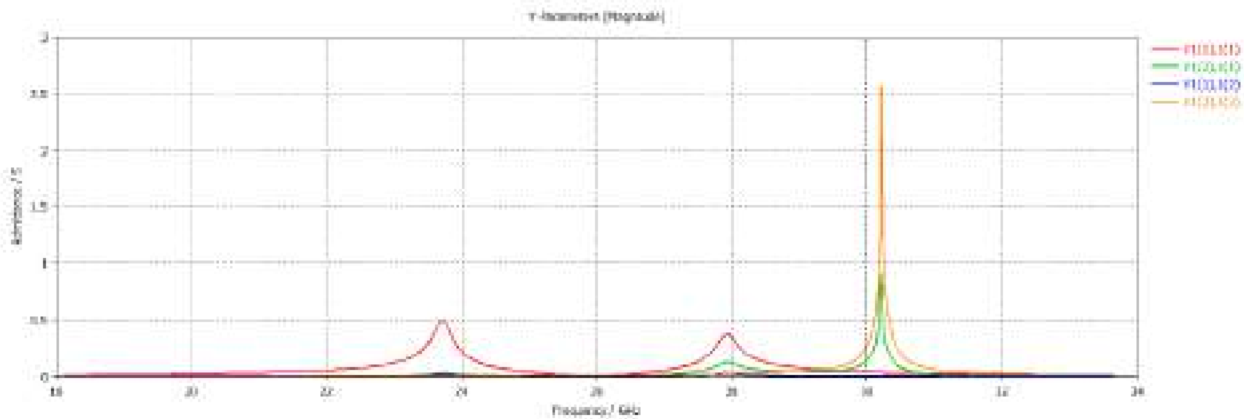
Efficiencies:



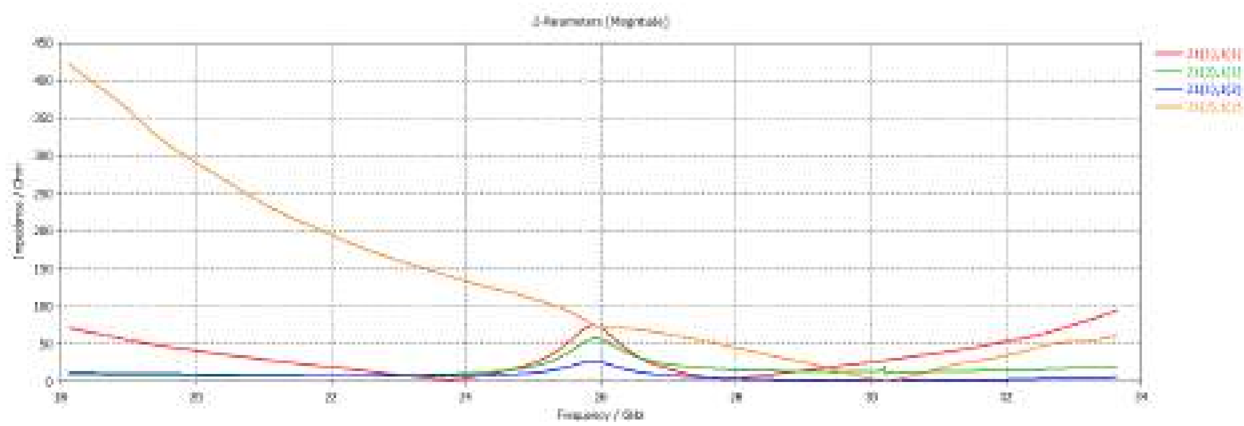
VSWR:



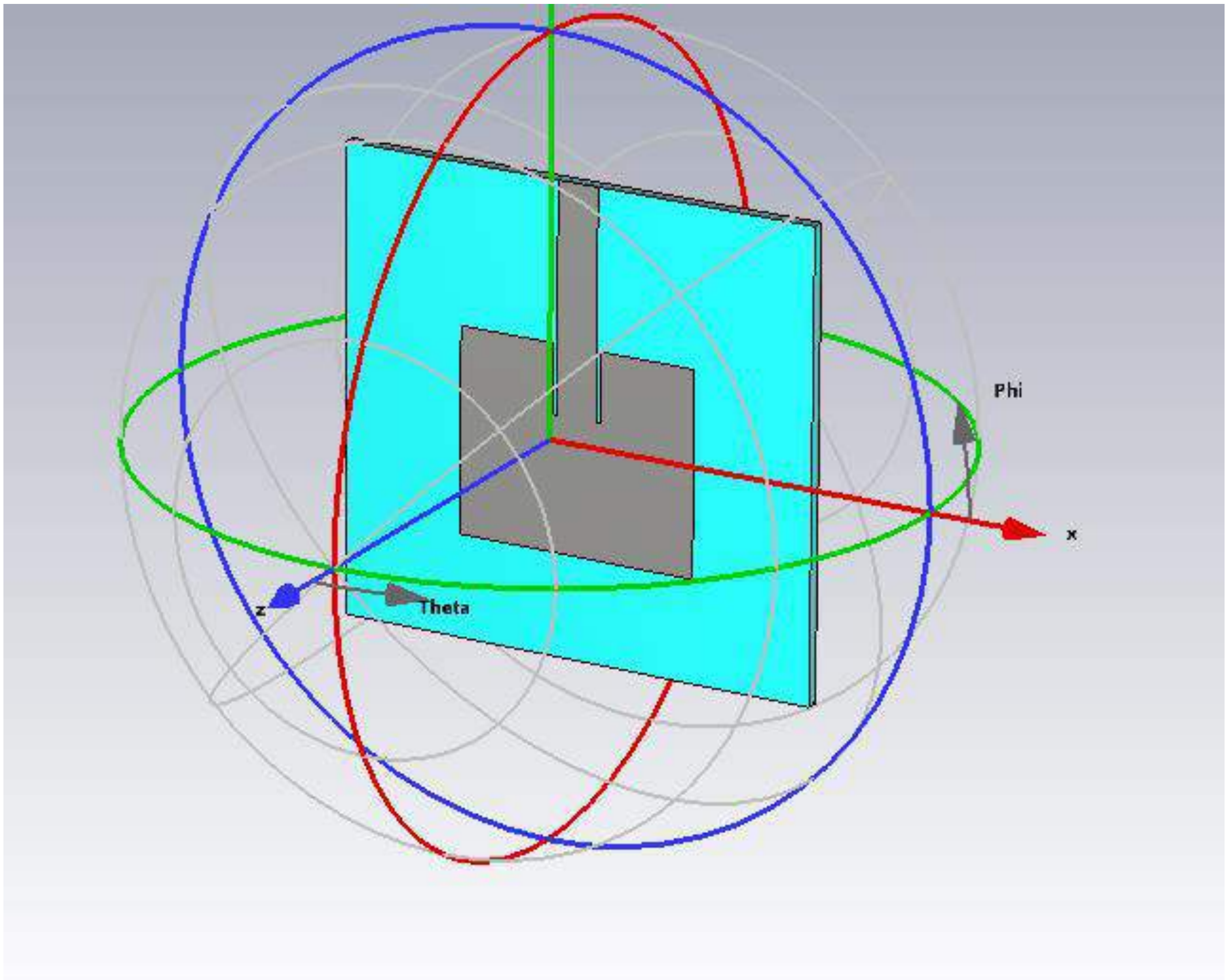
y-Matrix:

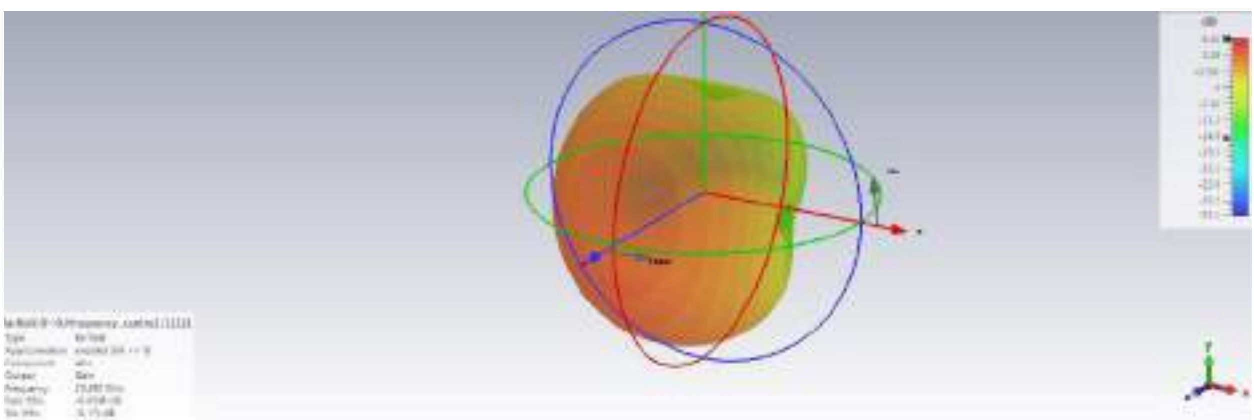


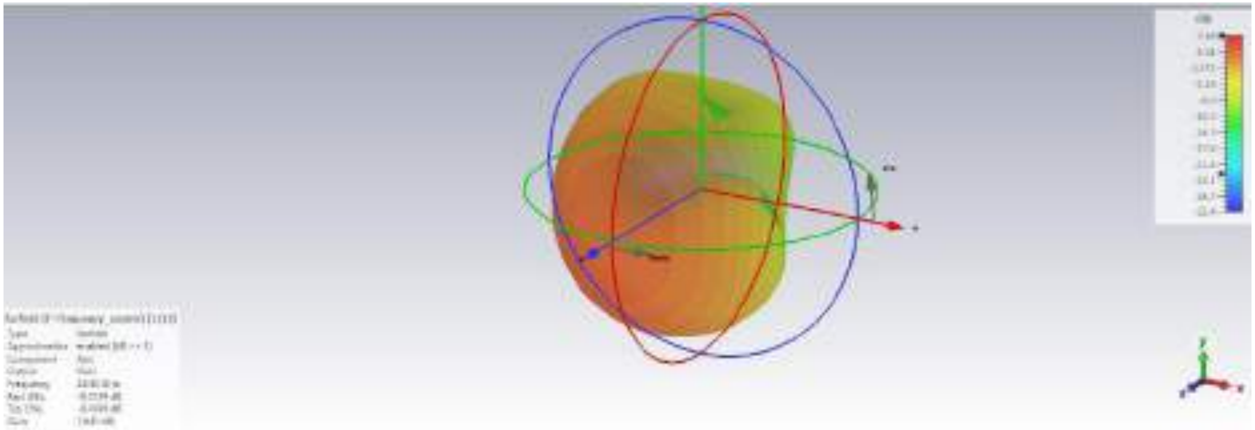
Z-Matrix:

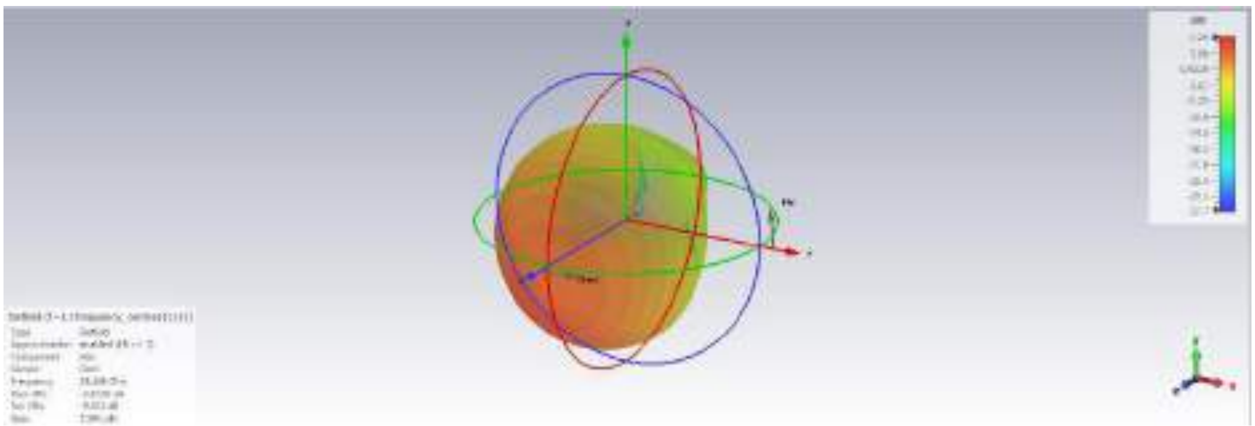


Far fields:


Phi
x
z
Theta





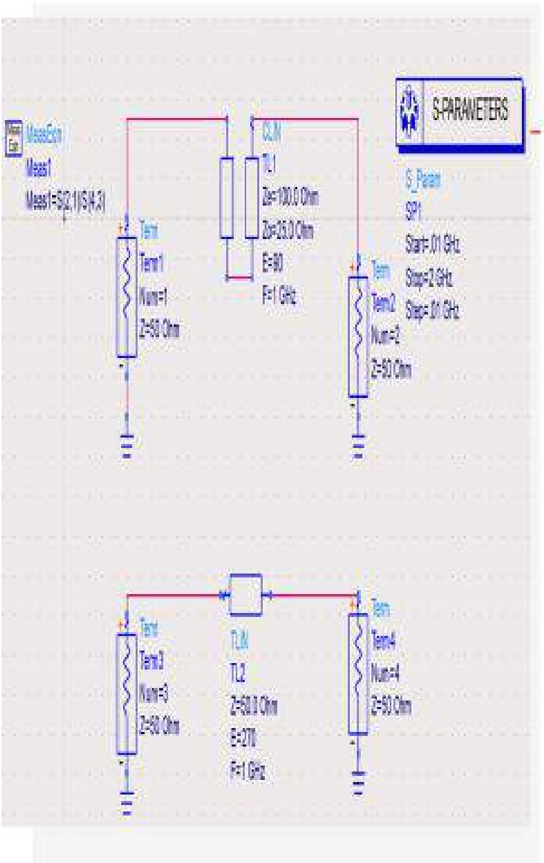


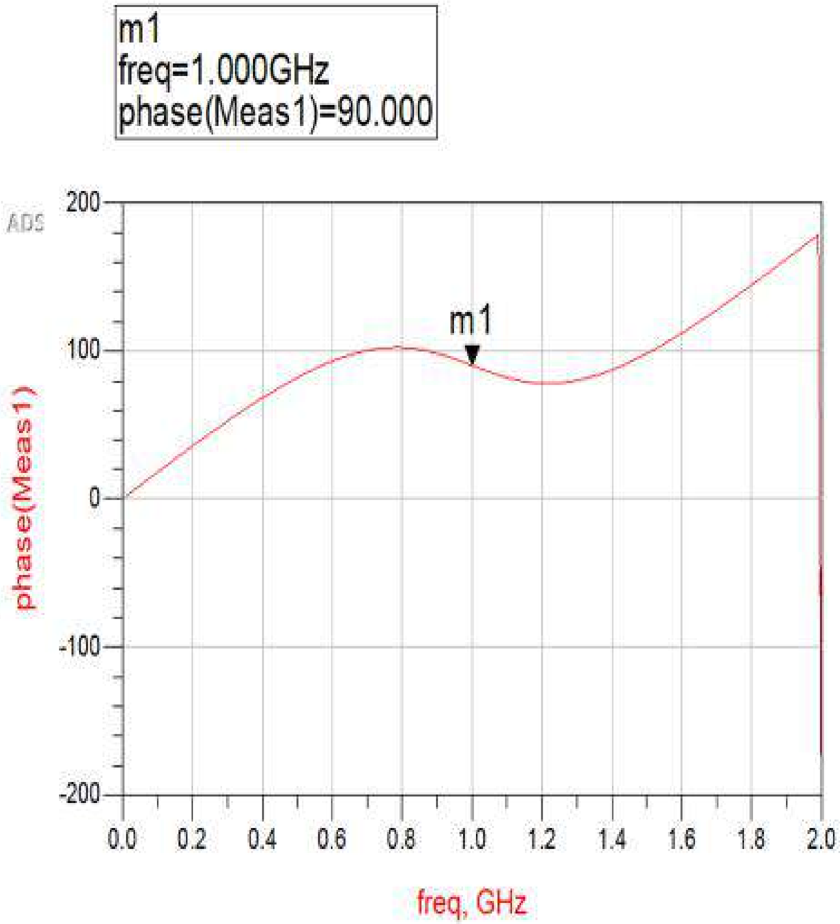
RF Circuit Design in ADS and Antenna Design in HFSS:

Designer: Hamid Ali Hassan

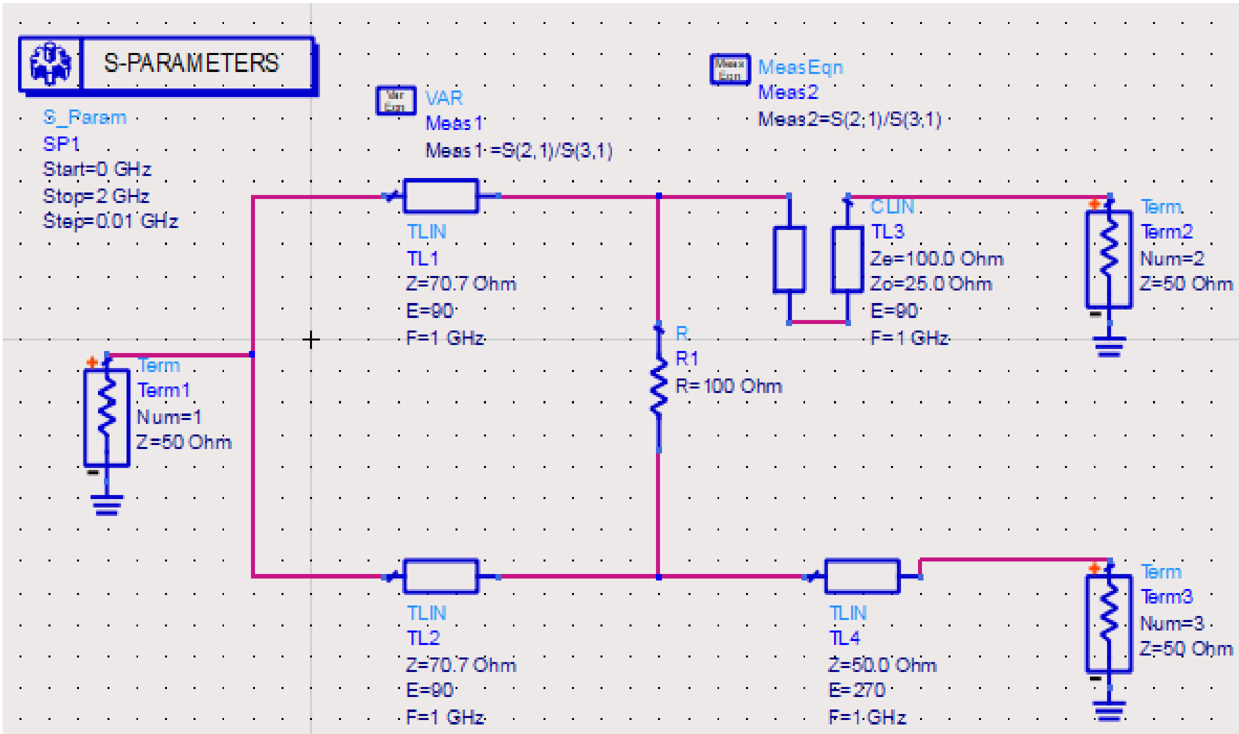
Research Associate (RF Engineer), Institute of Space Technology, Islamabad, Pakistan.

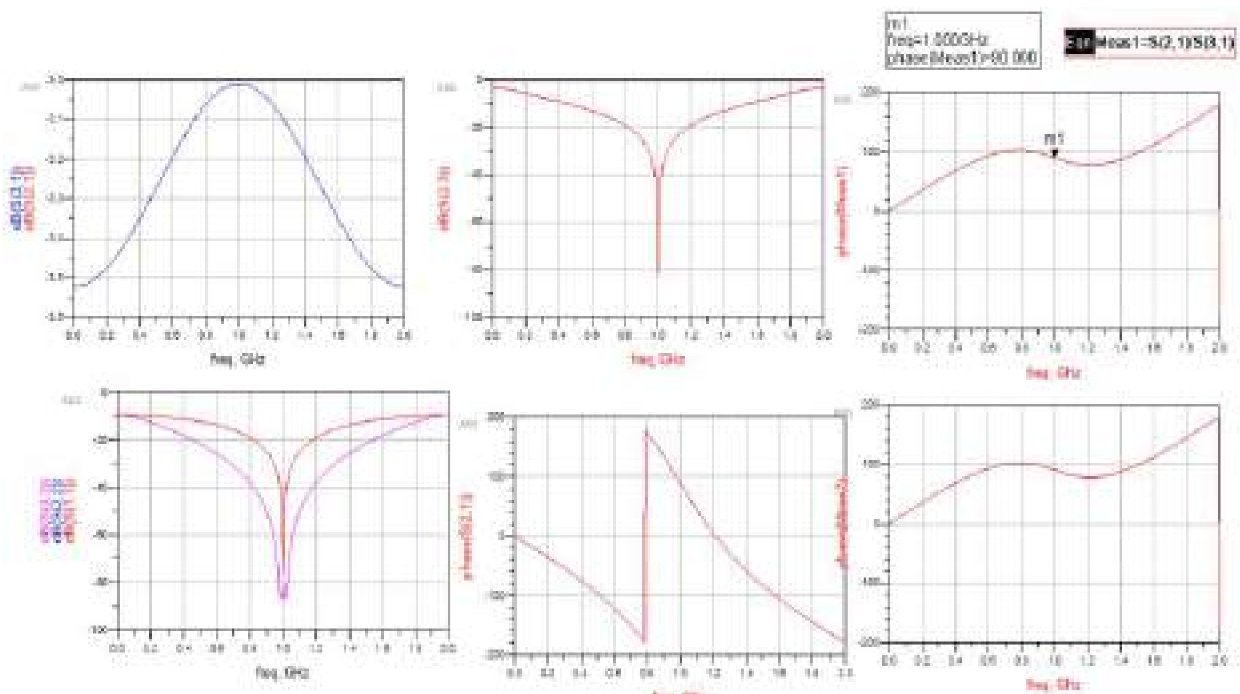
90-degree Planar Phase shifter Design in ADS:



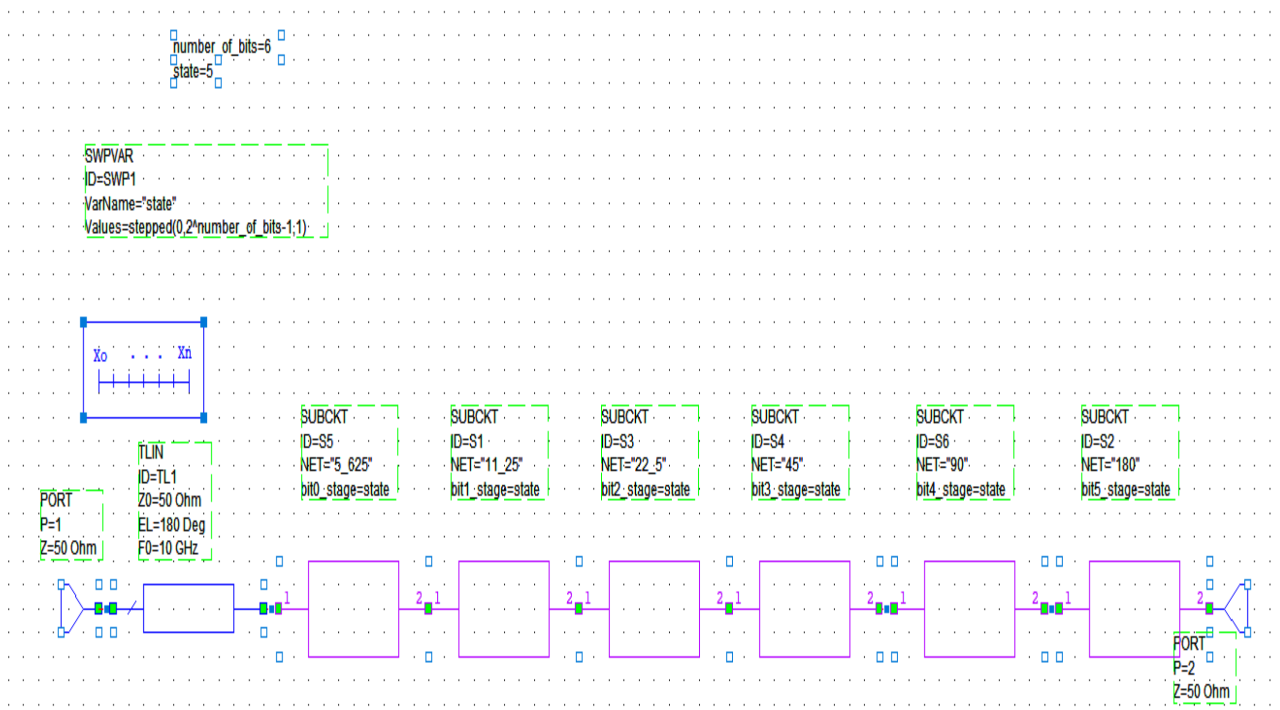


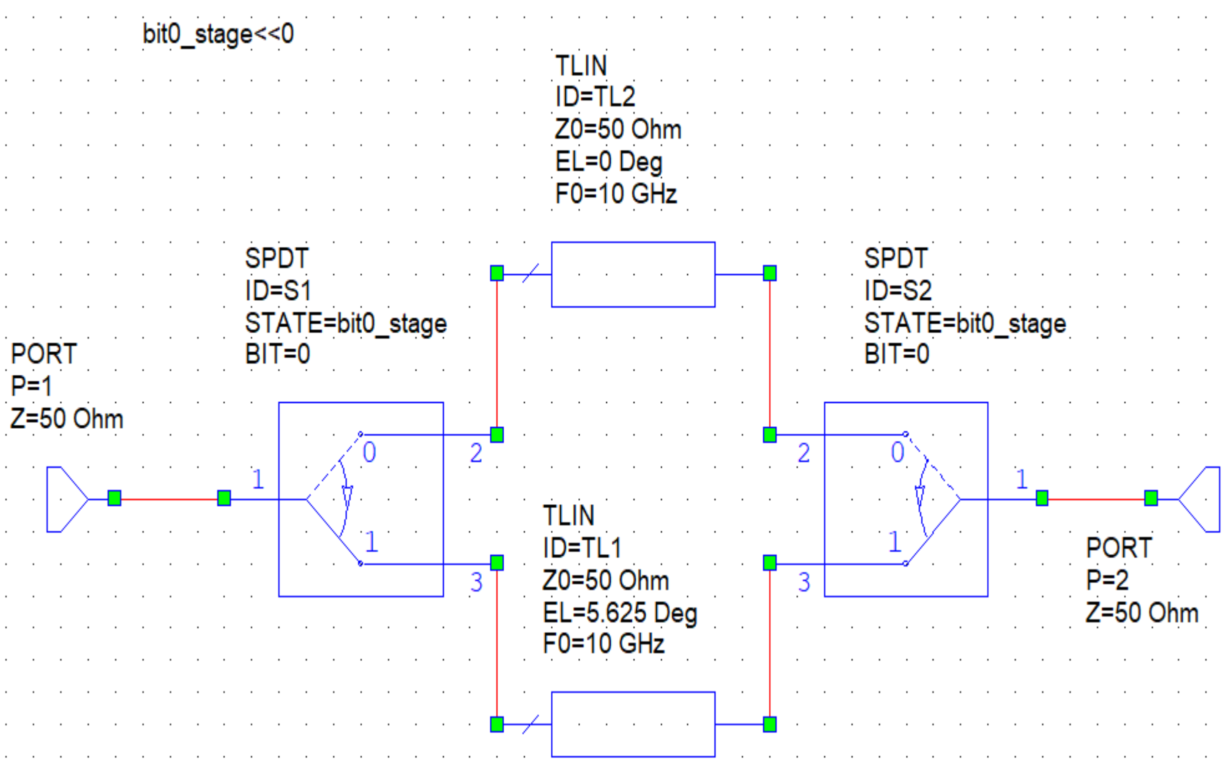
90-degree Planar Phase shifter Design in ADS WITH Power Combiner:

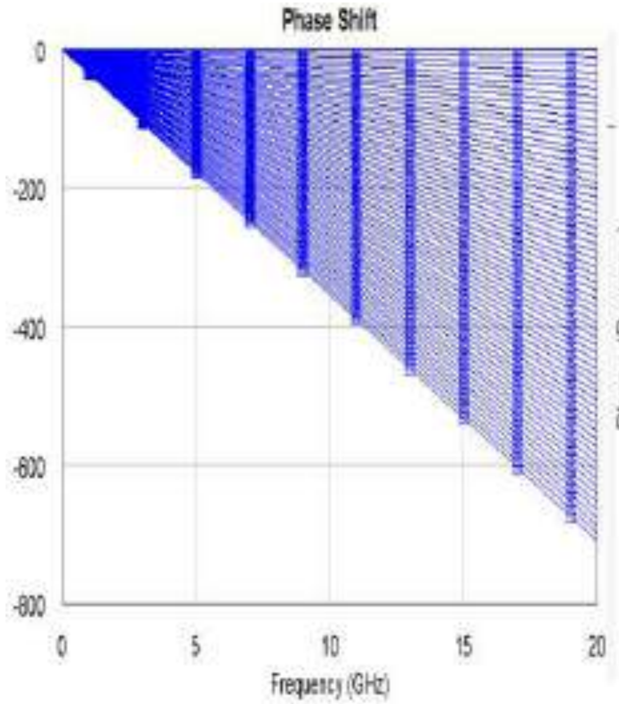

S-PARAMETERS
S_Param
SP1
Start=0 GHz
Stop=2 GHz
Step=0.01 GHz
VAR
Meas1
Meas1=S(2,1)/S(3,1)
MeasEqn
Meas2
Meas2=S(2,1)/S(3,1)
TLIN
TL1
Z=70.7 Ohm
E=90
F=1 GHz
CLIN
TL3
Ze=100.0 Ohm
Zo=25.0 Ohm
E=90
F=1 GHz
Term
Term2
Num=2
Z=50 Ohm
Term
Term1
Num=1
Z=50 Ohm
R
R1
R=100 Ohm
TLIN
TL2
Z=70.7 Ohm
E=90
F=1 GHz
TLIN
TL4
Z=50.0 Ohm
E=270
F=1 GHz
Term
Term3
Num=3
Z=50 Ohm

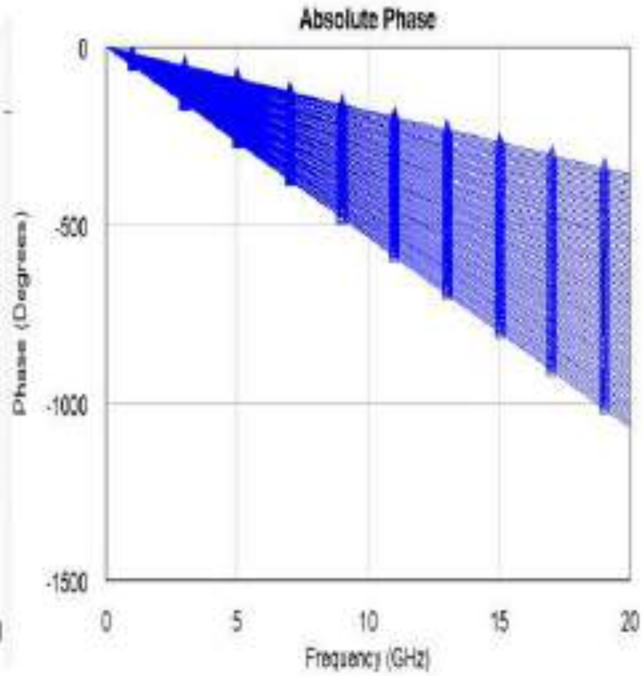

m1
freq=1.000GHz
Meas1=S(2,1)/S(3,1)
freq, GHz

6-Bit Phase Shifter in AWR Design Environment:

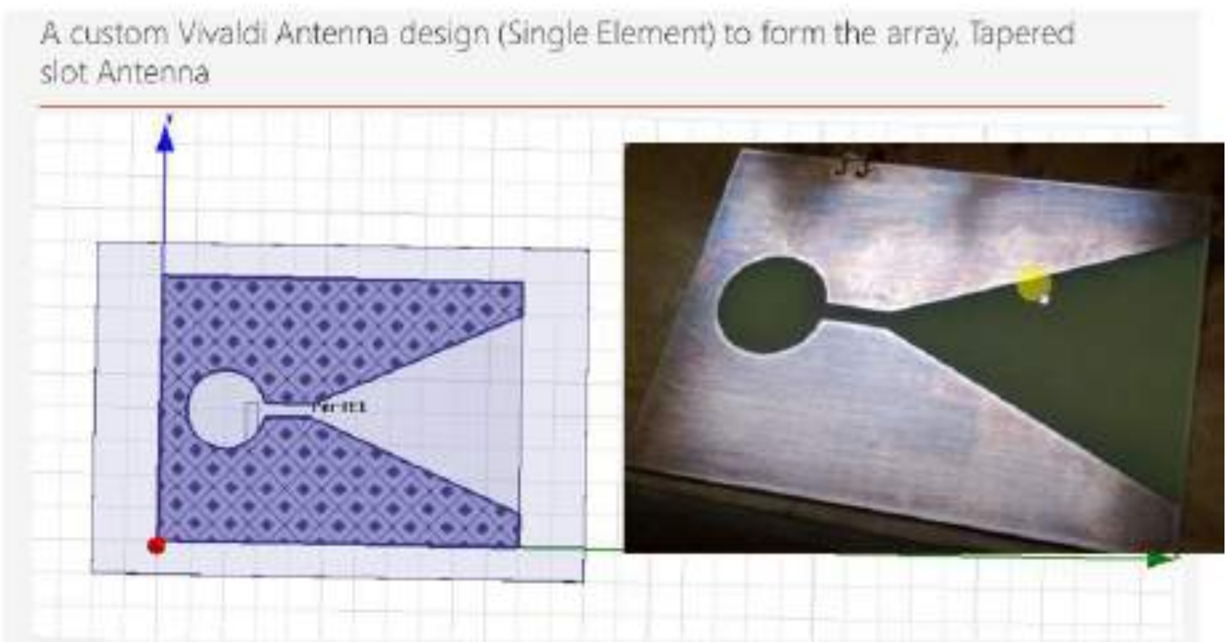




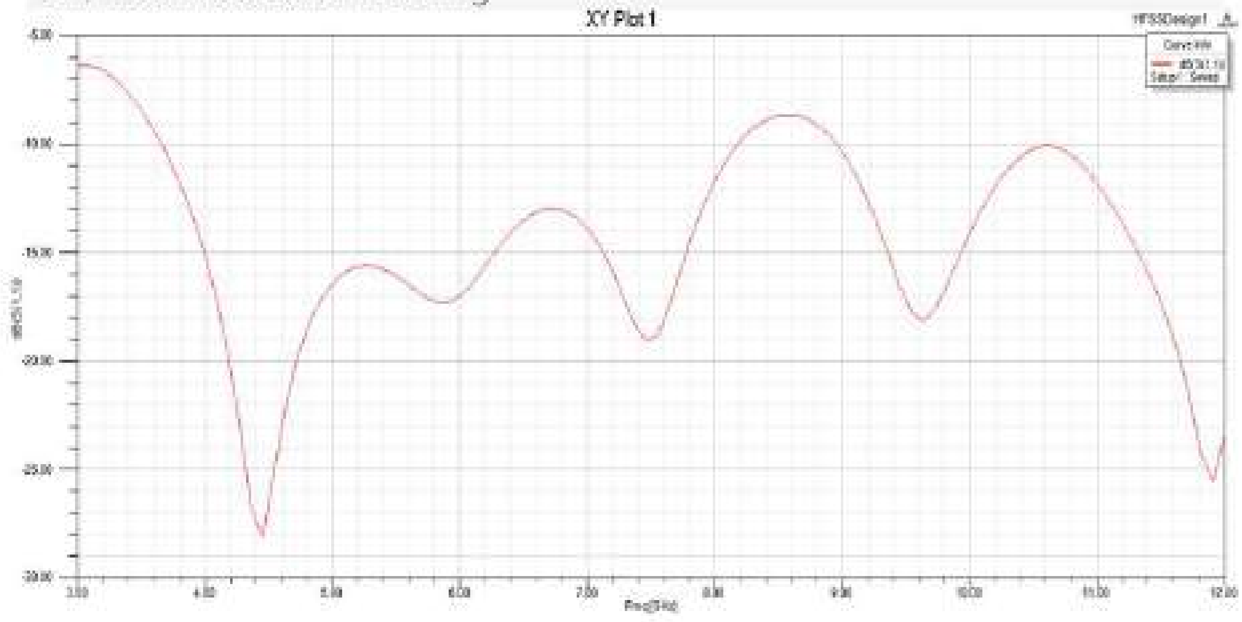




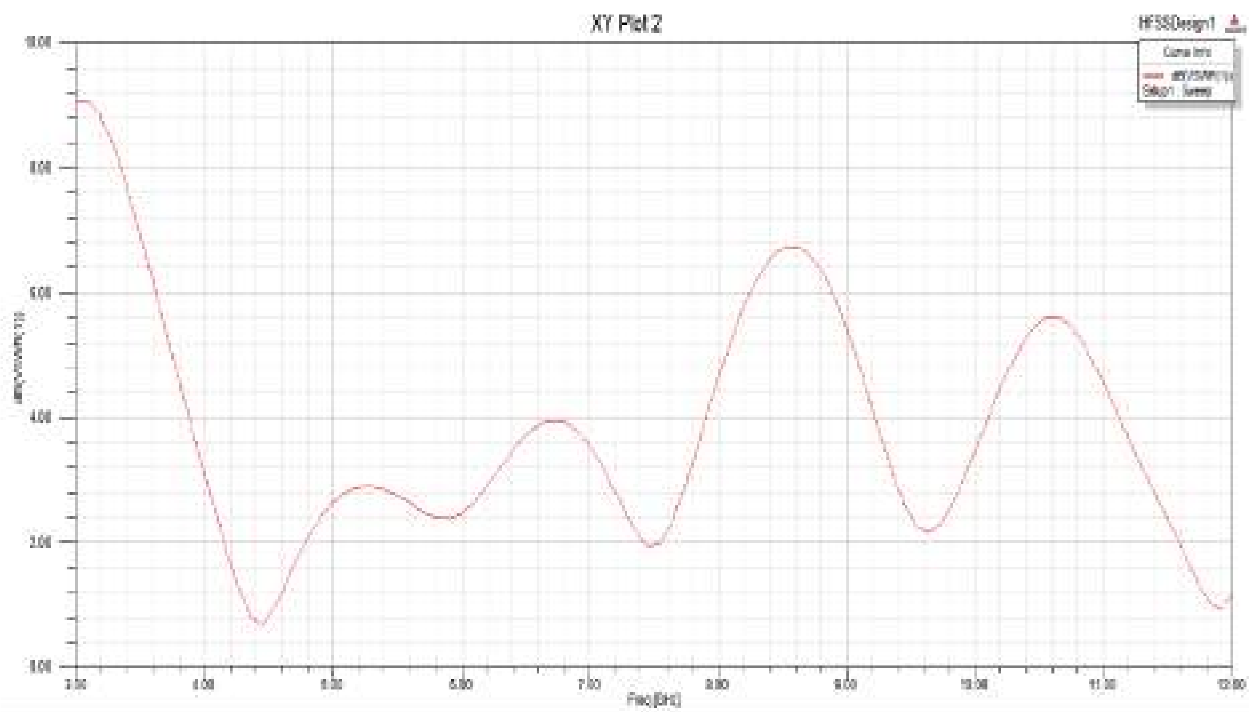
A custom Vivaldi Antenna design (Single Element) to form the array, Tapered slot Antenna



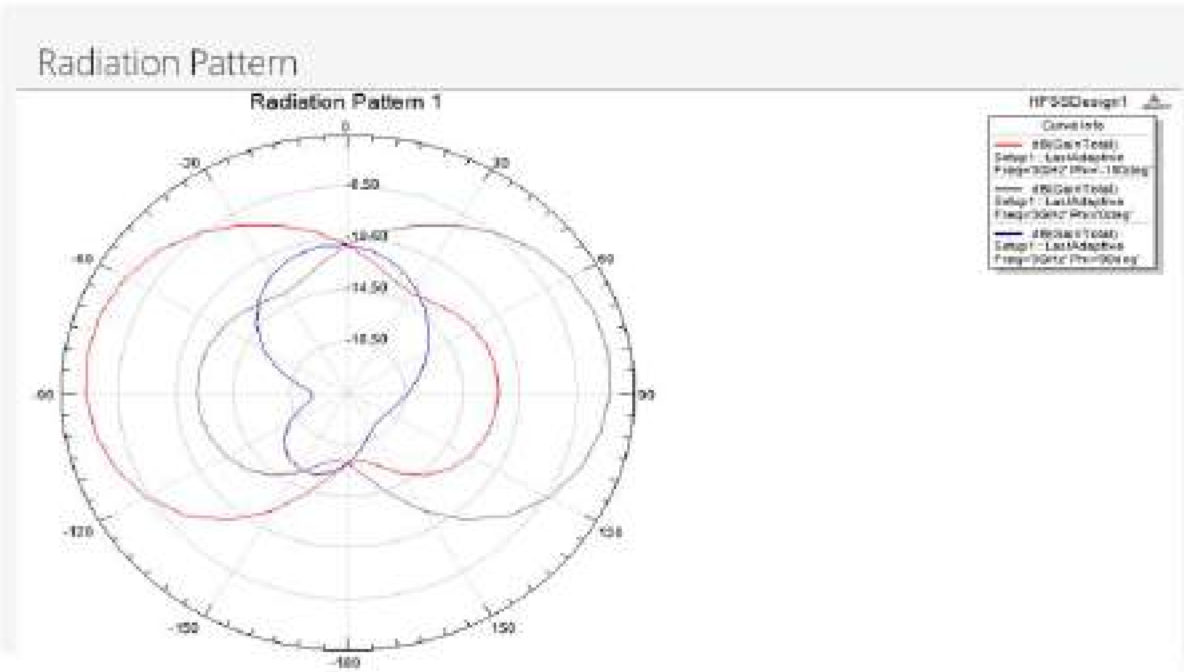
S11, Return loss and Matching

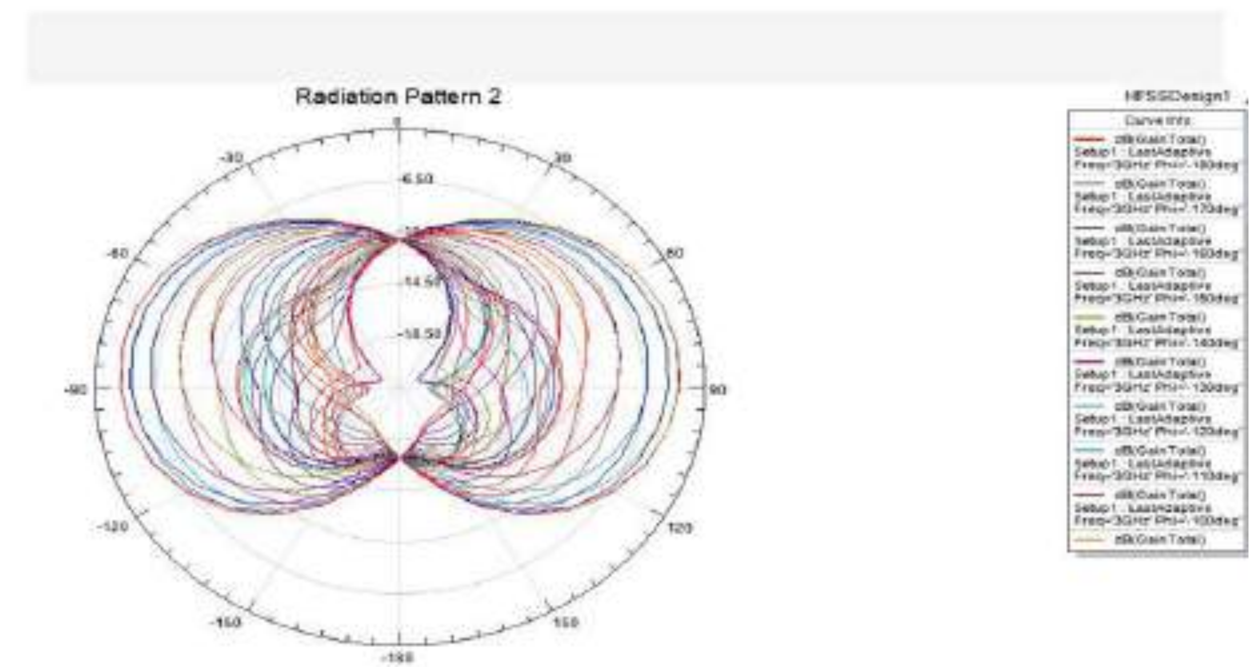


VSWR:

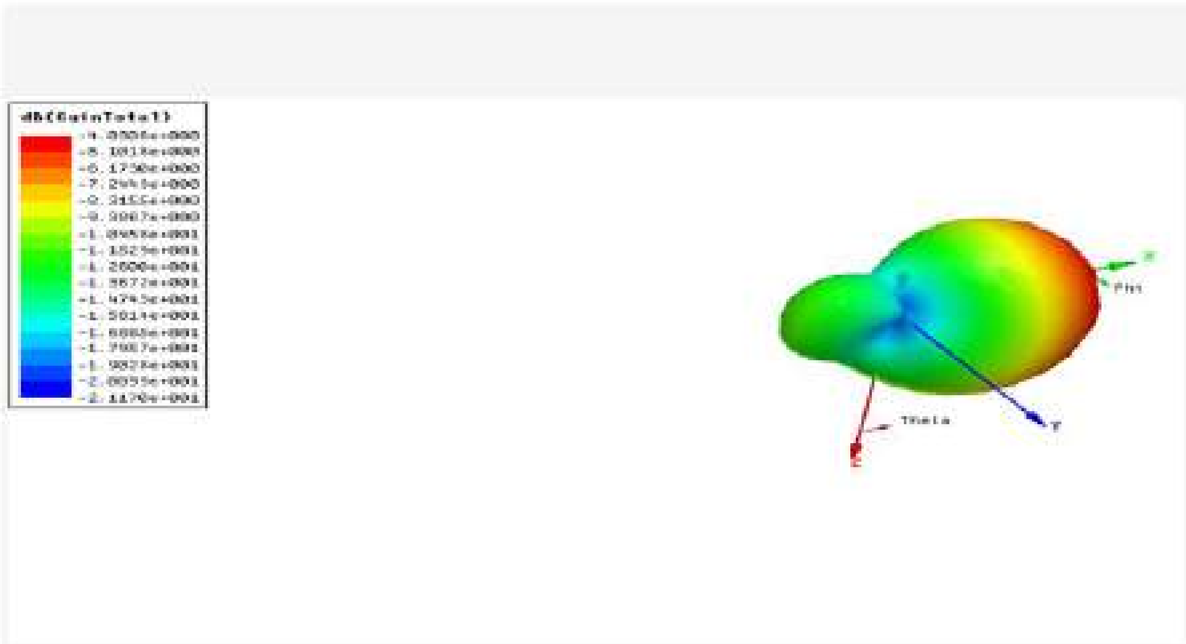


Radiation Pattern:

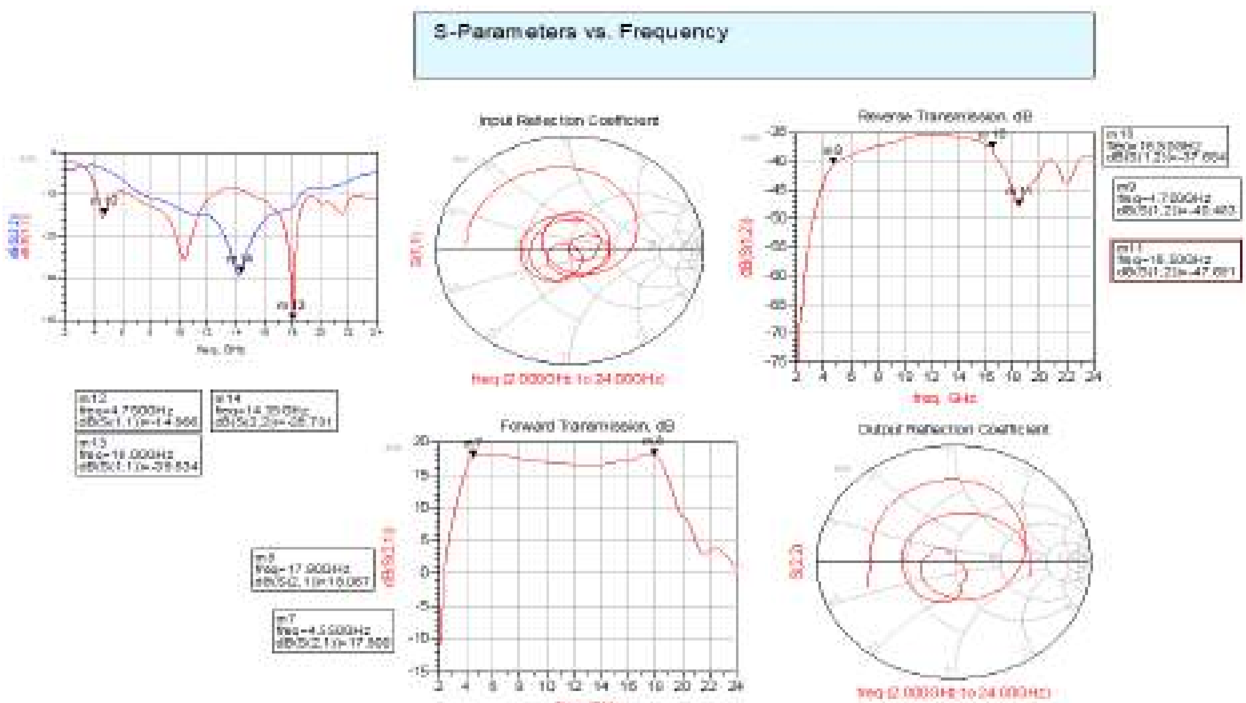




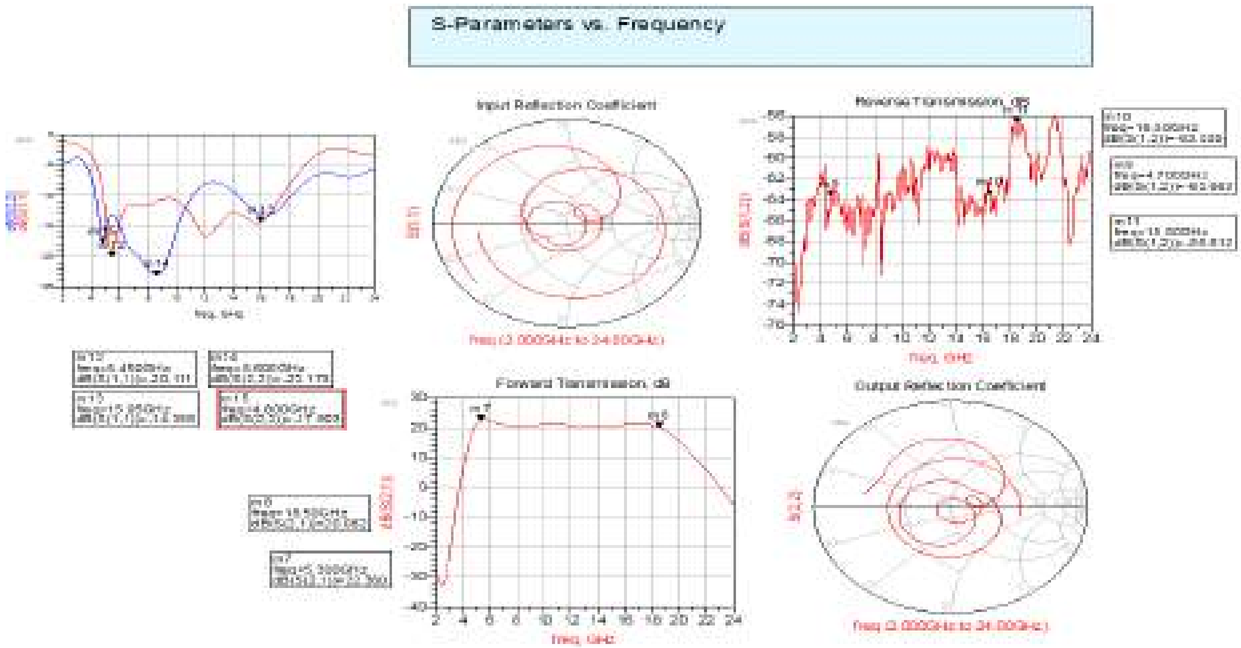
3D Radiation Pattern:



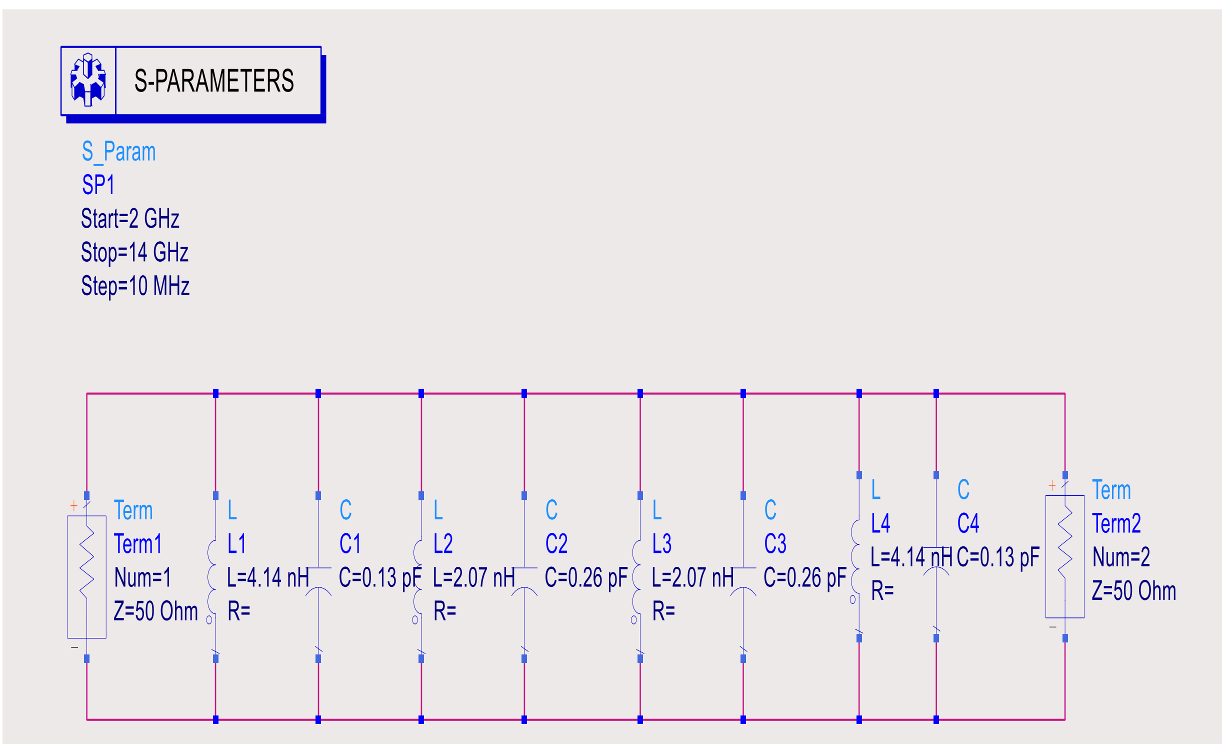
S-Parameters verification of ADTR 1107 Receiver side

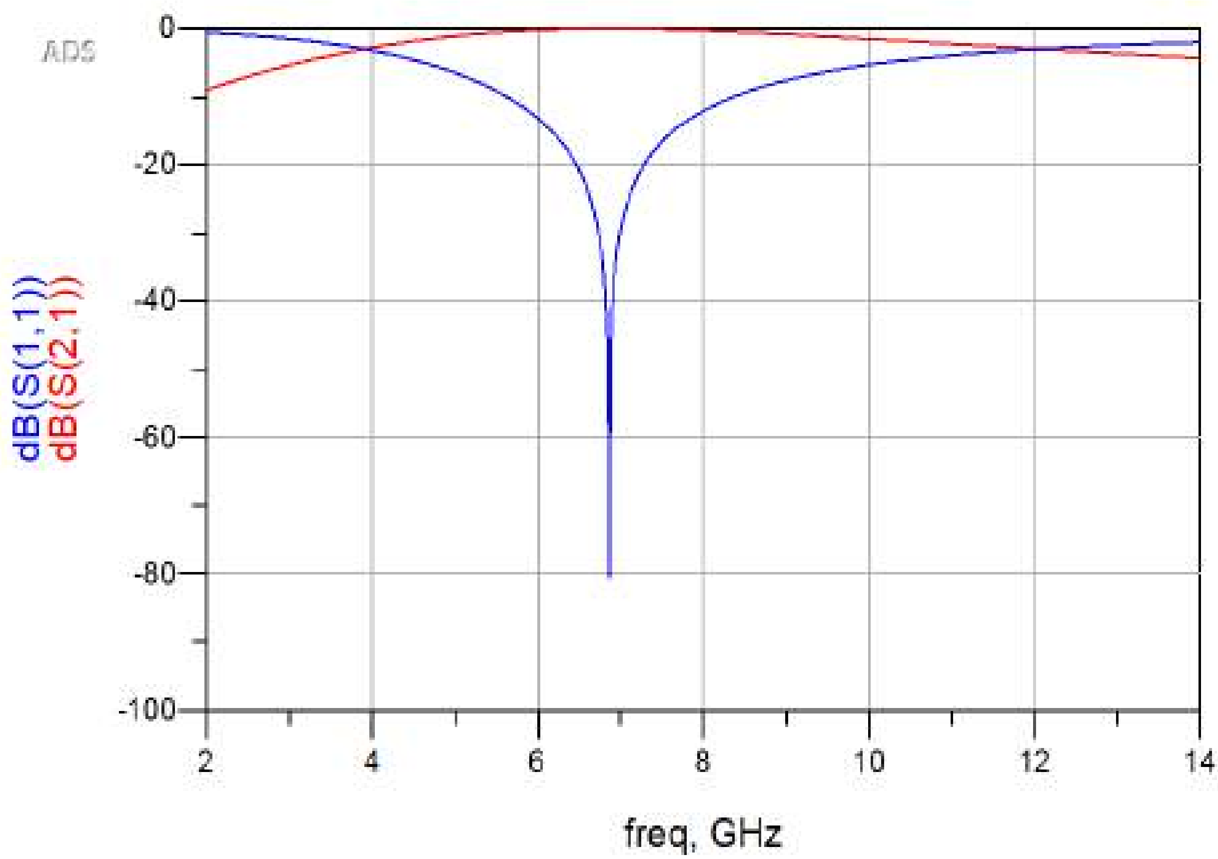


S-Parameters verification of ADTR 1107 Transmitter side

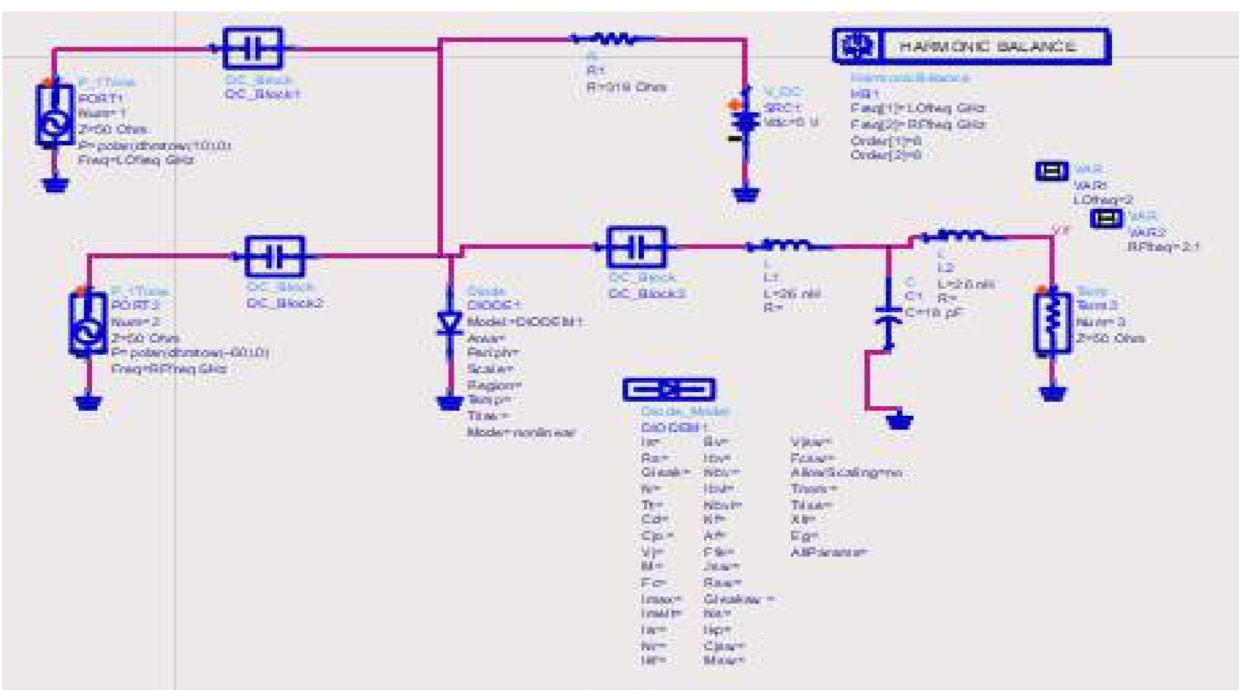


Broadband Filter Design (Lumped Components):

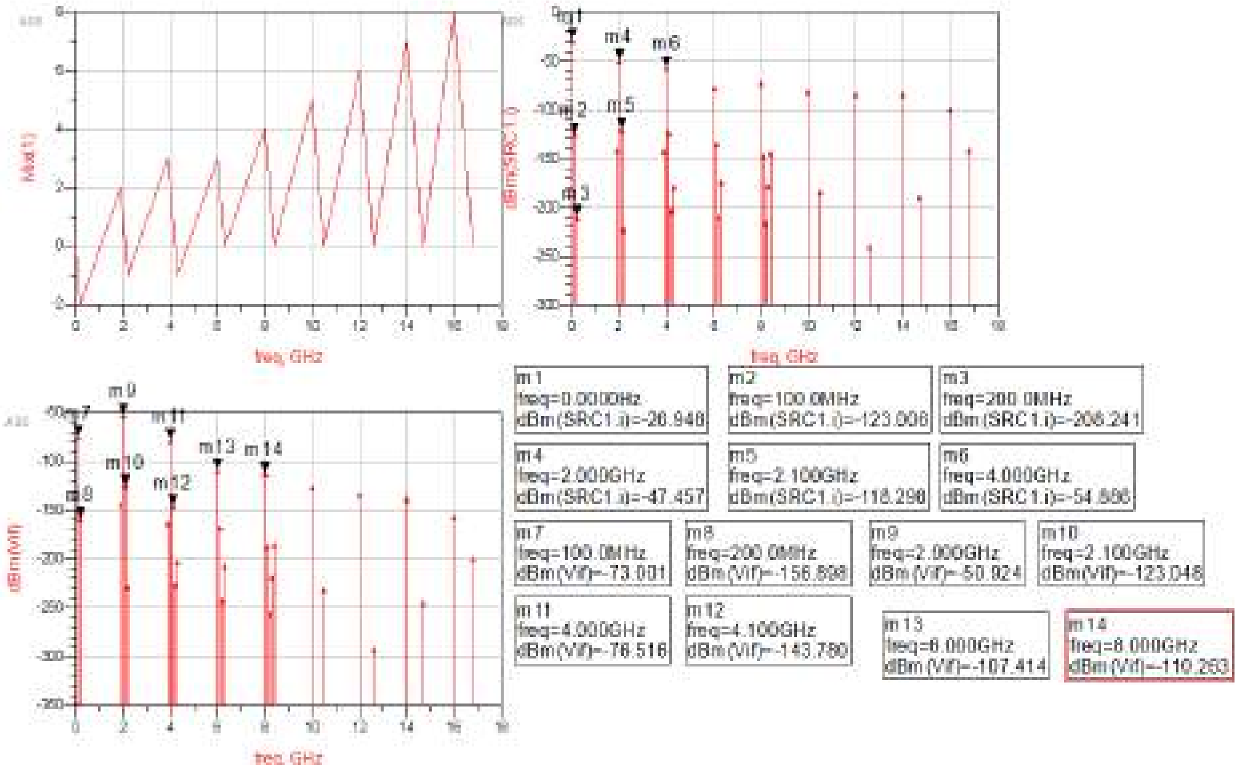




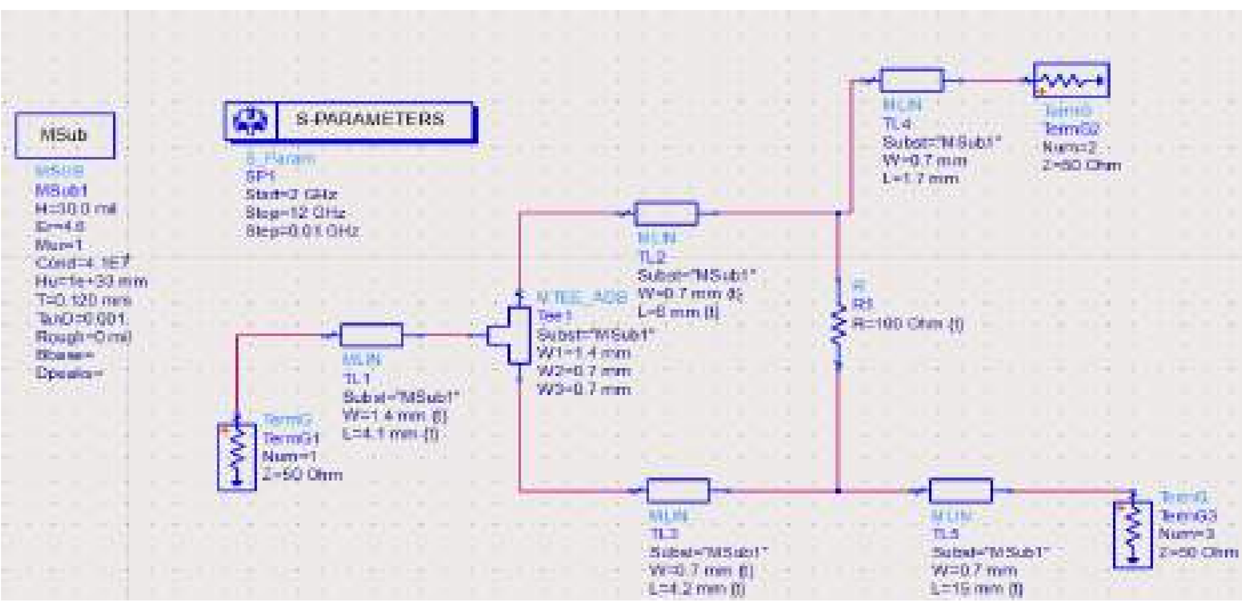
A Generic Mixer Circuit Design in ADS.

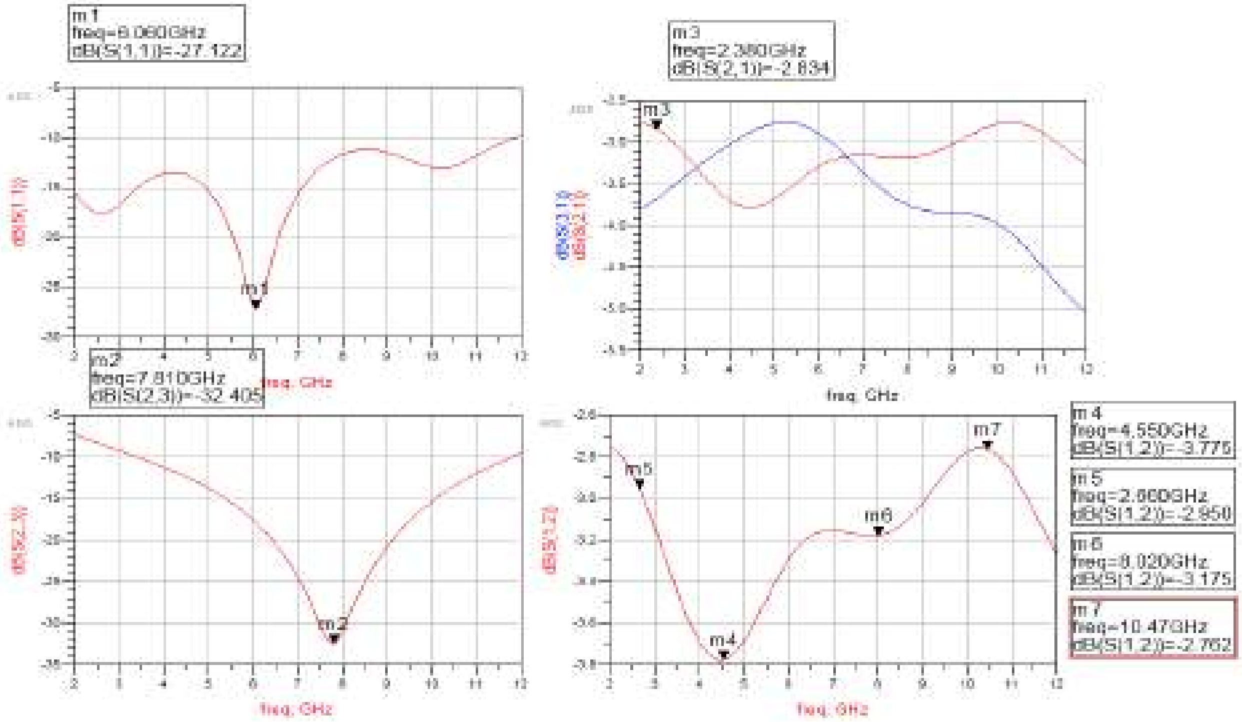


Results of Mixer Design in ADS:



Wilkinson Power Divider from 2-12 GHz in ADS




m1
freq=6.060GHz
dB(S(1,1))=-27.122
m3
freq=2.380GHz
dB(S(2,1))=-2.834
m2
freq=7.810GHz
dB(S(2,3))=-32.405
m4
freq=4.550GHz
dB(S(1,2))=-3.775
m5
freq=2.660GHz
dB(S(1,2))=-2.950
m6
freq=8.020GHz
dB(S(1,2))=-3.175
m7
freq=10.47GHz
dB(S(1,2))=-2.762
freq, GHz

Antenna engineering – lab report

Design, simulation and measurement of antennas

Hassan. Hamid Ali(861218-T670)

02 April 2012

Abstract

In this laboratory report, a brief description of measurement of Pyramidal horn antenna, dipole being most widely used antenna and most importantly, a small size low profile design of slot feed micro strip patch antenna is proposed at a frequency of 2010 MHz

For Horn Antenna, Radiation measurement setup is formed, for dipole, two dipole were designed to study gain and radiation pattern measurements with respect to frequency. VNA is used to study frequency variation for dipole antenna.

Micro strip patch is designed in HFSS (high frequency structural simulator) & and different parameters like return loss, VSWR, gain along Θ, Ø directions, radiation pattern in 2-D and 3-D, are studied. All of simulation parameters study is done using HFSS 13.0.

The measured parameters satisfy required limits hence making the proposed antenna suitable for Desired frequency.

Table of Contents

List of figures

1. Introduction

The purpose of this laboratory work is to gain experience in the manufacture, measurement and simulation of antennas. From this specification the following sections will be covered in this report:

- The horn antenna,
- The half-wave dipole antenna,
- And the slot-feed micro-strip patch antenna.

The section on the horn antenna discusses antenna measurements; the section on the half-wave dipole antenna discusses the basic wire antenna design; and the section on the slot-feed micro-strip patch antenna discusses the simulation of an antenna using Ansys High Frequency Structural Simulator (HFSS).

2. Horn antenna

2.1 Background

The horn antenna has been widely used in many applications since its discovery in the late 1800s. These applications include large radio astronomy, satellite tracking and communications where the horn is used as the feed element for the reflectors and lenses. The horn antenna is also used as a universal standard for the calibration and gain measurements of high-gain antennas. This is due to the simple construction and excitation, good performance, large gain and versatility of the horn antenna. [1]

Various types of horn antennas exist, such as the E-plane, H-plane, conical, and pyramidal horns. In this section only the pyramidal horn, as can be seen in Figure 2-1, will be investigated. The pyramidal horn consists of a waveguide that has been flared to a larger opening. The type direction and amount of flare determines the performance of the antenna.

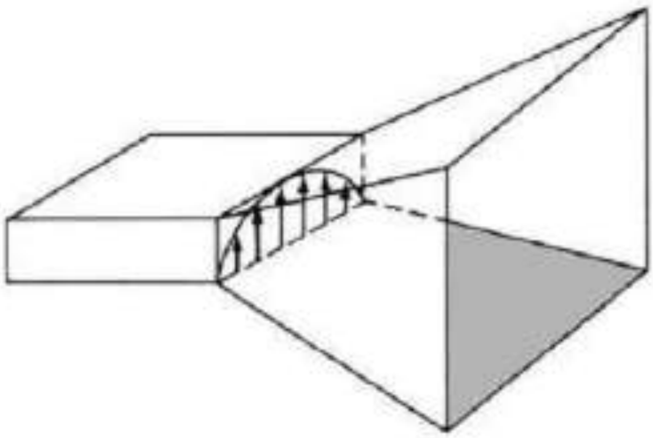


Figure 2-1 Pyramidal horn antenna [1]

This section will cover the basic theory and calculations needed, the measurements performed, and a discussion of the results. The goal of this section is to investigate the characteristics of the horn antenna, and to gain experience in the measurement of antennas.

2.2 Theory and calculations

For this assignment the characteristics of the horn antenna that will be investigated, are the radiation pattern and the gain as determined by the IEEE standard on test procedures for antennas [2].

The radiation pattern is determined in the far-zone field by using the setup presented in Figure 2-2. From this setup it can be seen that the modulator and power source are used to generate the power that will be transmitted. The klystron is then used to convert this power to convert the power in to the electric and magnetic waves that will be used to transmit the power across the air from the transmitting antenna to the receiving antenna. The variable attenuator is used to ensure that the transmitted wave has the desired amplitude and frequency. The ferrite isolator is used to minimise the reflection loss between the source and the antenna to eliminate damage to the equipment. The receiving antenna is connected to a power meter to note the power delivered to the load.

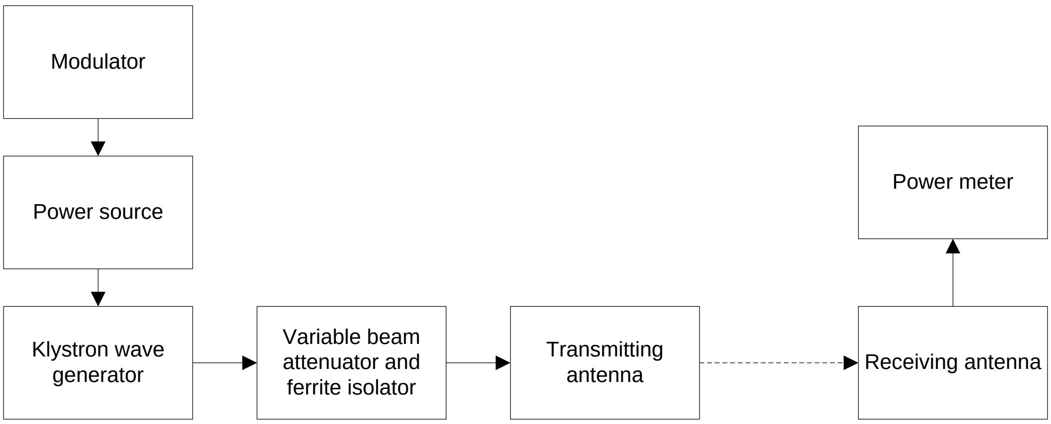


Figure 2-2 Horn antenna radiation pattern measurement setup

The transmitting and receiving antennas are the same to reduce the losses in the system. Thus, by using the same type of antennas on the same elevation the effects of polarisation are minimised. Due to reciprocity the characteristics of the transmitting and receiving antennas are the same. The radiation of the horn antenna is measured by keeping the transmitting antenna stationary and rotating the receiving antenna. The size of the increments must be chosen small enough to ensure that beams and nulls can be determined from the measured data. This will give two dimensional representation of the radiation pattern of the horn antenna.

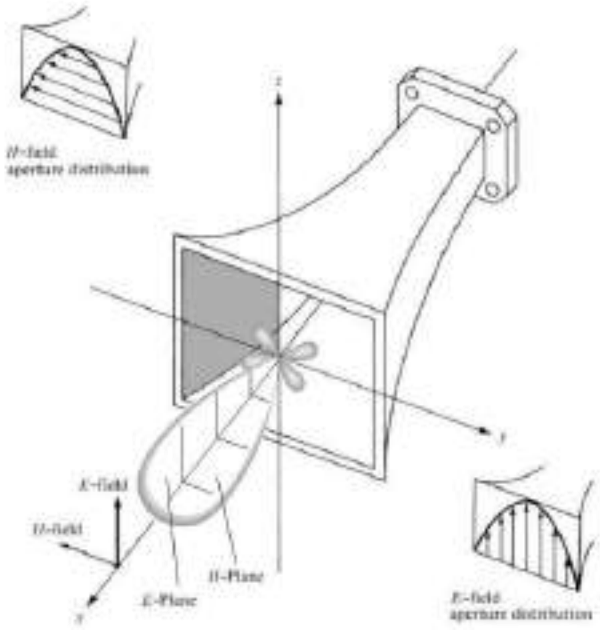


Figure 2-3 Typical radiation pattern for a pyramidal horn antenna

Also, in order to determine the far zone field radiation pattern, the distance between the transmitting and receiving antennas must be larger than *2D/λ*, with *D* the largest dimension of the horn antenna (typically the mouth of the taper) and *λ* the wavelength [1]. Typically the far-field radiation pattern of a horn antenna has very high gain with a large major lobe in the $\theta = 0^0$ direction, with very small side-lobes compared to the major lobe, as can be seen in Figure 2-3.

From the measurements of the radiation pattern, the gain of the antenna can also be determined. This is done using the two antenna method with two identical antennas described in [1]. From this discussion the gain of the antenna can be determined by:

$$\left(G_{ot}\right)_{dB} = \left(G_{or}\right)_{dB} = \frac{1}{2}\left[20\log_{10}\left(\frac{4\pi R}{\lambda}\right) + 10\log_{10}\left(\frac{P_t}{P_r}\right)\right]$$

Where: $(G_{ot})_{dB}$ = gain of the transmitting antenna (dB)

$(G_{or})_{dB}$ = gain of the receiving antenna (dB)

P_r = received power (W)

P_t = transmitted power (W)

R = antenna separation (m)

λ = operating wavelength (m)

The received power of is taken as the maximum power measured and the other parameters are known from the setup of the experiment.

2.3 Measurements results

From the discussion in the previous section the experiment is performed at an operating frequency of 1.9 GHz resulting in a wavelength of $\lambda = 0.158$ m.

For the far-field radiation pattern the distance between the transmitting and receiving antennas are determined to be:

$$R_{\min} > \frac{2D^2}{\lambda} = 0.37\,m$$

With D = 17cm. From this restriction the distance between the radiating and transmitting antennas was chosen as R = 1m.

In order to obtain a good two dimensional representation of the radiation pattern of the pyramidal horn antenna, increments of 15^0 were used to rotate the antenna during measurements in the azimuthal plane. The resulting radiation pattern (normalised to 100 dBm) is given in Figure 2-4. The maximum measured power was P_r = -19.1 dBm.

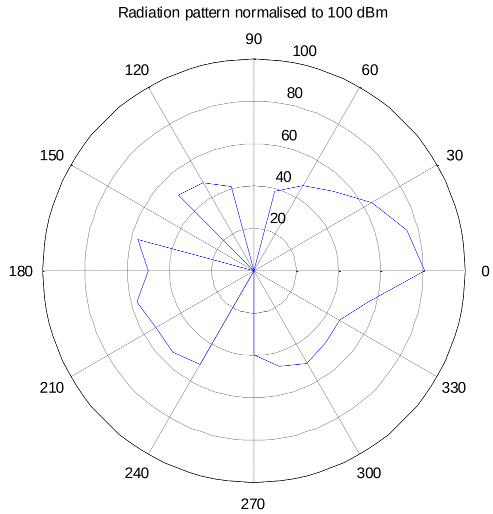


Figure 2-4 Measured radiation pattern of pyramidal horn antenna

In order to determine the gain of the pyramidal horn the values were either chosen, determined from the experiment setup, or measured. The values of the parameters that were used are given in the following table:

Table 2-1 Parameters used for gain calculation

Parameter	How it was obtained:	Value
R	Chosen	1 m
Λ	From experiment guide	1.9 GHz

P_t	From experiment guide	1 mW
P_r	Measured	-19.1 dBm → 0.0123 mW

From these values the gain of the antenna can be calculated as:

$$\left(G_{ot}\right)_{dB} = \left(G_{or}\right)_{dB} = \frac{1}{2}\left[20\log_{10}\left(\frac{4\pi(1)}{(0.158)}\right) + 10\log_{10}\left(\frac{1}{0.0123}\right)\right]$$
$$= 0.286$$

2.4 Discussion

Based on the results obtained from the measurement some differences from the expected performance of the horn can be noted. These differences include the relative size of the side lodes compared to the major lobe, and the low gain of the horn antenna.

These differences can be ascribed to inaccuracies encountered while performing the measurements. The inaccuracies may stem from the fact that the measurements were performed in the classroom and not in the anechoic chamber. This means that the transmitted waves can be reflected by nearby objects such as objects standing behind the receiving antenna during the measurements. This measurement in free-space can also decrease the gain of the antenna when losses due to reflections from objects are incurred.

This experiment has resulted in valuable experience in the measurement of antenna characteristics.

3. Half-wavelength dipole

3.1 Introduction

Dipole antennas form part the family of wire antennas that are one of the oldest, cheapest, simplest and most versatile types of antenna. The most common type of dipole antenna is the half-wavelength dipole antenna. This is due to the fact that the half-wavelength dipole has a radiation resistance of 73 Ω, which is close to the 75 Ω characteristic impedance of most transmission lines. This makes the matching of the line to the antenna very simple, especially at resonance. [1]

A typical configuration for the half-wavelength dipole can be seen in Figure 3-1 (a). The configuration basically consists of two wires of length λ/4 each. Due to this simplicity in the configuration of the half-wavelength dipole it is easy to design the antenna, given a specific frequency. Figure 3-1 (b) shows the typical radiation pattern for a half-wavelength dipole.

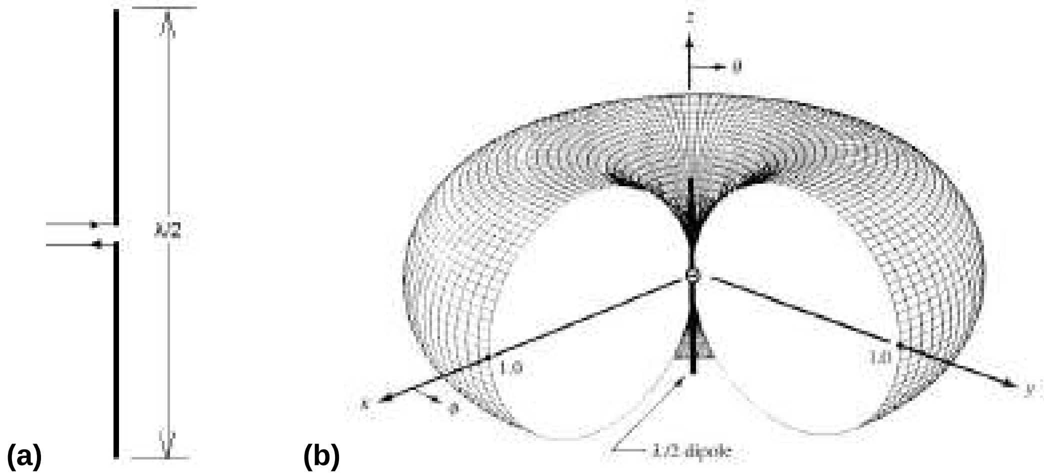


Figure 3-1 Half-wavelength antenna: (a) typical configuration and (b) typical radiation pattern [1].

This section will discuss the theory and calculations necessary for the design of a half-wavelength dipole. This design is implemented and a measurement of some of the characteristics of the dipole is made. The goal of this section is to gain experience in the design of an antenna.

4. Slot-feed micro-strip patch antenna

4.1 Introduction

Micro-strip antennas are common in applications where lightweight and low-profile constraints are very stringent, such as high-performance aerospace applications. A major advantage of micro-strip antennas is that the antennas can be printed on any surface and moulded to any configuration. Due to printed circuit technology, these micro-strip antennas are also inexpensive to implement. For certain shapes of patches the design can also be very versatile in terms of the radiation characteristics of the antennas. [1,3]

However, micro-strip antennas have some disadvantages that can limit their performance. These disadvantages include low efficiency, low power, high quality factor, poor polarisation purity, poor scan performance, spurious feed radiation, and narrow frequency bandwidth [1]. For this reason various designs have been suggested to improve the performance of the micro-strip antennas.

One such design is the slot-feed (or aperture-feed) micro-strip patch antenna as shown in Figure 4-1. From this figure it is can be seen that the signal from the feed is coupled to the patch through the slot in the ground plane. The radiation characteristics of the antenna are determined by the physical dimensions of the antenna such as the size of the patch, size and shape of the slot, thickness of the substrates (ε_{r1} and ε_{r2}), the types of materials used in the substrate, the size of the patch, and the positions of the patch, feed and slot relative to each other.

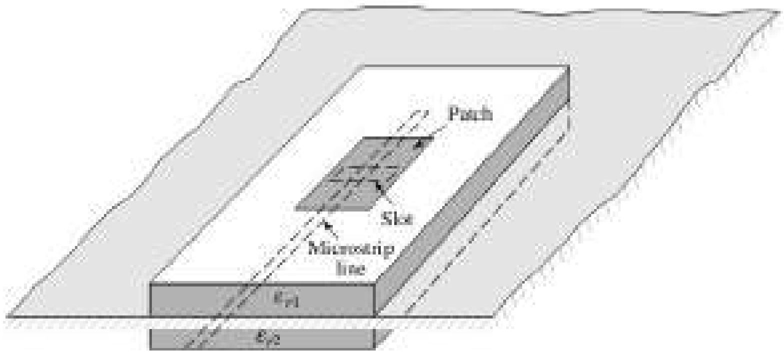


Figure 4-1 Typical slot-feed micro-strip patch antenna configuration

This section will cover the theory and calculations necessary for the design and simulation of slot-feed micro-strip patch antenna in Ansys® HFSS™.

4.2 Theory and calculations

In this section, the width of the patch is calculated using

$$W=v0/2fr\sqrt{2/\in r}+1= 5.994 \text{ cm}$$

Where $v0$ is free space velocity of light, frequency used is 2010 MHz

Material is Teflon:

Relative permittivity is 2.1, Relative permeability is 1, thickness of substrate is 0.8 mm and Thickness of conductor 38 um.

The length of the patch is determined using

$L= (1/2fr\sqrt{\in \mathrm{reff}}\sqrt{\mu 0 \in 0})\ -2\Delta L = 5.110$ cm

Where $\in \mathrm{reff}$ is the effective dielectric constant & ΔL is the extended incremental length of the patch & can be calculated using

$\in \mathrm{reff} = (\in \mathrm{r} + 1/\ 2) + \in \mathrm{r} - 1/\ 2[1 +\ 12\ \mathrm{h/W}]^{-1/2}$

&

$\Delta L/h = 0.412[(\in \mathrm{reff} + 0.3)(\frac{W}{h} + 0.264)/(\in \mathrm{reff} - 0.258)(\frac{W}{h} + 0.8)]$

Whereas Length & width of substrate are 3 times the length & width of the patch & slot length & width are 10th fractions of the wavelength.

4.3 Simulation results

In the HFSS™ simulation various tests can be performed to check the validity of the design. For this simulation only the frequency response and radiation pattern are considered for the simulation results.

Figure 4-2 shows the model used for the simulation of the slot-feed micro-strip patch antenna in HFSS™. The figure shows the feed strip at the bottom, the Teflon™ substrate with the slotted ground plane in the centre, and the copper patch on top of the substrate. This configuration is encased in a block that represents free space. The sides of the block are designated as a radiation boundary. The dimension for each component is given in Table 4-1.

The source used for the simulation is a wave port which is normalised to a full port impedance of 70 Ω to ensure the consistency of results [4]. From this setup a frequency sweep and far field radiation patterns can then be determined. The frequency sweep gives the response of the antenna at various frequencies, and the far field radiation patterns give the gain of the antenna in various directions at the designed frequency.

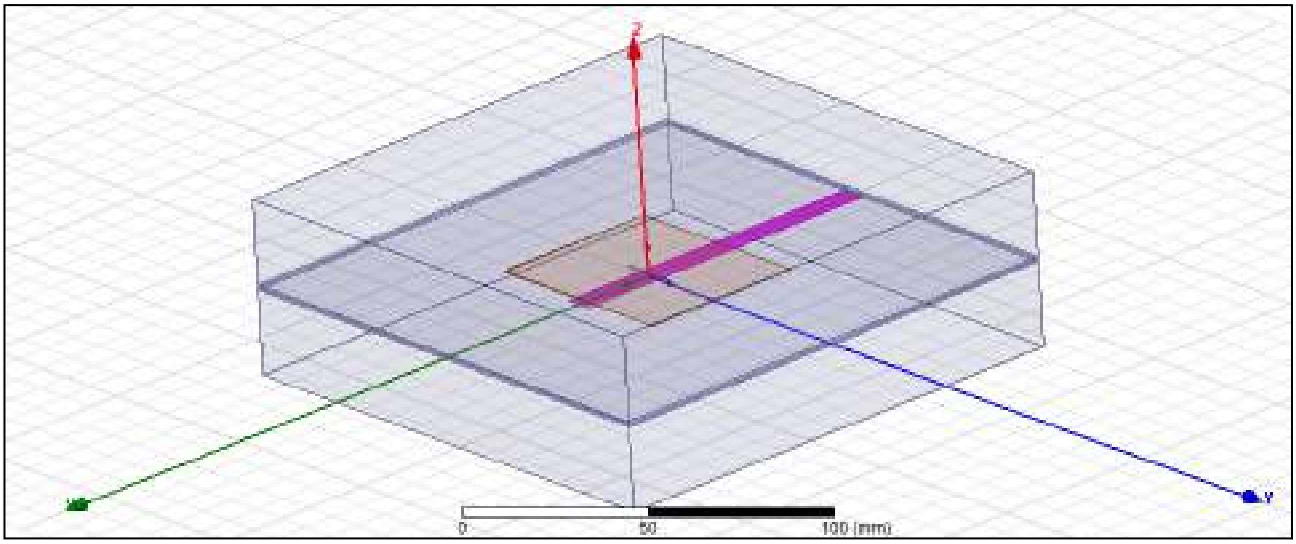


Figure 4-2 Slot-feed micro-strip patch antenna model for simulation

Table 4-1 Dimensions of patch antenna parts

Parameter	**Value**
Patch width	5.994 cm
Patch length	5.110 cm
Patch thickness	38 µm
Substrate length	15 cm
Substrate width	15 cm
Substrate thickness	0.8 mm
Feed length	10.075 cm
Feed width	0.767 cm
Slot length	1.493 cm
Slot width	0.149 cm

The results for a frequency sweep are given in Figure 4-3. The frequency sweep is done from 1.5 GHz to 2.5 GHz and shows that the reflections are a minimum at approximately 2.115 GHz, which is where the antenna will have resonance. This differs slightly from the designed value of 2.1GHz, but can be considered to be within an acceptable tolerance.

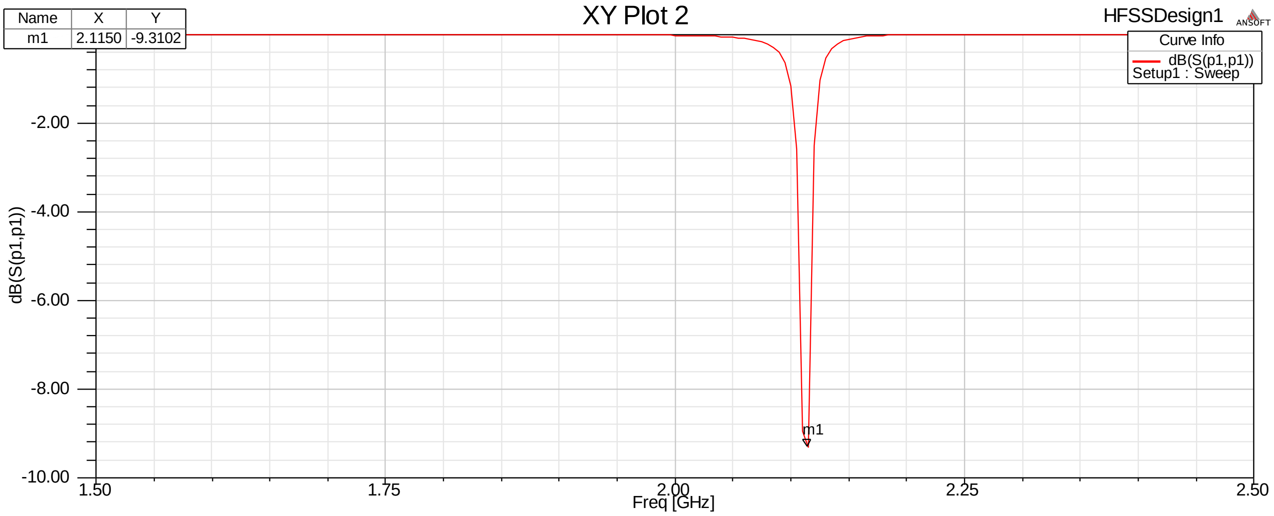


Figure 4-3 Port reflection for slot-feed micro-strip patch antenna

The far-field radiation pattern for both the elevation and azimuthal planes are given in Figure 4-4. This figure shows that the antenna has good directivity with very little backwards radiation. The corresponding three-dimensional far-field radiation pattern is given in Figure 4-5. These radiation patterns at measured by calculating the gains of the E- and H- fields at an infinite sphere around the antenna.

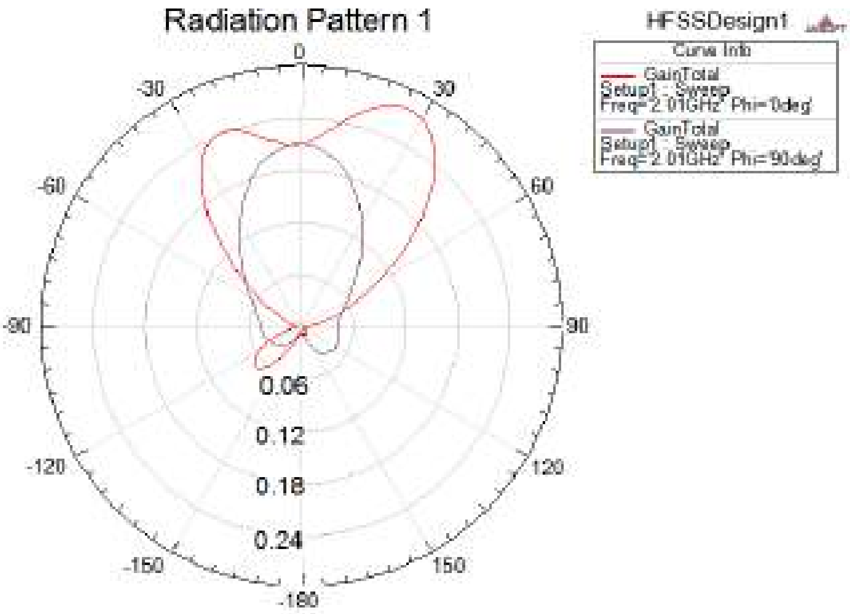


Figure 4-4 Total gain plotted for elevation and azimuth planes

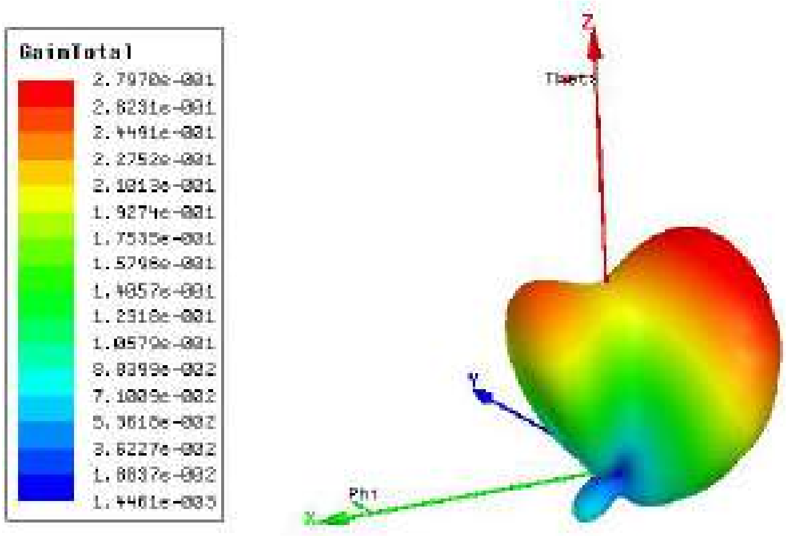


Figure 4-5 Three-dimensional plot of total gain for slot-feed micro-strip patch antenna

4.4 Discussion

Previous plot results are illustrating the back lobe radiation problem of the antenna which results in a power loss and SAR increases. Back lobe can be reduced using aperture coupled micro strip slot antenna which reduces the back lobe as well as increases the bandwidth of the antenna.

Aperture coupled micro strip slot antenna couples the patch antenna with micro strip line through an aperture.

5. Conclusion

Finally, the optimum dimension of patch antenna on Teflon substrate for 2010 MHz
has been investigated. The performance properties are analysed in HFSS and proposed antenna works at the required frequency with minimum reflection.

References

[1] C. A. Balanis, *Antenna Theory - Analysis and design*, 3rd ed. Hoboken, New Jersey: John Wiley & Sons, Inc. , 2005.

[2] IEEE, Inc., *IEEE Standard Test Procedures for Antennas: IEEE std. 149*.: Distributed by Wiley-Interscience, 1979.

[3] Z. Aijaz and S. C. Schrivastava, "An Introduction of Aperture Coupled Microstrip Slot Antenna," *International Journal of Engineering Science and Technology*, vol. 2, no. 1, pp. 36-39, 2010.

[4] Ansys, Inc., *Ansoft HFSS- User Guide*, 3rd ed., 2009.

Dipole Antenna, simulation– Report

Design, simulation, of Dipole antenna

Hassan. Hamid Ali(281815)

31 January 2021

Tampere University

Abstract

In this laboratory report, a brief description of design and calculation of the dipole being most widely used antenna is proposed at a frequency of 2484 MHz

Radiation measurement setup is formed, for dipole, the dipoles was simulated to study directivity (gain) and radiation pattern measurements with respect to frequency.

The simulated parameters satisfy the expected theoretical results, since MATLAB function give ideal results, hence making the proposed antenna fabrication and subsequent measurement suitable for Desired frequency.

Table of Contents

List of figures

1. Introduction

The purpose of this simulation and laboratory work is to gain experience in the manufacture, measurement, and simulation of antennas. From this specification the following sections will be covered in this report:

- The half-wave dipole antenna,

The section on the half-wave dipole antenna discusses the basic wire antenna design, using MTALAB simulation software and Octave GNU.

2. Half-wavelength dipole

2.1 Introduction

Dipole antennas form part the family of wire antennas that are one of the oldest, cheapest, simplest and most versatile types of antenna. The most common type of dipole antenna is the half-wavelength dipole antenna. This is due to the fact that the half-wavelength dipole has a radiation resistance of 73 Ω, which is close to the 75 Ω characteristic impedance of most transmission lines. This makes the matching of the line to the antenna very simple, especially at resonance. [1]

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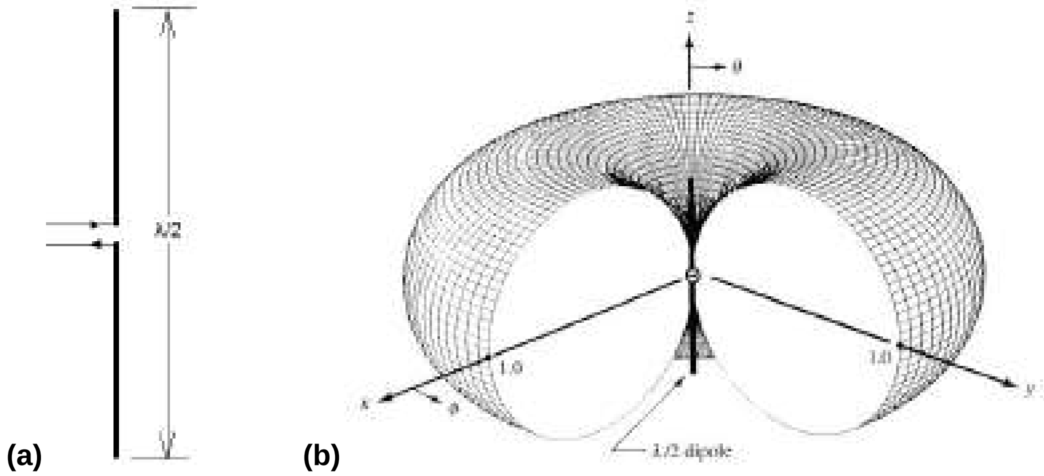
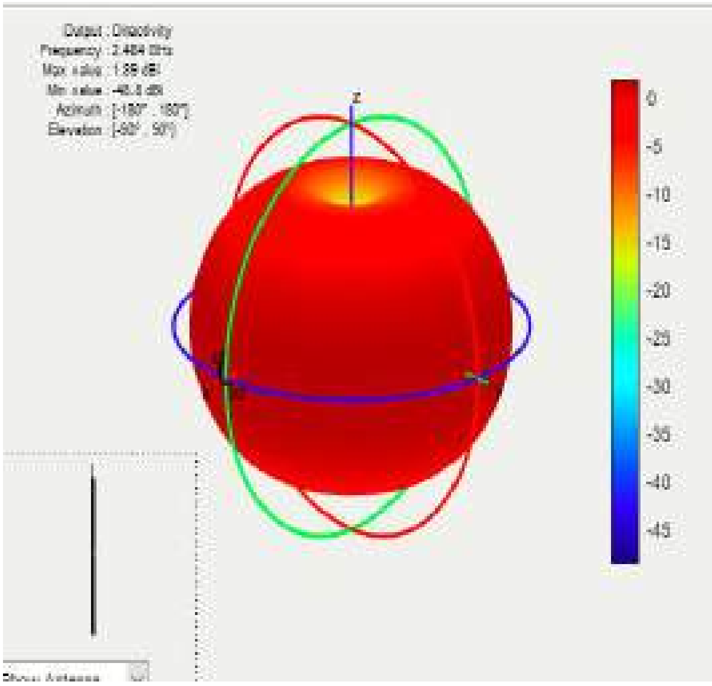


Figure 2-1 Half-wavelength antenna: (a) typical configuration and (b) typical radiation pattern [1].

This section will discuss the theory and calculations necessary for the design of a half-wavelength dipole. This design is implemented and a measurement of some of the characteristics of the dipole is made. The goal of this section is to gain experience in the design of an antenna.

3. Results:

The following figures show the radiation patterns, directivity and E-Plane and H-Plane figures.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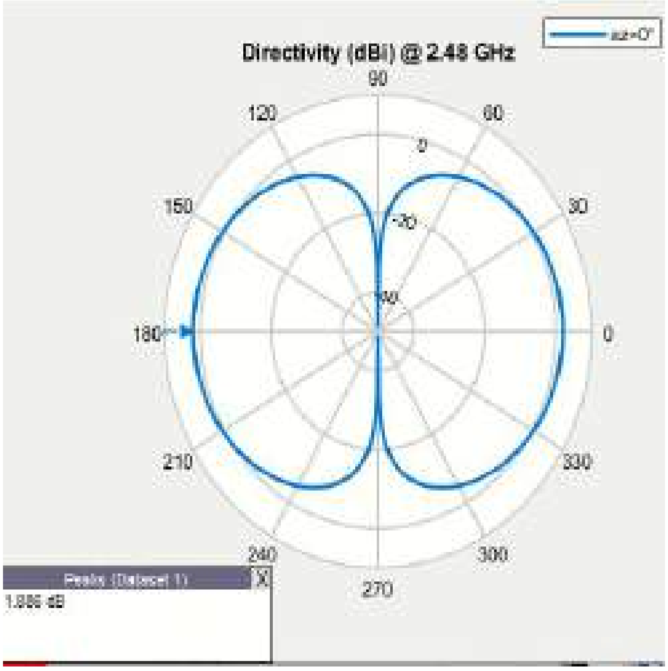
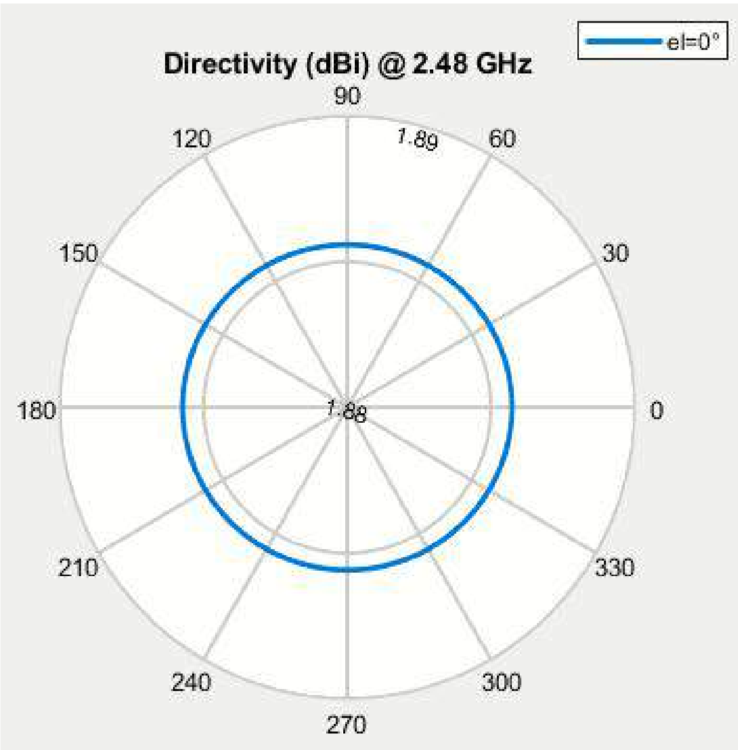
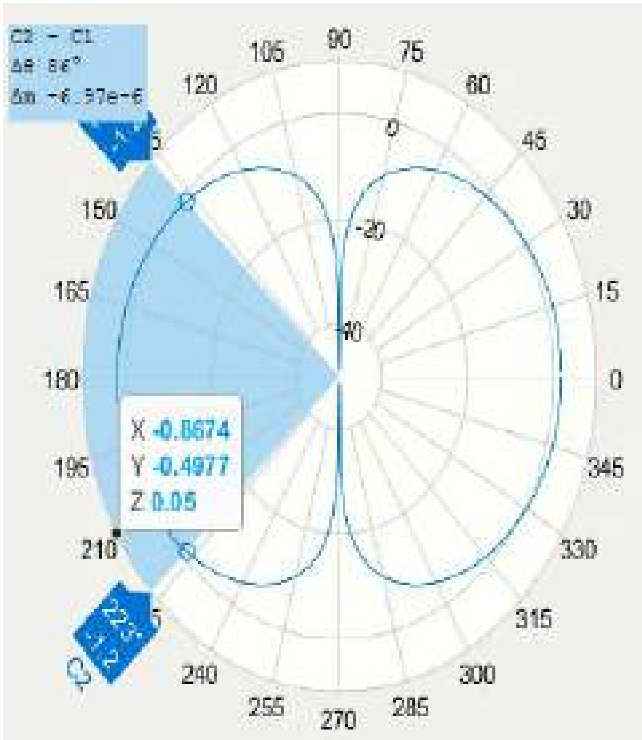
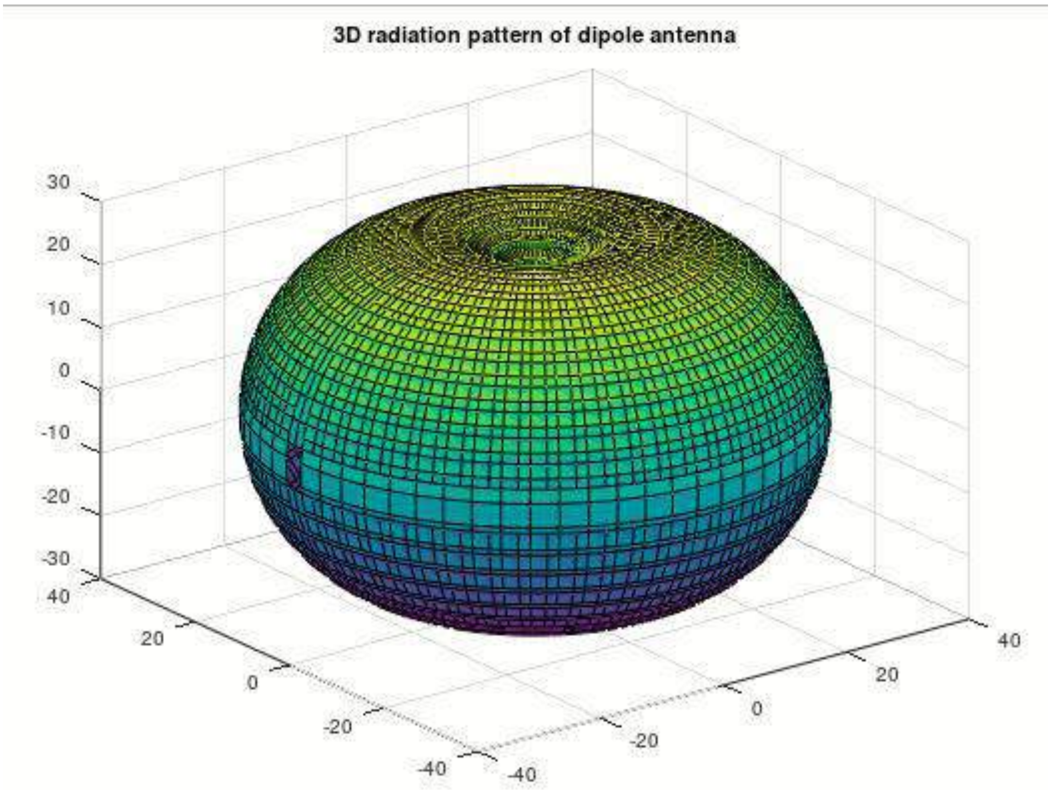
Frequency : 2.484 GHz
Max value : 1.89 dBi
Min value : -46.3 dB
Azimuth : [-180° , 180°]
Elevation : [-90° , 90°]
z
0
-5
-10
-15
-20
-25
-30
-35
-40
-45


az=0°
Directivity (dBi) @ 2.48 GHz
90
120
60
150
30
180
0
210
330
240
300
270
0
-20
-40
Peaks (Dataset 1)
1.886 dB

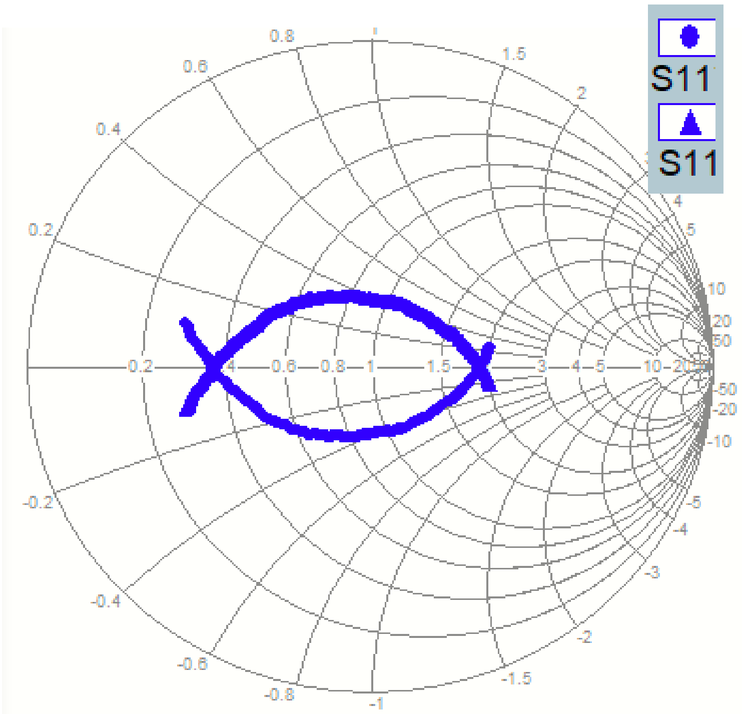

el=0°
Directivity (dBi) @ 2.48 GHz
90
120
60
150
30
180
0
210
330
240
300
270
1.89
1.88


90
105
75
120
60
45
150
30
165
15
180
0
195
345
210
330
315
240
300
255
285
270
0
-20
-40
X -0.8674
Y -0.4977
Z 0.05



The above 3d plot is obtained from the radiation pattern formula of the dipole antenna.
Urad= (eta*(i0^2)*((cos(kl*cos(theta-(pi/2))/2)-cos(kl/2))./sin(theta-(pi/2))).^2)/(8*(pi)^2);

The following plot is a quick S11 parameter plot of the actual monopole antenna at 2484 MHz, at the given specifications, (Group 6) and manufactured in the lab and antenna parameters extracted in s1p files. The reflection of the manufactured antenna is symmetric and value ranging 0.4 to 1.2 on x axis of smith chart allowing to read Zin and reflection coefficient. The details of radiation plot and gain are included in simulation part II.



4. Conclusion

The dipole antenna is designed at 2.48 GHz and results are displayed from the MATLAB simulations. There are also the readings and s-parameters files form the manufactured monopole antenna at the same frequency. Those readings are taken latest and will be a part of the simulation part II assignment. The performance properties are at the desired frequency and the directivity is plotted. The results match theoretical references [1] as the dipole is simulated using the built-in functions in MTALAB.

References

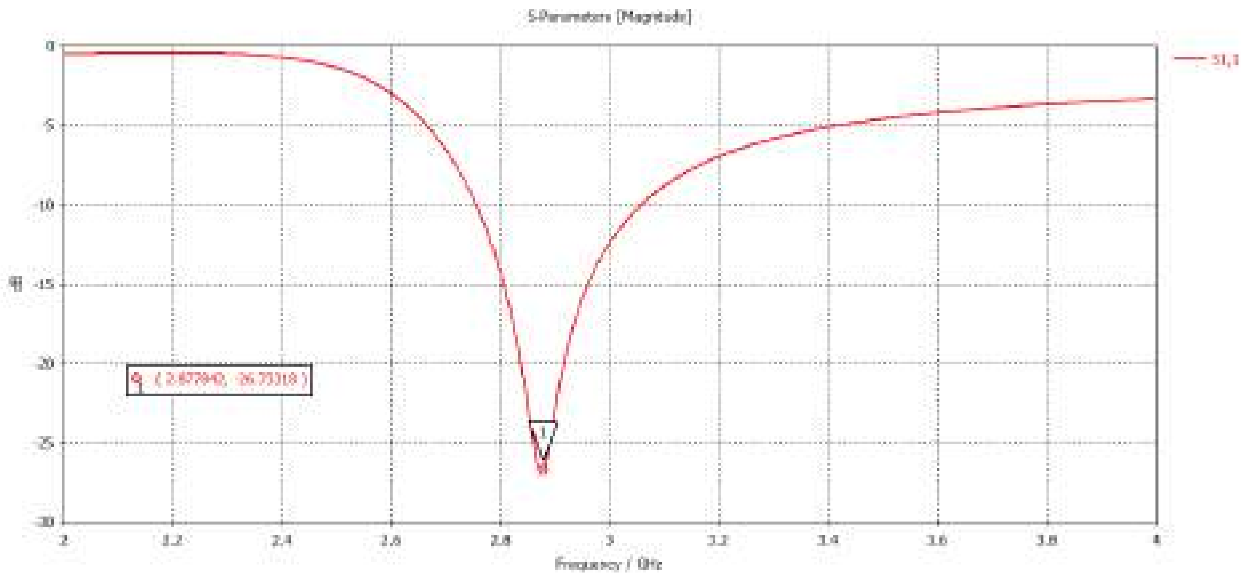
[1] C. A. Balanis, *Antenna Theory - Analysis and design*, 3rd ed. Hoboken, New Jersey: John Wiley & Sons, Inc. , 2005.

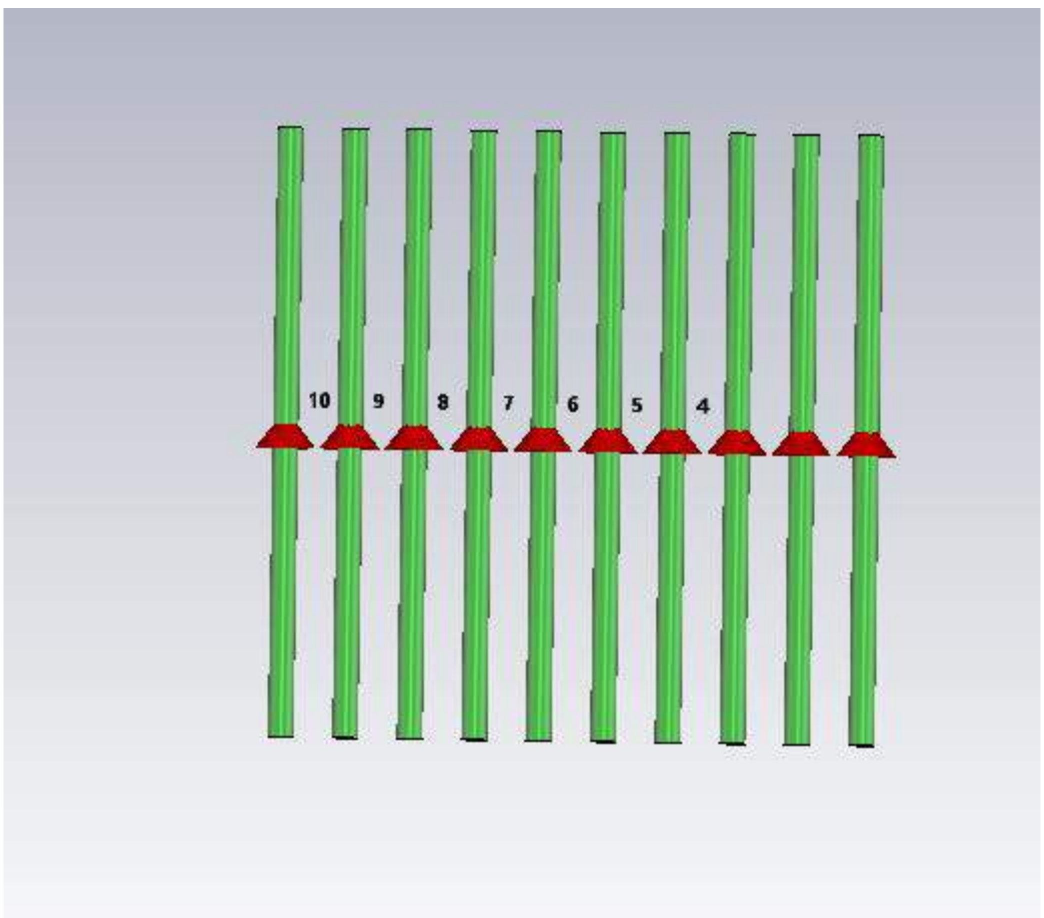
Dipole Antenna Array simulation– Report

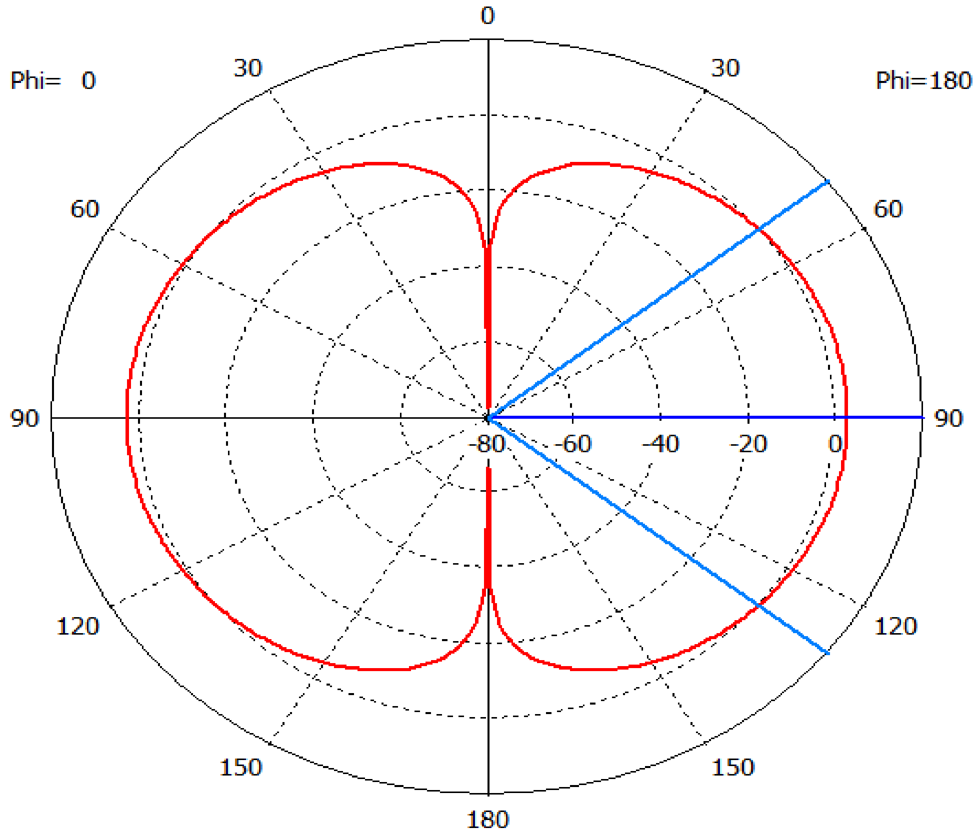
Design, simulation, of Dipole array antenna at 2.87 GHZ

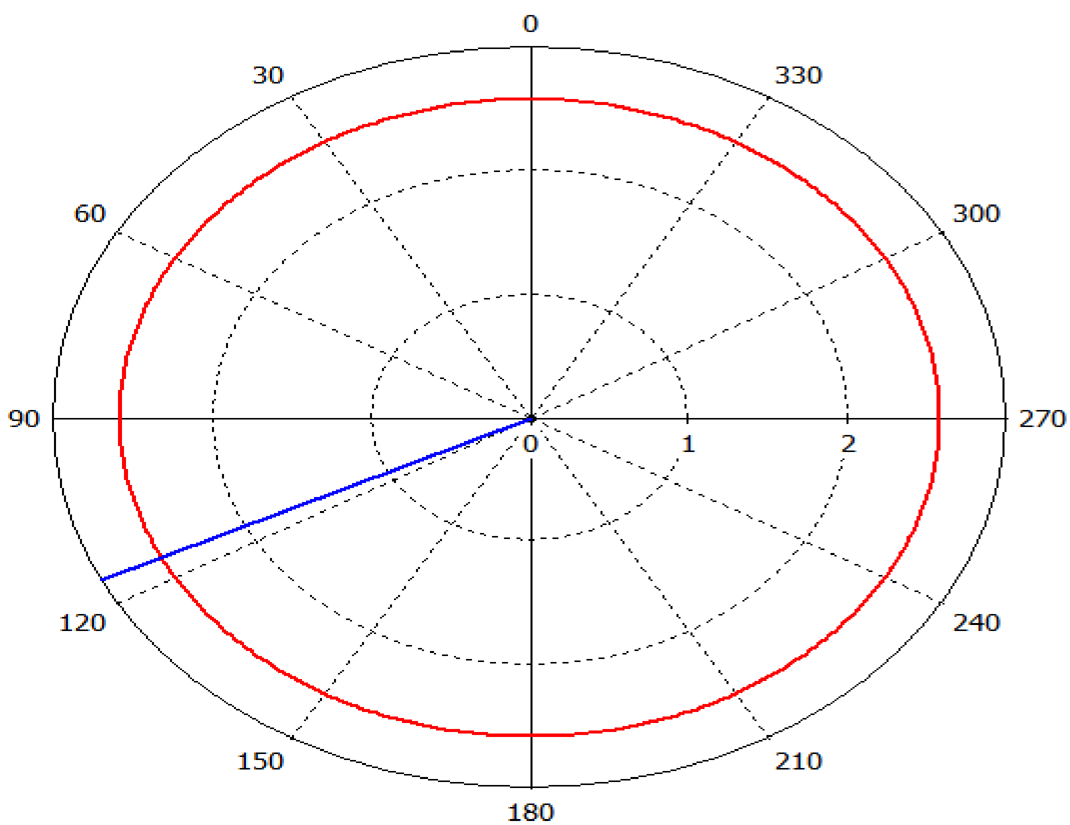
Hassan. Hamid Ali (281815)

ONLY RESULS


S-Parameters [Magnitude]
0
-5
-10
-15
-20
-25
-30
dB
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
Frequency / GHz
S1,1
1


10
9
8
7
6
5
4

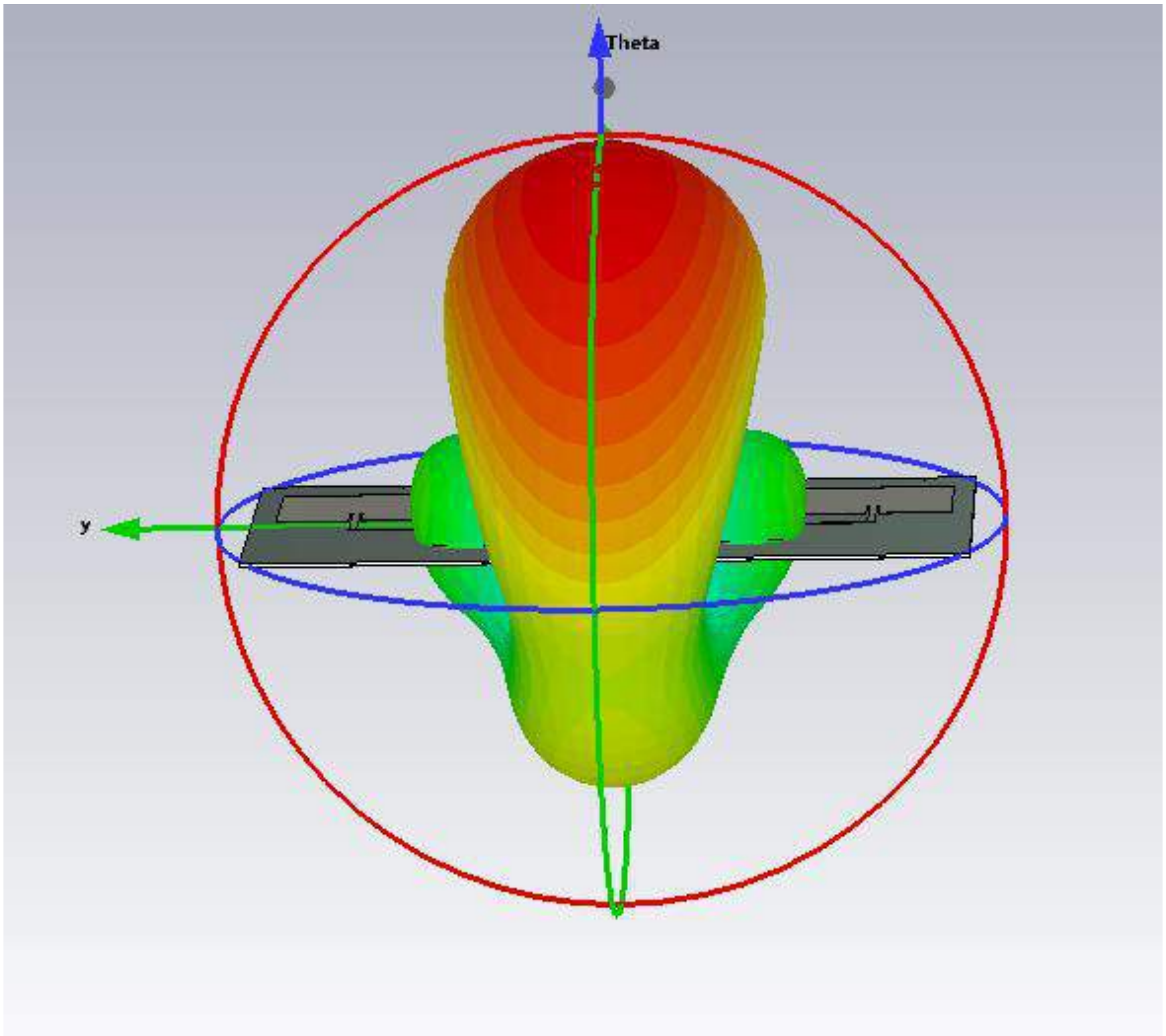

Phi= 0
Phi=180
0
30
30
60
60
90
90
-80
-60
-40
-20
0
120
120
150
150
180

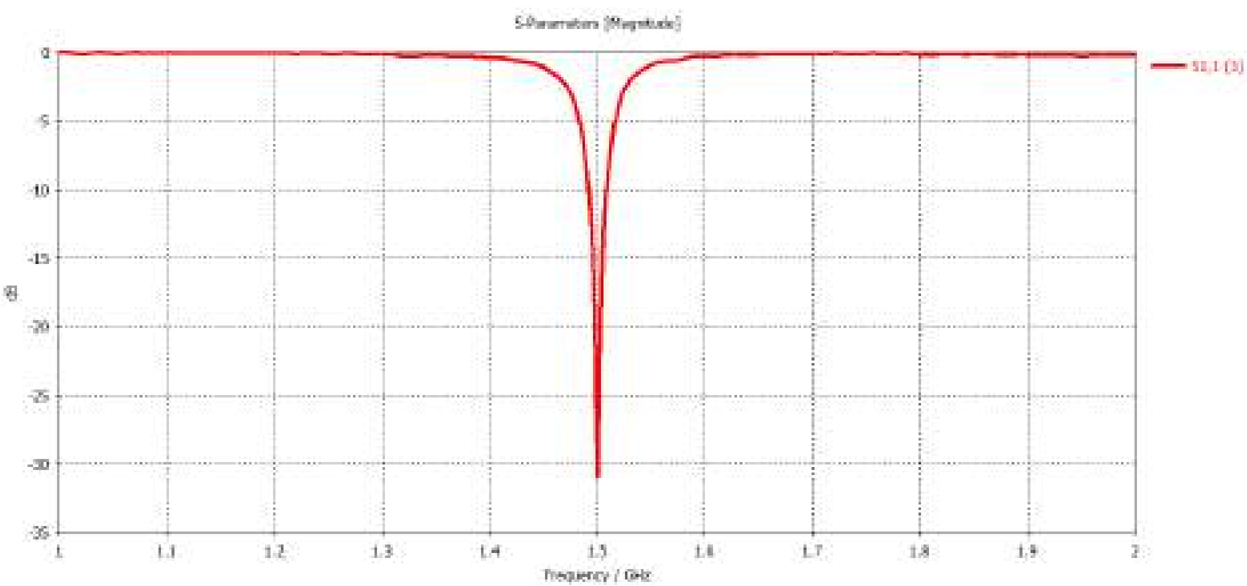

0
30
330
60
300
90
270
0
1
2
120
240
150
210
180

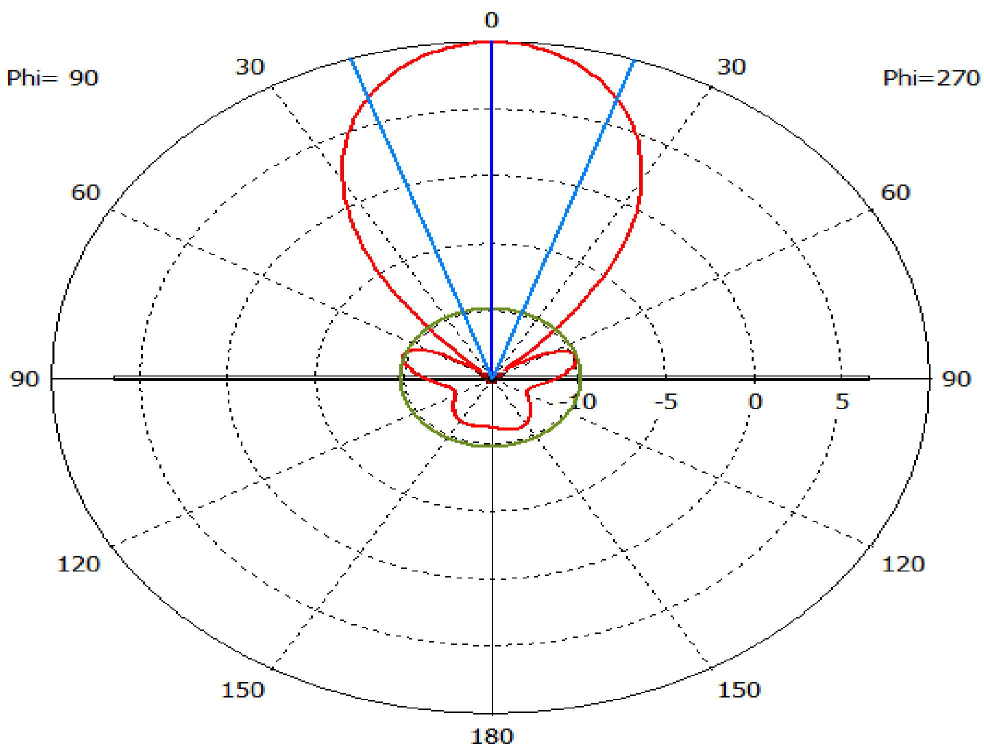
Patch Antenna Array simulation– Report

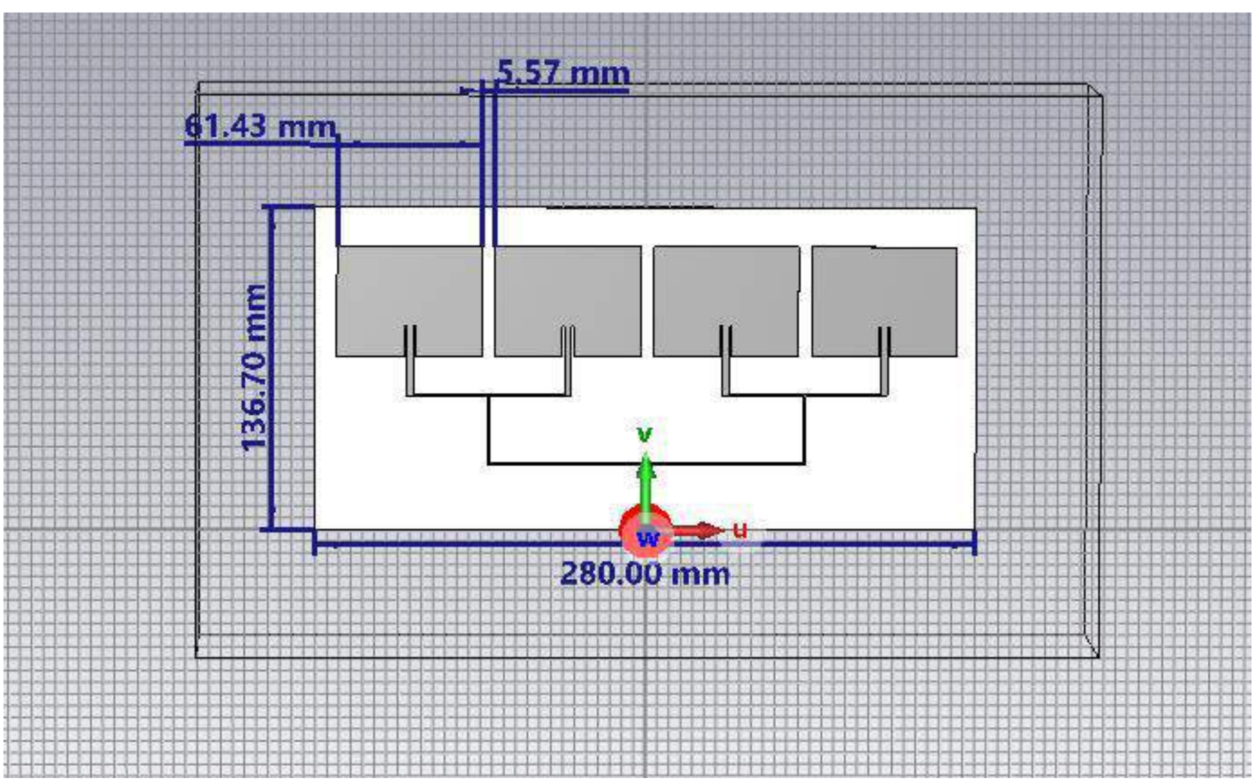
Design, simulation, of 4 element Patch array with corporate feed at 1.5 GHz

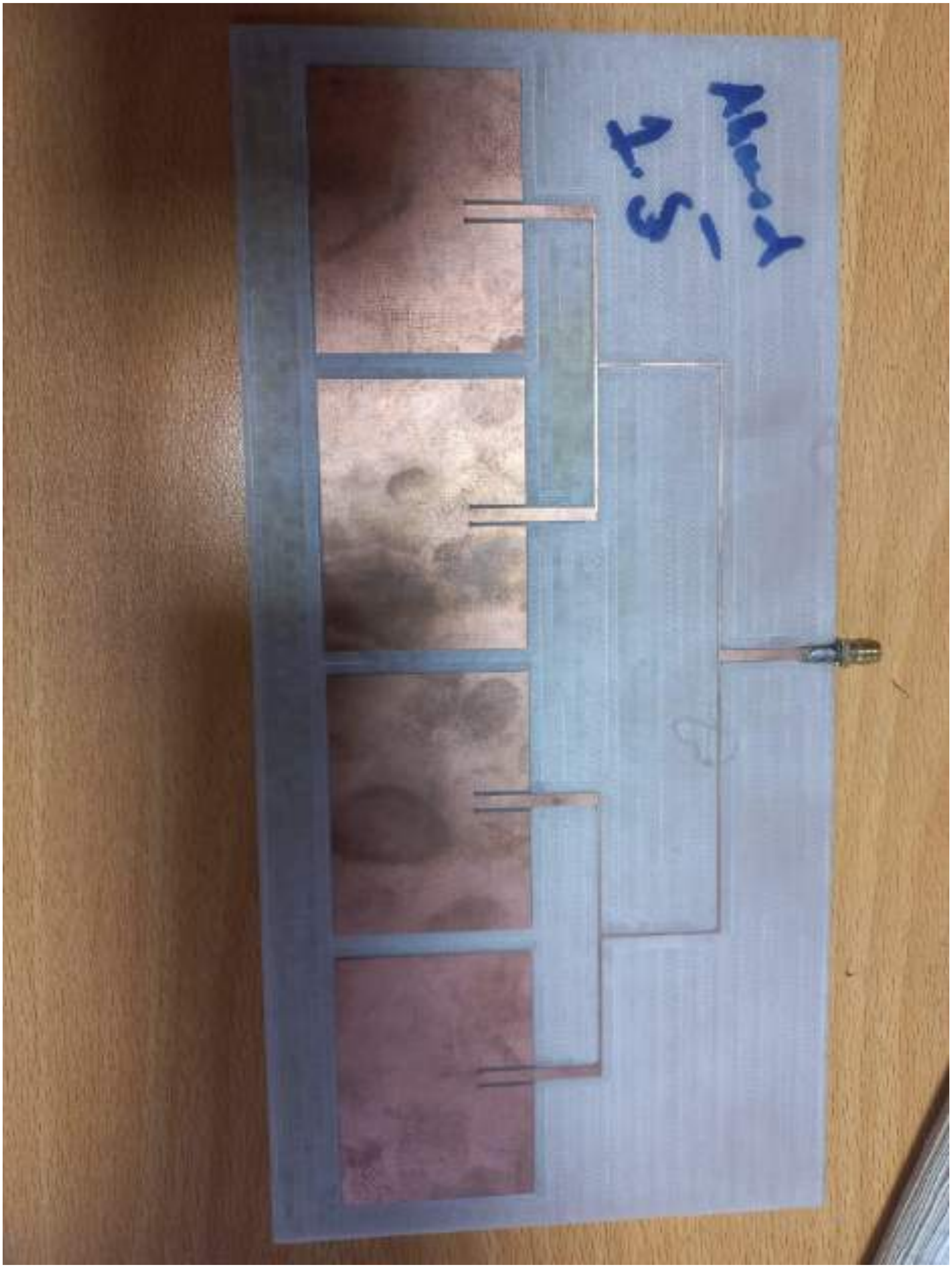
Hassan. Hamid Ali


Theta
y


S-Parameters [Magnitude]
0
-5
-10
-15
-20
-25
-30
-35
dB
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
Frequency / GHz
S1,1 (3)


0
30
30
Phi= 90
Phi=270
60
60
90
90
-10
-5
0
5
120
120
150
150
180

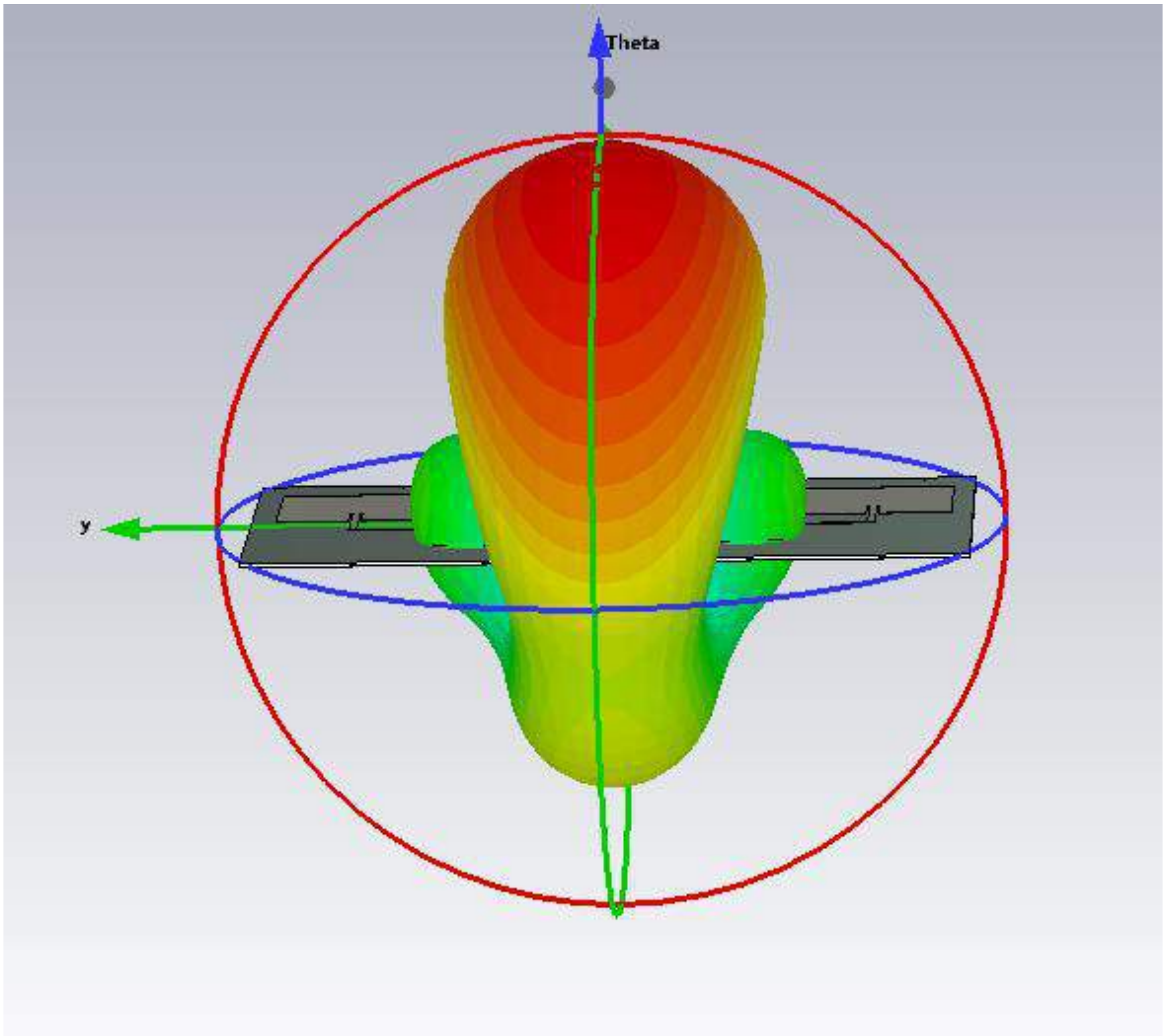

5.57 mm
61.43 mm
136.70 mm
v
w
u
280.00 mm



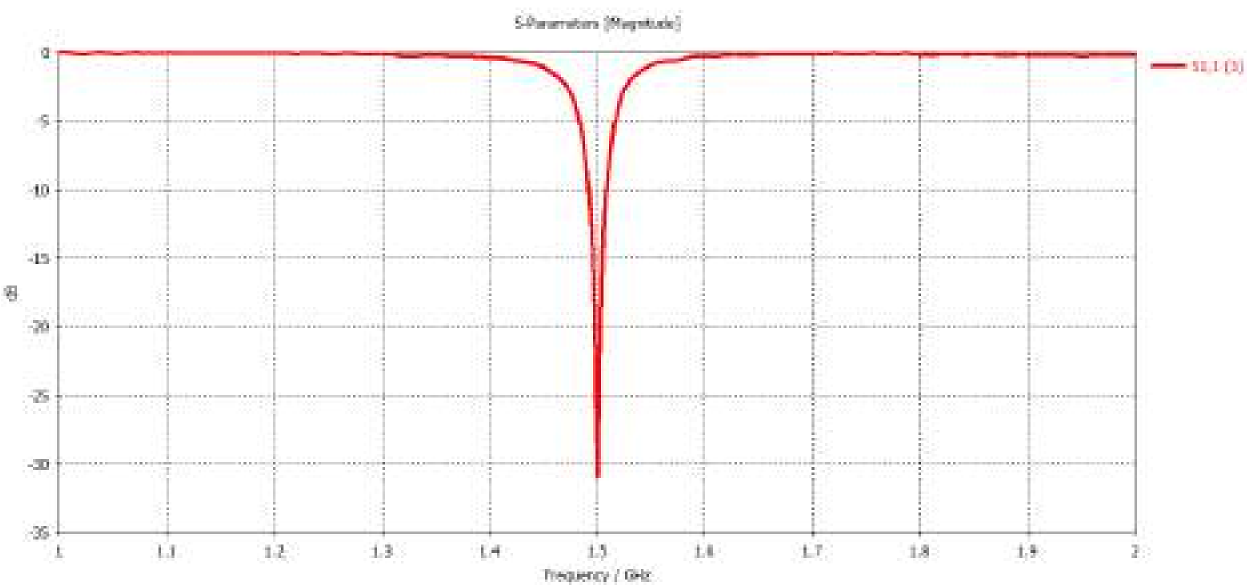
Patch Antenna Array simulation– Report

Design, simulation, of Patch antenna array at 1.5 GHz

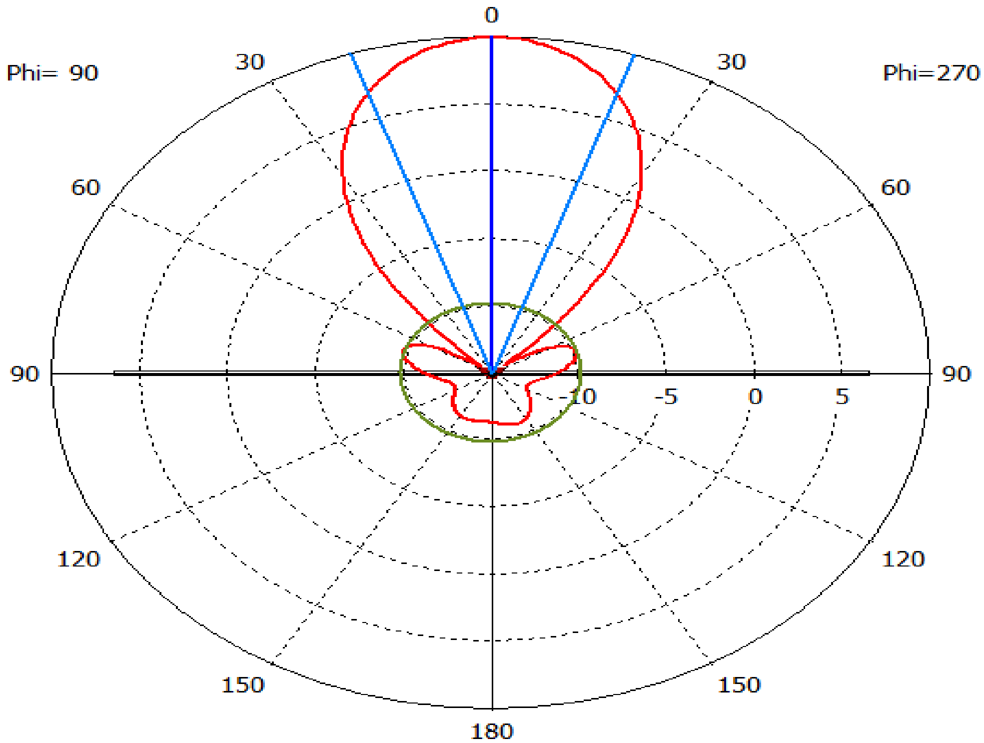
Hassan. Hamid Ali(281815)

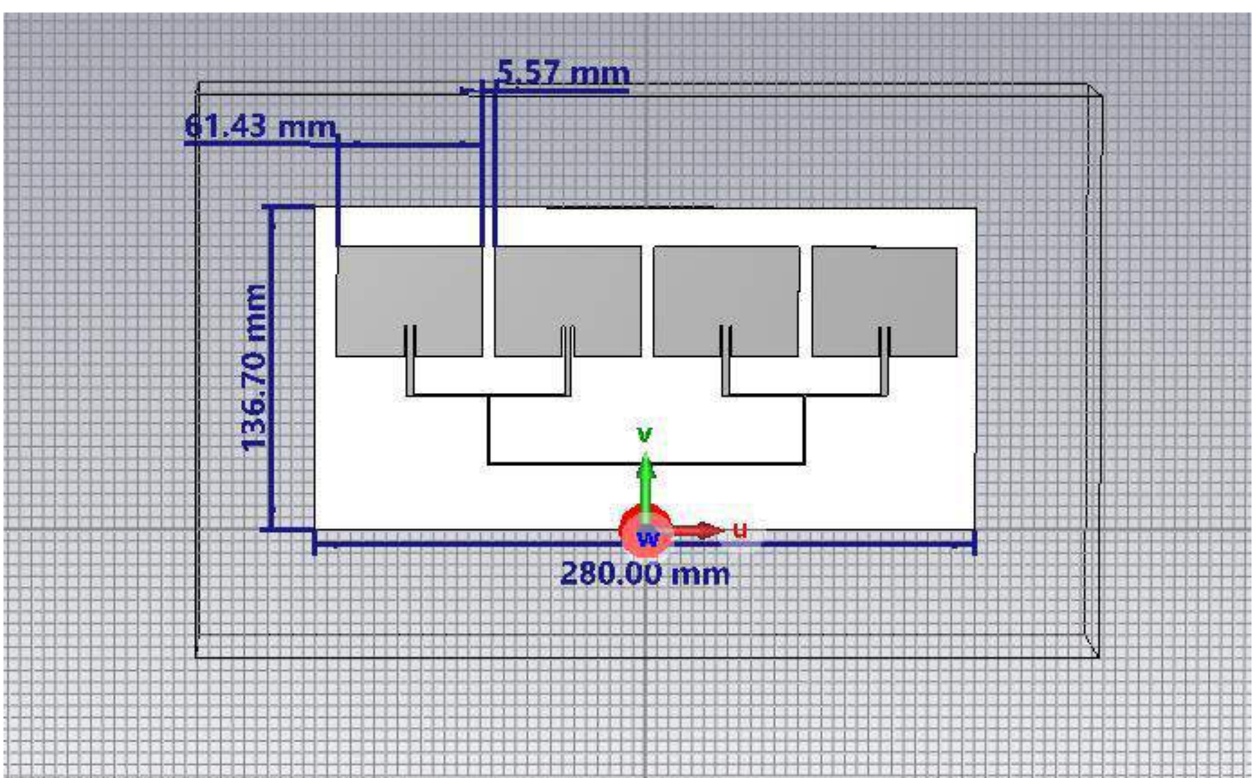


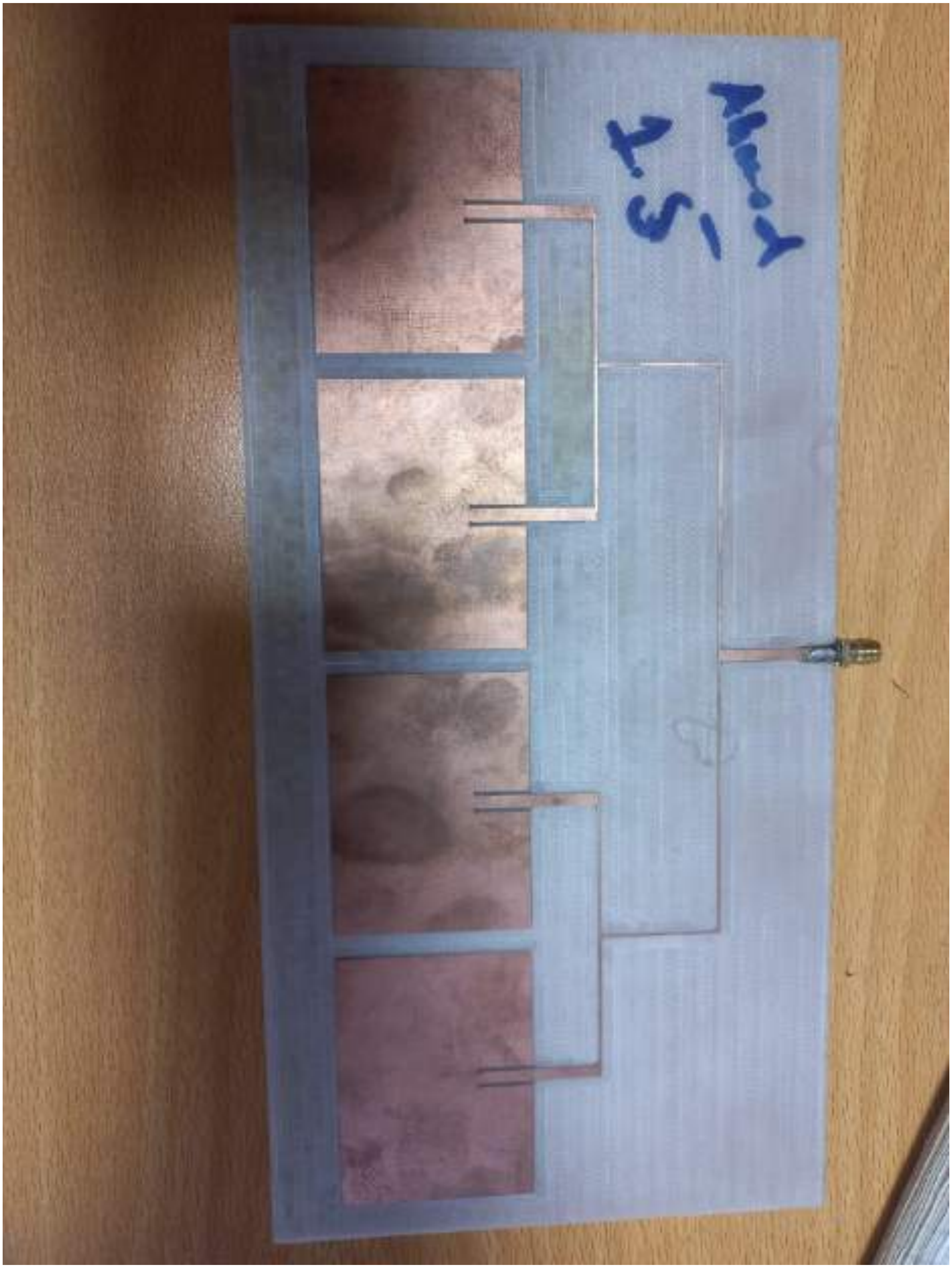
Theta
y



S-Parameters [Magnitude]
0
-5
-10
-15
-20
-25
-30
-35
dB
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
Frequency / GHz
S1,1 (3)


0
Phi= 90
30
30
Phi=270
60
60
90
90
-10
-5
0
5
120
120
150
150
180


5.57 mm
61.43 mm
136.70 mm
v
w
u
280.00 mm



Patch Antenna at 60 GHz simulation– Report

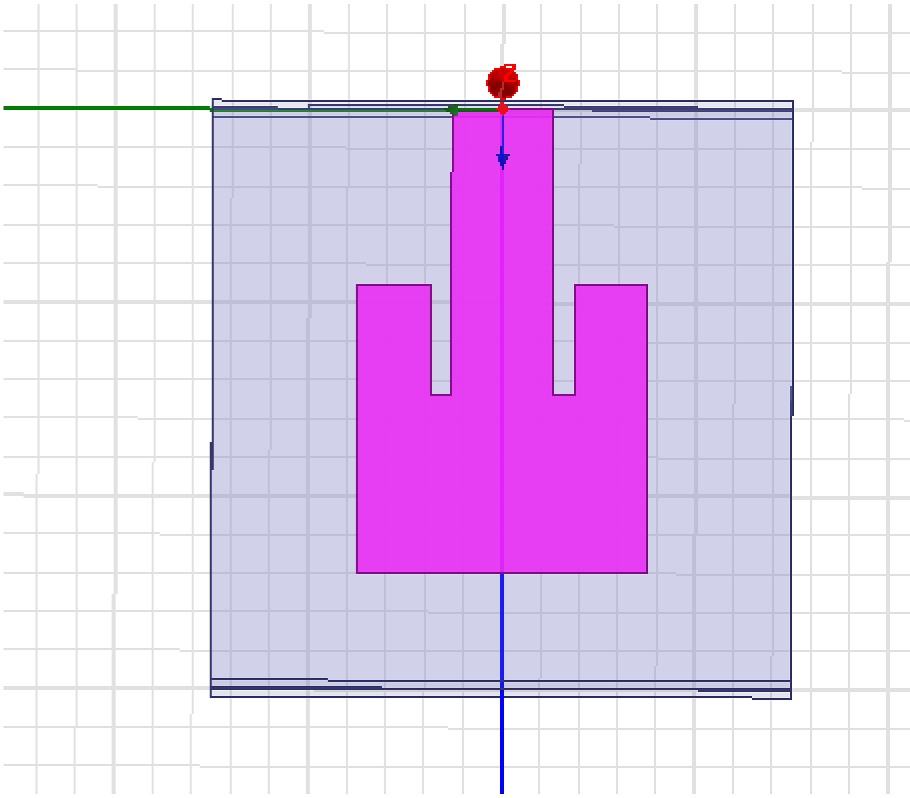
Design, simulation, of patch antenna with substrate Rogers RT/Duroid 5880

Hassan. Hamid Ali

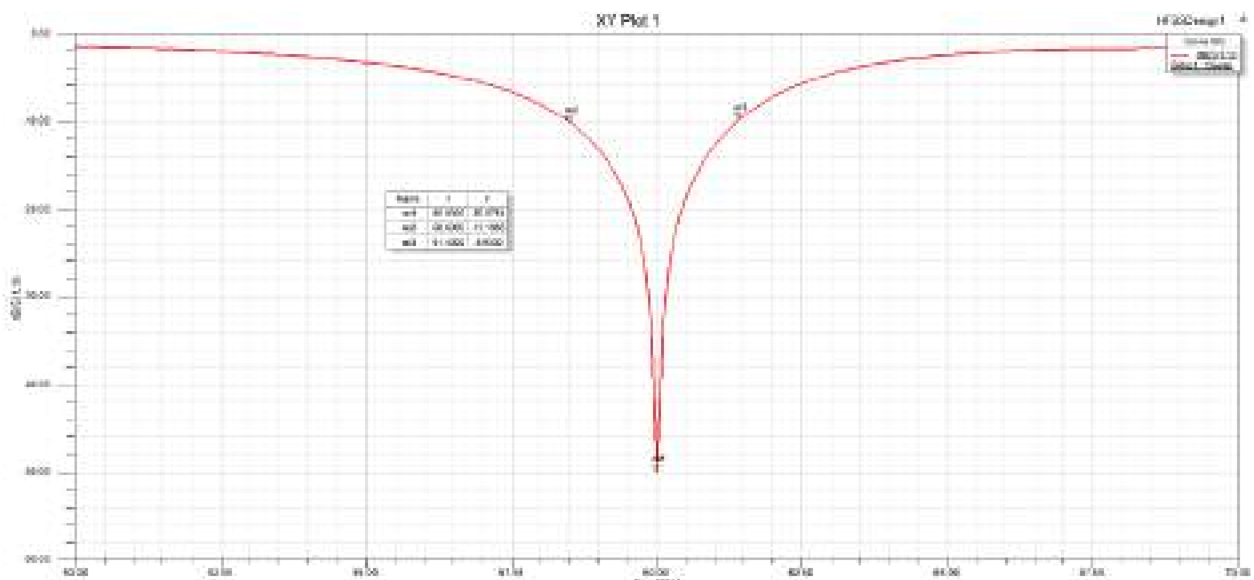
ONLY RESULTS

January 2022

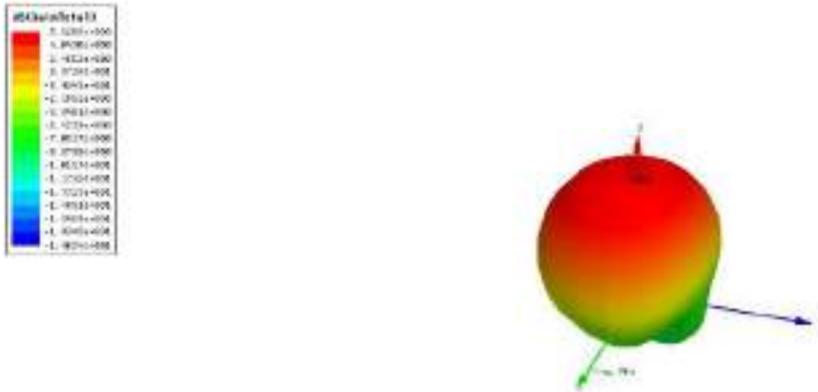
Rogers RT/Duroid 5880:



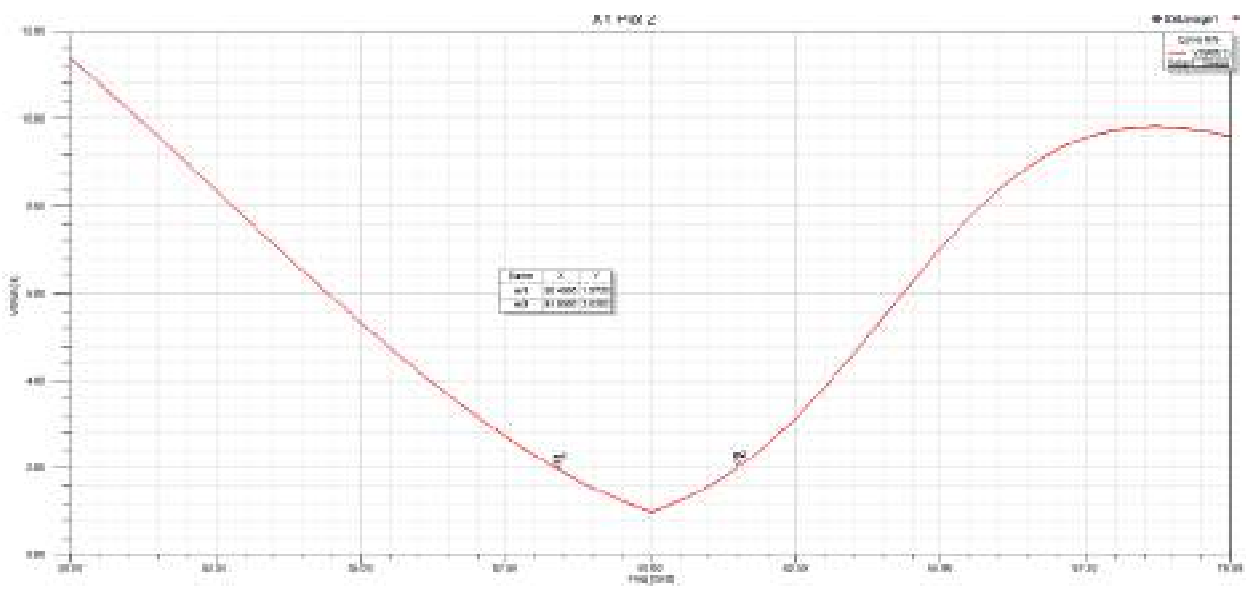
S11:



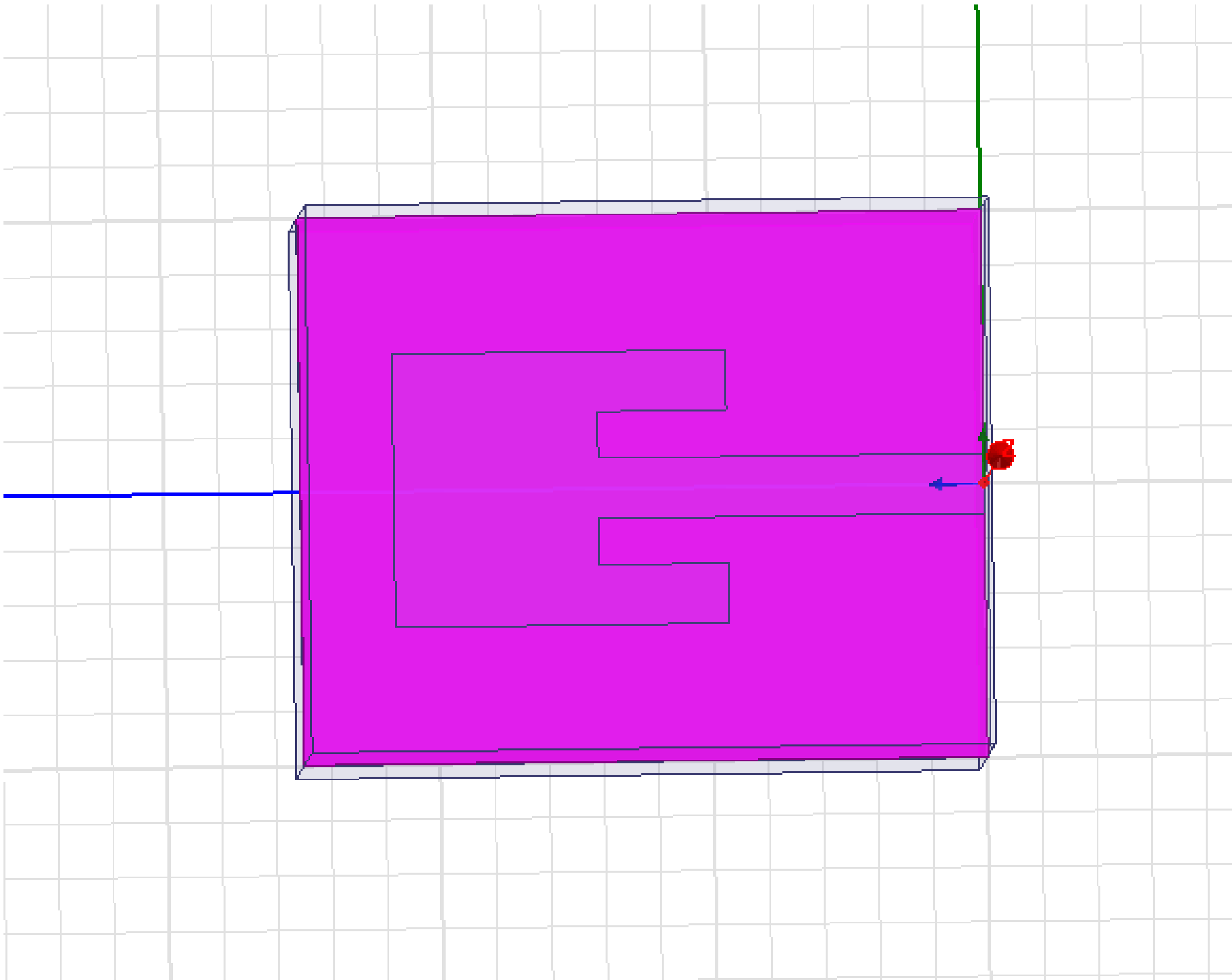
Gain:



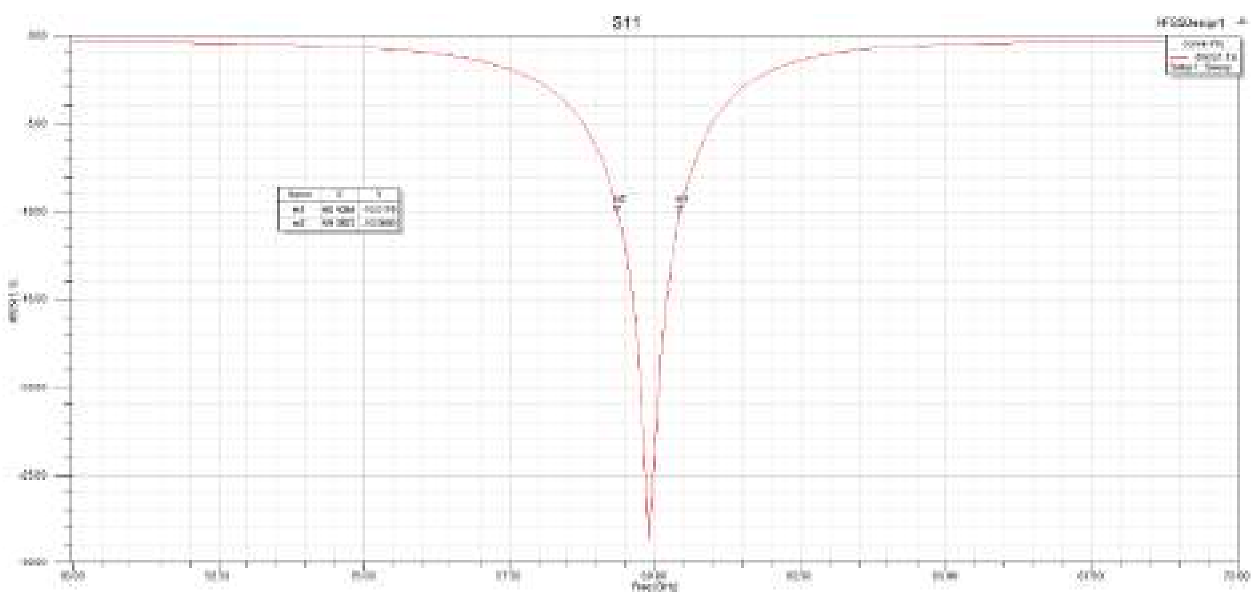
VSWR:



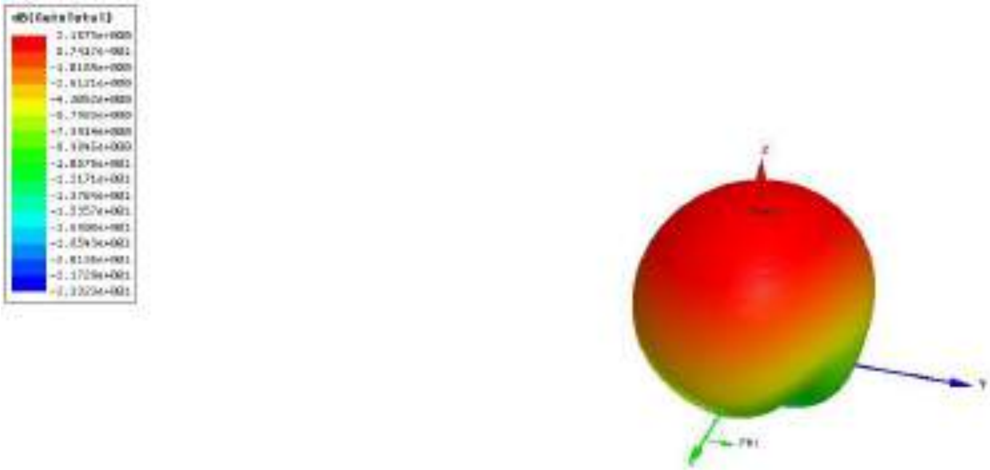
Rogers RO4350:



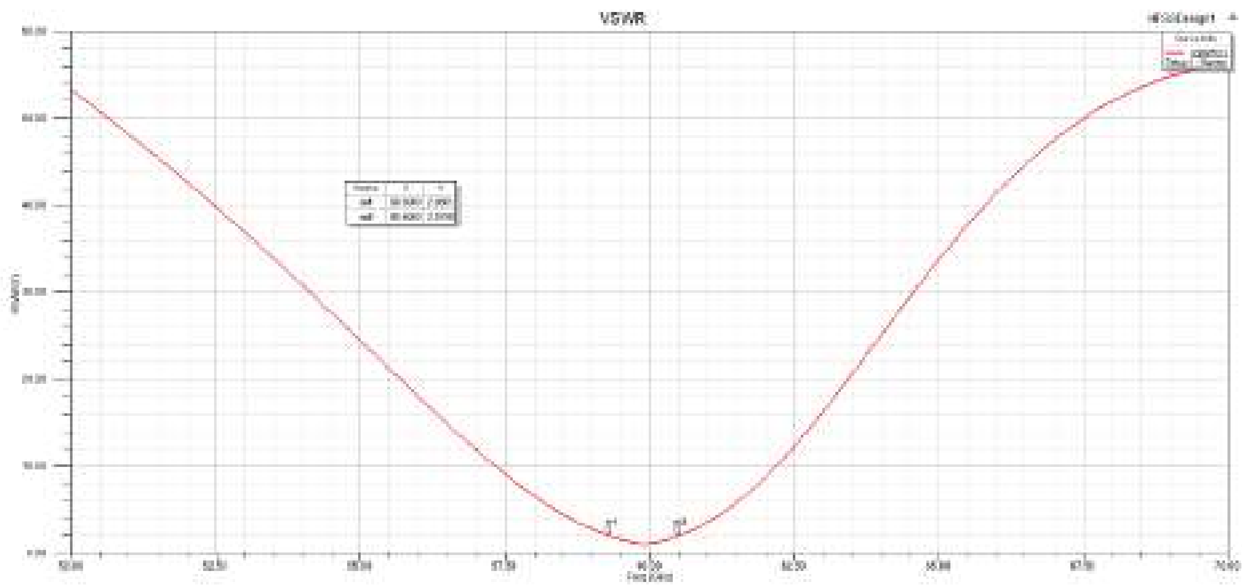
S11:



Gain:



VSWR:

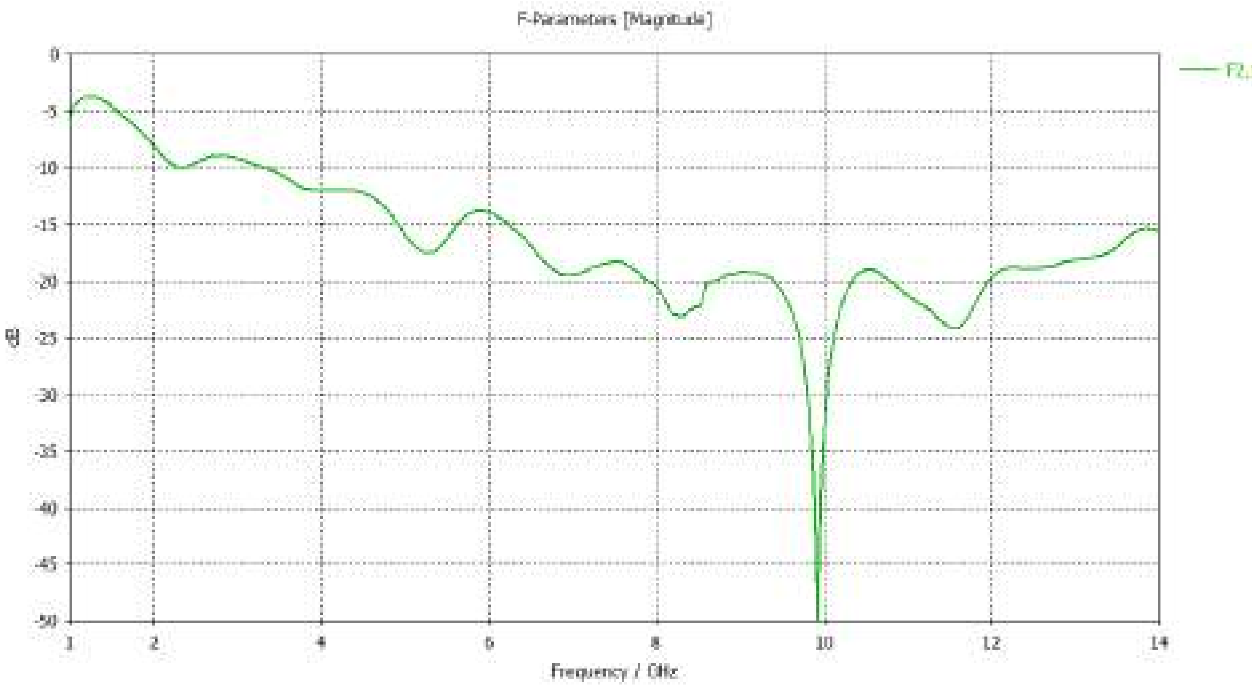


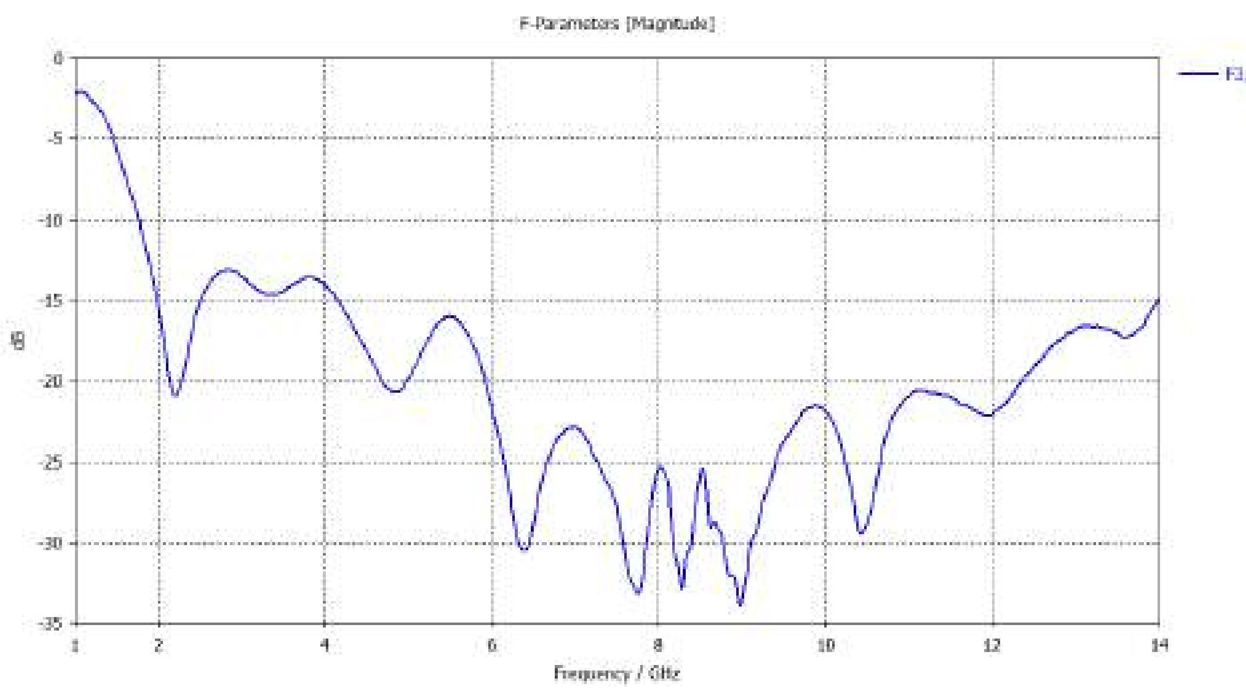
UWB Antenna Design (2-12 GHz)

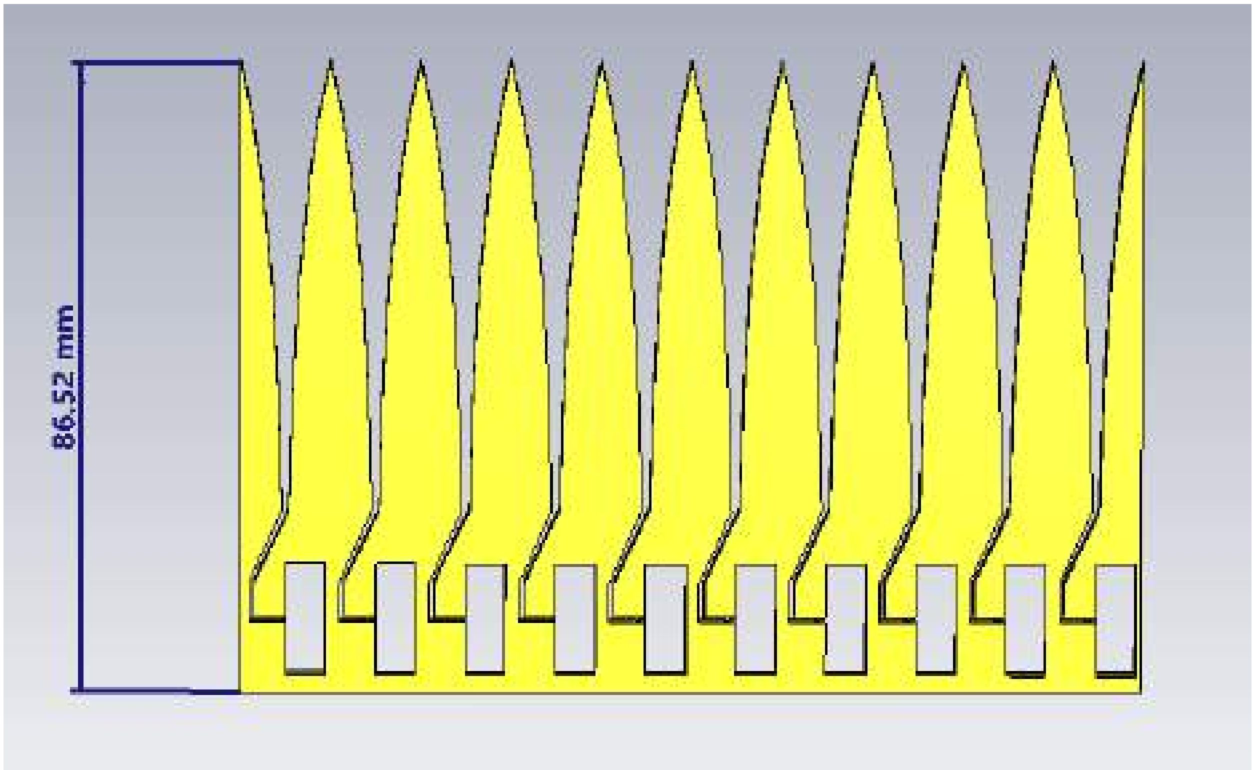
Vivaldi array of 1* 10 Elements.

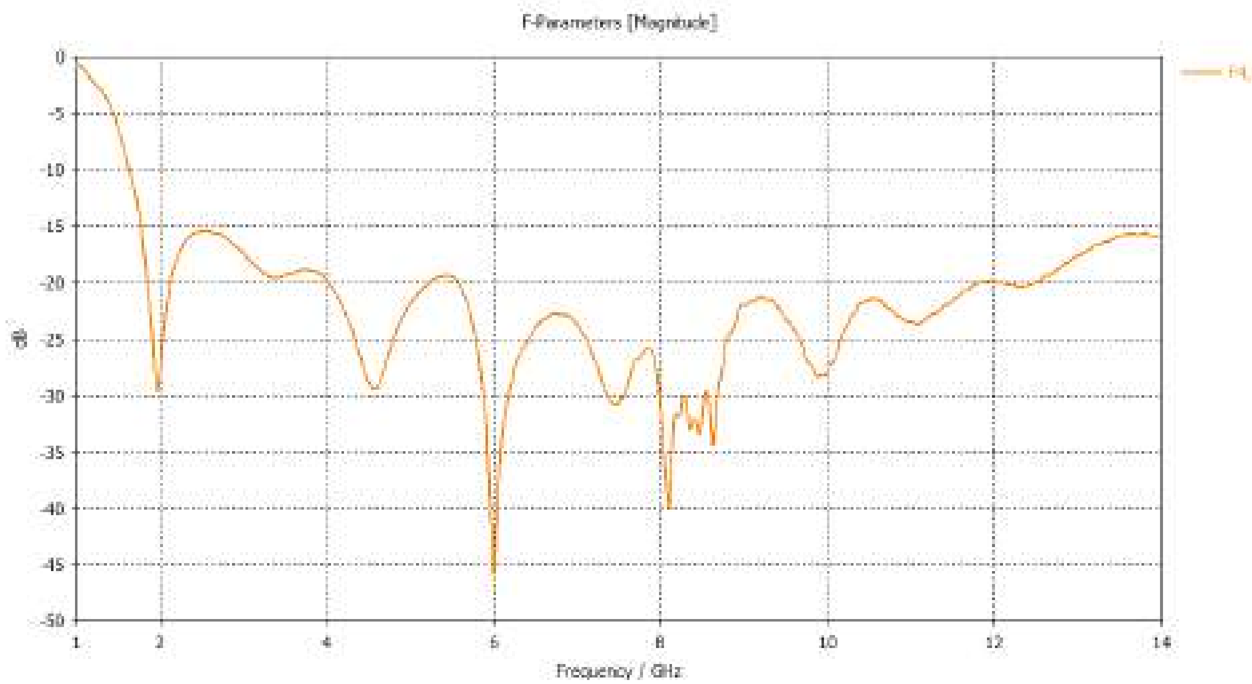
Hamid Ali Hassan (281815)

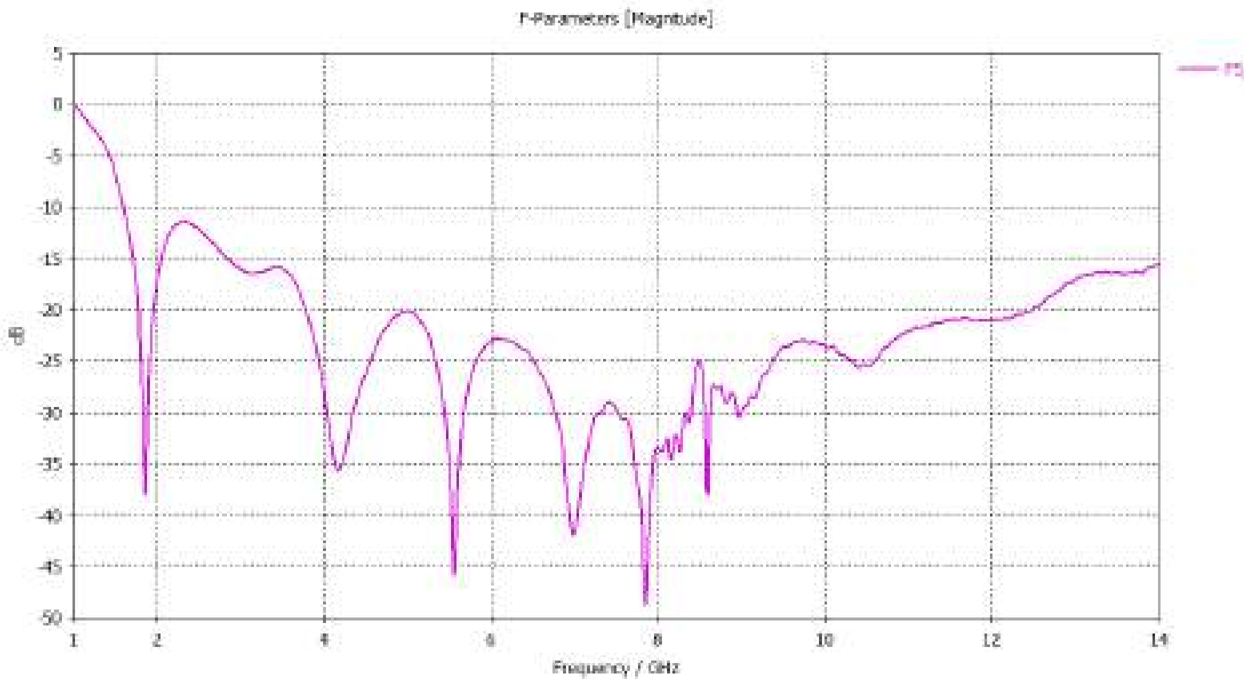
ONLY RESULTS

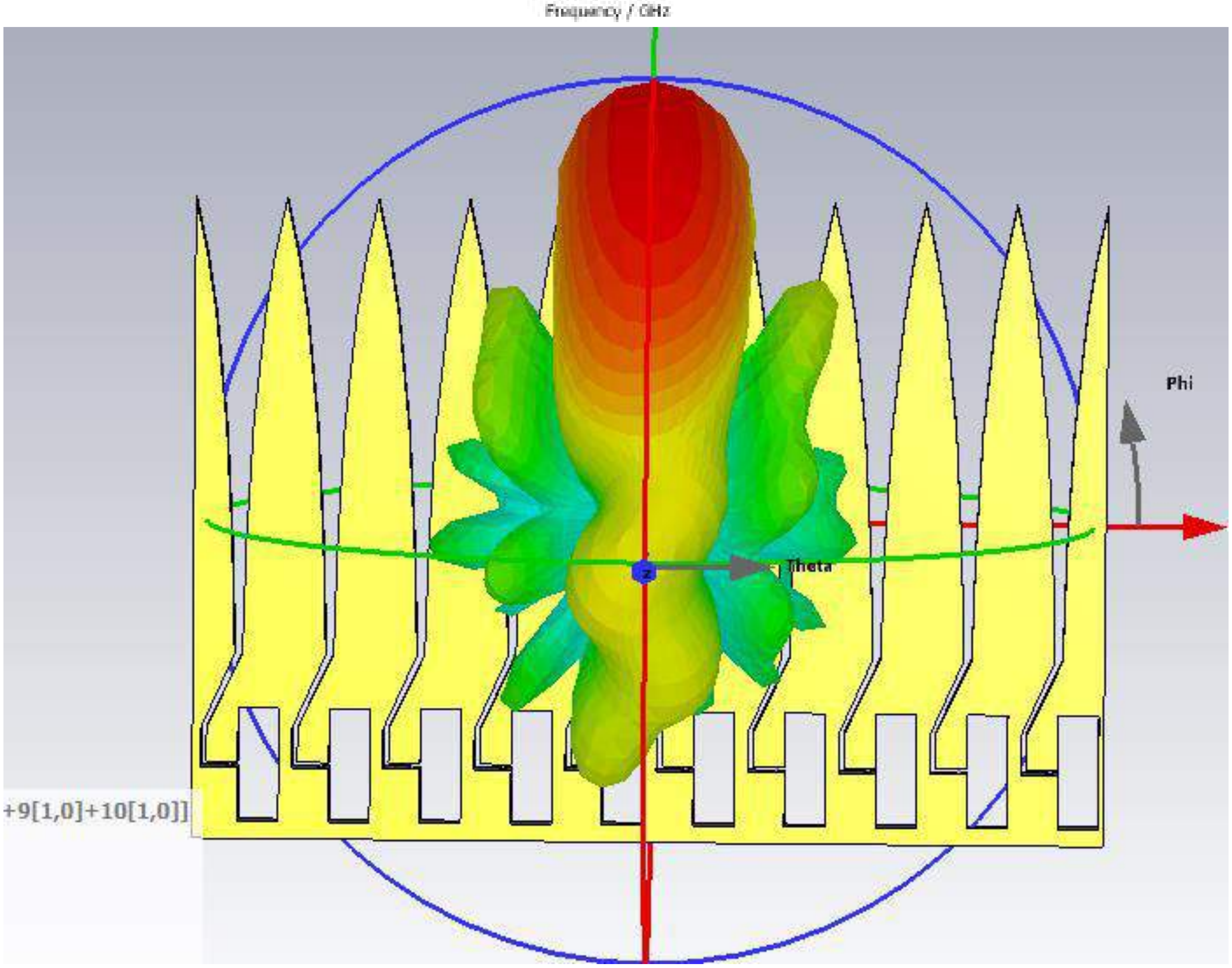

F-Parameters [Magnitude]
F2,1
dB
Frequency / GHz

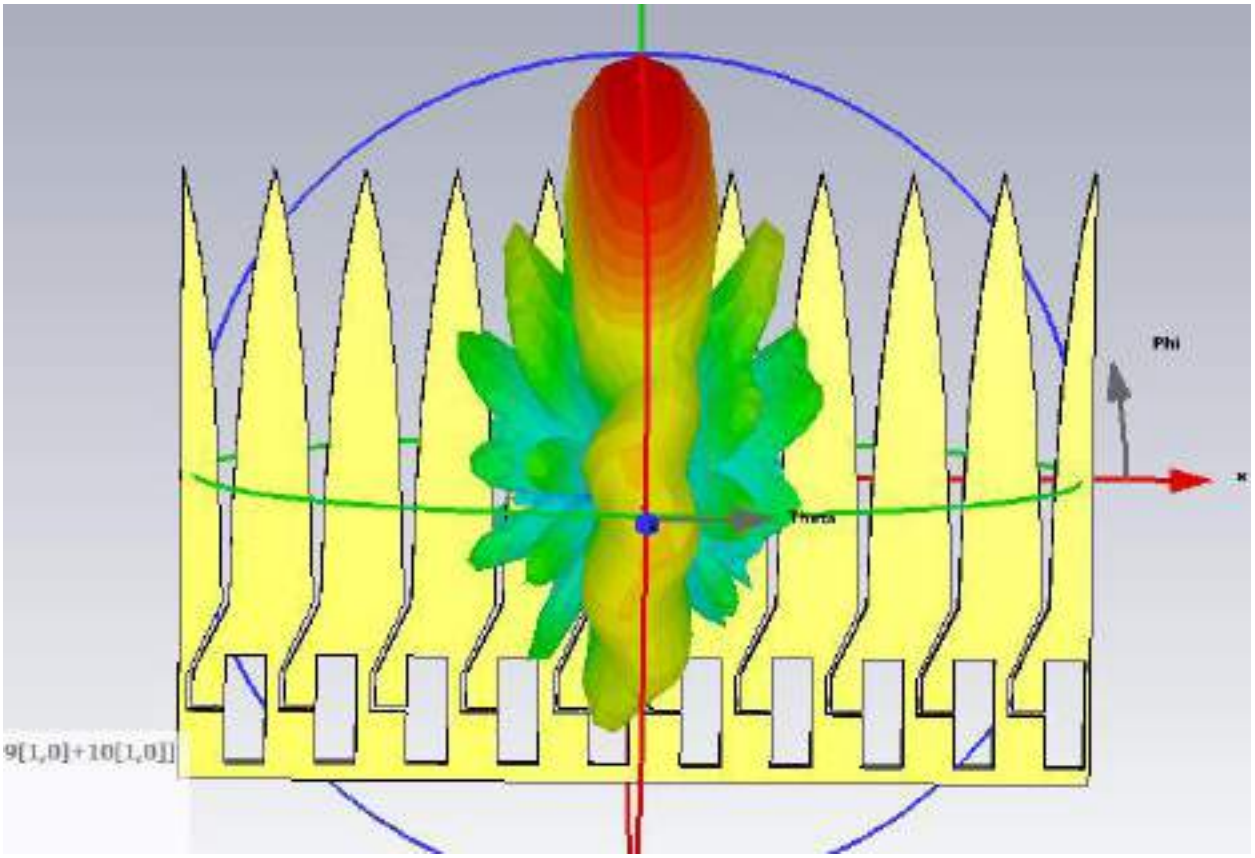

F-Parameters [Magnitude]
F3,
dB
Frequency / GHz

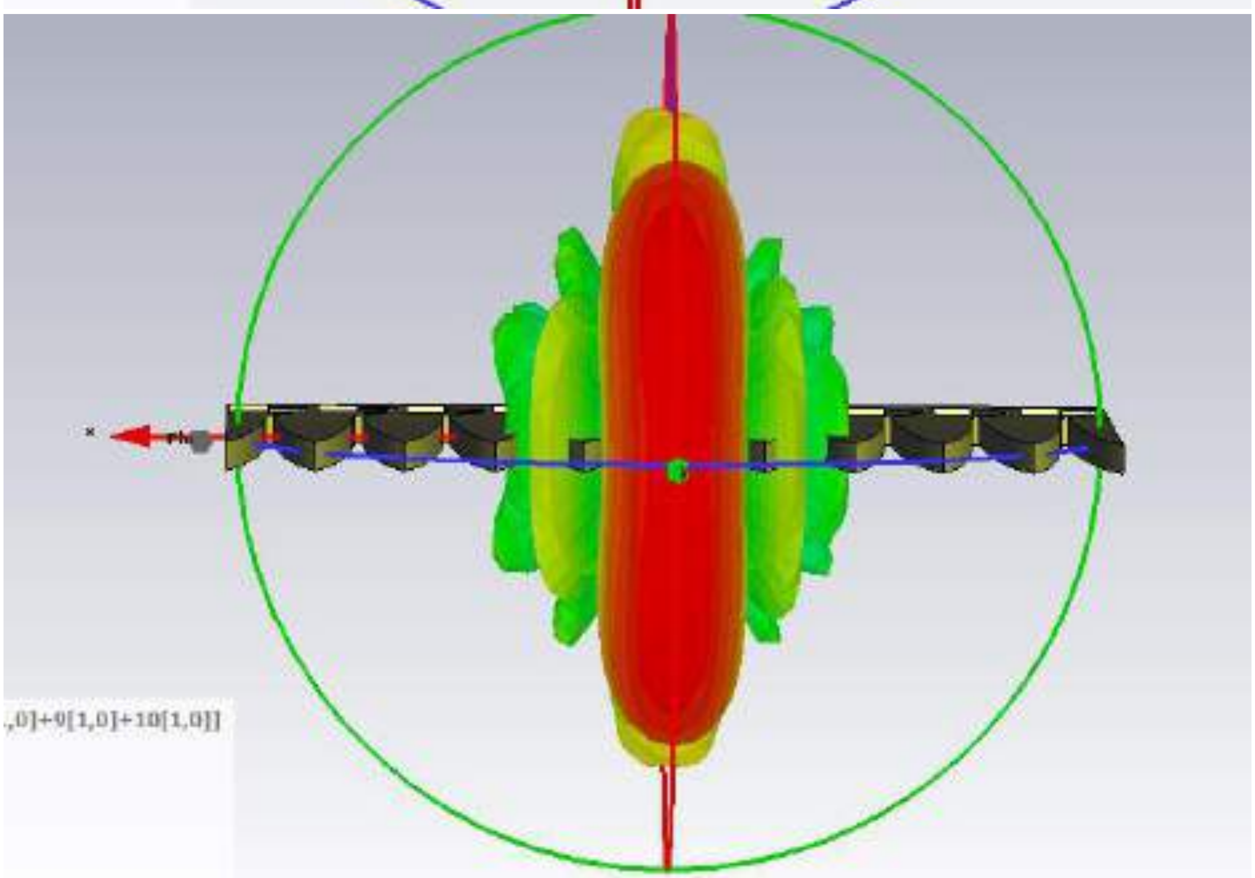

86.52 mm


F-Parameters [Magnitude]
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
dB
1
2
4
6
8
10
12
14
Frequency / GHz


F-Parameters [Magnitude]
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
dB
1
2
4
6
8
10
12
14
Frequency / GHz


Phi
Theta
z
+9[1,0]+10[1,0]]


Phi
x
Theta
9[1,0]+10[1,0]]


x
,0]+9[1,0]+10[1,0]]