CLASS: B.E. E &TC **SUBJECT: RMT**

EXPT. NO.: 1(b) **DATE:**

TITLE : To measure and compare radiation pattern, return loss, impedance, gain, beam width of folded dipole antenna at microwave frequency.

PREREQUISITES:

1. Half Power Beam Width
2. First Null Beam width
3. Reflection coefficient
4. Standing wave ratio

OBJECTIVE **:** To study various antenna parameters like radiation pattern, return loss, impedance, Directivity, gain and beam width so as to get a thorough understanding of an antenna.

APPARATUS **:**

Sr. No.	Apparatus	Range
1	Antenna Trainer Kit Amtec	0-2Ghz
2	Simple Dipole Antenna	
3	Folded Dipole Antenna	

THEORY **:**

Basic Characteristics:

In order to provide good matching characteristics, variations of the single dipole element must be used. One simple geometry that can achieve this is folded wire which forms a very thin (s<<lamda) rectangular loop.

A Folded dipole operates basically as an unbalanced transmission line and it can be analyzed by assuming that its current is decomposed into two distinct modes; a Transmission line mode and antenna mode.

Properties :

- It is basically a single antenna consisting two or three elements. The first element is fed directly while second and or third elements are coupled inductively at the ends.
- In a straight dipole, the total current is I but in folded dipole if current fed is I. Then the current in each arm is I/2 with condition that both arms are of same dimension.
- The radiation pattern of folded dipole antenna is same as that of straight dipole.
- The input impedance of folded dipole is 4 times that of straight dipole

- Rrad=4(73)=292ohm
- The spacing between arms of the folded dipole is very small and it is of the order of lamda/100.
- By using different diameters of two arms of folded dipole, the impedance can be transformed by factor ranging from 1.5 to 25.
- In yagi -uda antenna the folded dipole is used extensively as an active element.

Applications:

- Feed element of TV antennas such as Yagi-auDA ANTENNAS.
- As the terminal impedance of the folded dipole antenna can be adjusted over a wide range of impedances using different techniques it can be used as feed element for the antennas with very low and very high terminal impedances so that no impedance matching is required .

Advantages:

- It has high input impedance
- It has greater bandwidth
- It acts as built in reactance compensation network.
- It has better impedance matching characteristics.
- Its construction is simple and is cheaper.

PROCEDURE :

For Beam Width Calculations:

1. Connect the trainer kit with folded dipole antenna as the receiver and a dipole as the transmitter
2. Set the frequency of operation in the transmitter and receiver
3. Set the receiver to automatic mode
4. Mount the receiver on the stepper motor
5. Set the desired memory location on the receiver
6. Set the step size of motor as 5 units
7. Observe that the receiver power should be more than 40dBµ and less than 72dBµ.
8. Set the stepper motor on auto mode and let it rotate 360˚
9. Connect the receiver to the plot software and see the log plot.
10. Calculate the Beam-width of an antenna and print the radiation pattern.

For Gain Measurement:

1. Connect the trainer kit with folded dipole antenna as the receiver and a dipole as the transmitter
2. Set the frequency of operation in the transmitter and receiver
3. Set the receiver to automatic mode
4. Use a power splitter and measure input power to the transmitter in dBµ

5. Now measure the received power.
6. Observe that the receiver power should be more than 40dBμ and less than 72dBμ. Use attenuator if necessary. (Each Attenuator attenuates by 20dBμ)
7. Note the readings.
8. Calculate the Gain of an antenna.

For Directivity measurement

1. Follow the procedure of beam width calculation for horizontal orientation and vertical orientation of an antenna under test.
2. Calculate the half power beam width for vertical (elevation) and horizontal (azimuthal) antenna.
3. Calculate directivity using formula given below.

For Impedance Measurement

1. connect the IN terminal of directional coupler to the transmitter output.
2. Connect the OUT terminal of directional coupler to an antenna under test.
3. Connect the SAMPLE terminal to the receiver section
4. Note down the forward power seen on receiver screen.
5. Reverse the connections for IN and OUT terminals
6. Note down the reverse power on receiver screen
7. Calculate return loss and impedance of antenna using formulae and the chart given below .

OBSERVATIONS:

Type of Receiving antenna: Folded Dipole Antenna

Resonant Frequency: 600 MHz

Length of antenna element: 25 cm

Beam-width:

For Azimuthal:

HPBW	FNBW
360	**-**

For Elevation:

HPBW	FNBW
71	**180**

Gain of an Antenna:

Sr no.	Accepted power	Received Power	Gain
1.	338.85 nW	97.73 nW	111.08

Return Loss, VSWR and impedance:

Forward Power = -34.5 dBm

Reverse Power = -77.1 dBm

VSWR = 1.014936934

Return Loss = 42.6 dBm

Z_0 = 50 ohm

Reflection coefficient = 0.007413102413

Impedance = 50.74684669 ohm

Formulae:

1. **D**= 41000/(Half Power Azimuthal Beam width * Half Power Elevation Beam width)
2. $G_R = \frac{1}{G_T} \frac{P_{recieved}}{P_{accepted}} \left[\frac{4\pi R}{\lambda} \right]^2$
3. C=f*λ

CALCULATIONS:

1. **Beam width**

   Electric field is maximum at $\theta = 90^o$ with value 9 V/m

   3 dB scaled down value of max E-field is 4.85 V/m

   Angles corresponding to this value are $\theta = 36^o$ and $\theta = 325^o = -35^o$

   E-field HPBW = 36 – (-35)

   E-field HPBW = 71^o

   As H-field pattern is covering whole 360^o

   H-field HPBW = 360^o

2. **Gain:**

   Pt = 338.85 nW
   Pr = 97.73 nW
   R=1m
   Gt=1.64
   lambda=0.5

   Pr = Pt Gt Gr sq(lambda / 4 pi R)

   97.73n = 338.85n * 1.64 * Gr * (0.5/(4*pi*1)) * (0.5/(4*pi*1))

   Gr = 111.08522

3. **Directivity:**

   E-plane HPBW = 71 degrees
   H-plane HPBW = 360 degrees

   D = 41000 / ((HPBW-E) * (HPBW-H)) = 41000 / ((71) * (360)) = 1.604068858

   D= 1.604068858

4. **Return Loss**

   Forward power = -34.5 dBm
   Reverse power = -77.1 dBm

Return loss = Forward power - Reverse Power = (-34.5) - (- 77.1) = 42.6 dBm

Return loss = 42.6 dBm

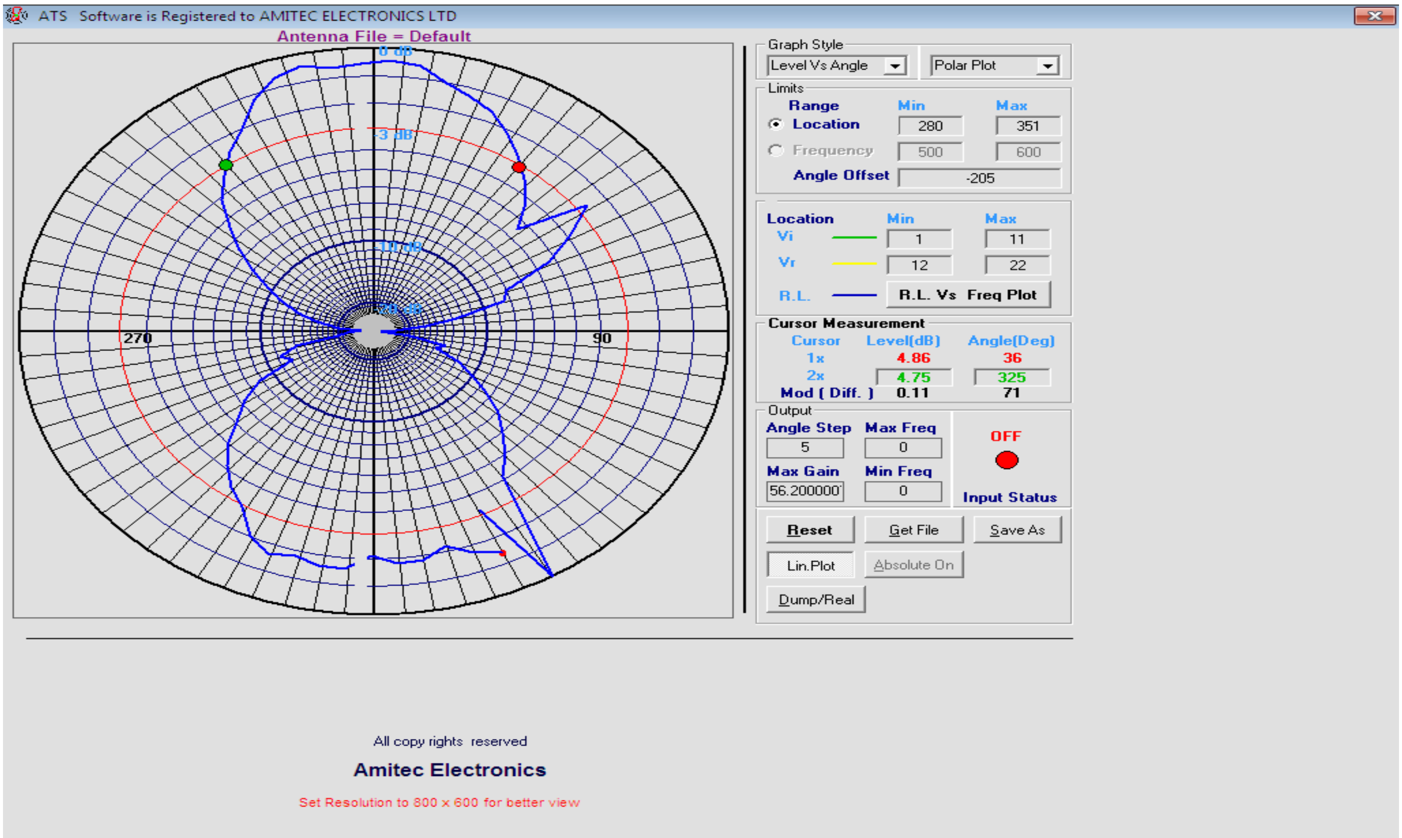
5. **Impedance:**

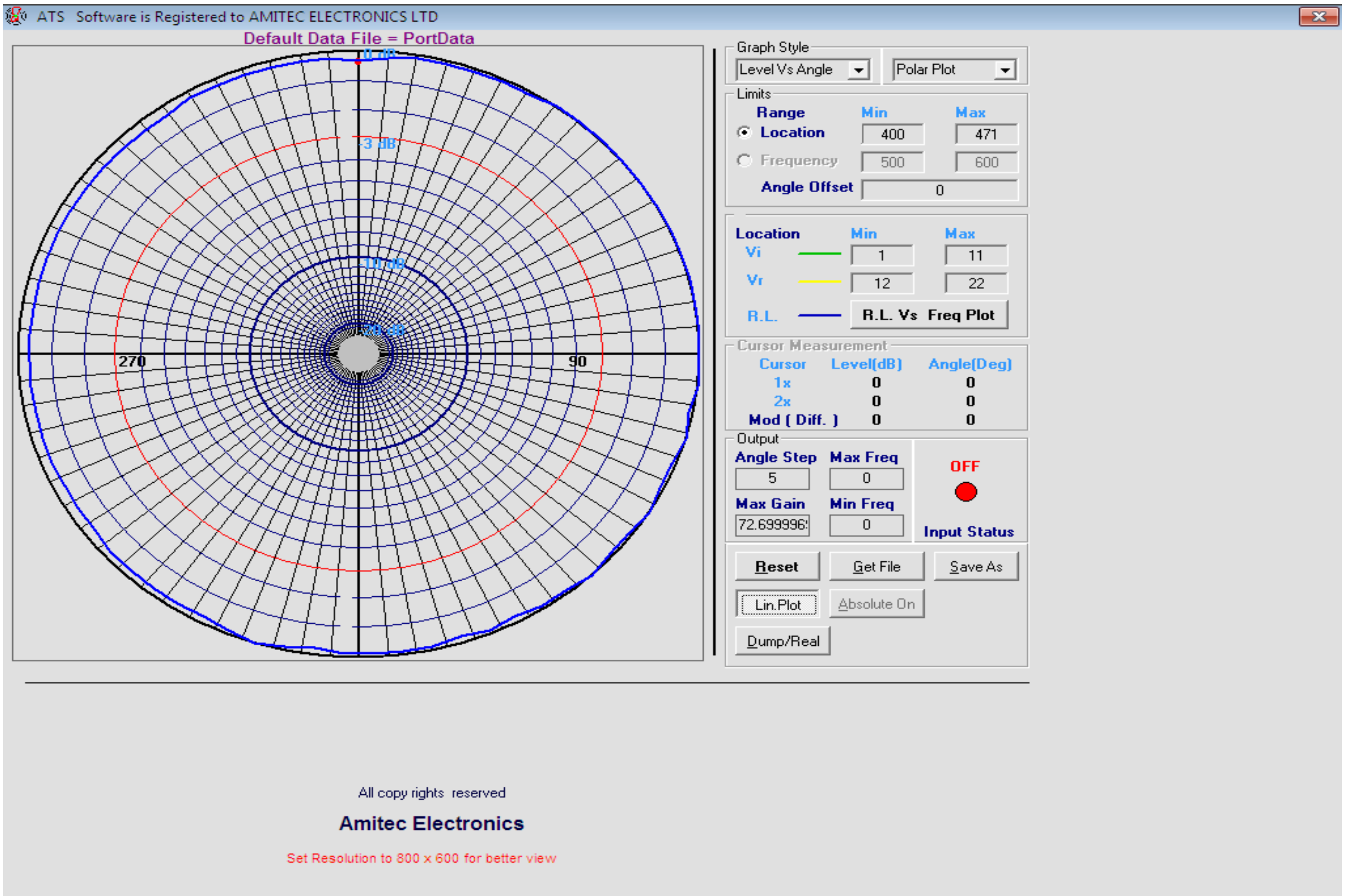
Return loss = -20log(tau) = 42.6
tau = 10 pow (-2.13) = 0.007413102413

tau = (Zl - Zo)/(Zl + Zo) = (Zl - 50)/(Zl + 50) = 0.007413102413

Zl = 50.74684669 ohm

GRAPHS:





CONCLUSION:

We studied various parameters for folded dipole antenna and variation of electric field over different theta values i.e. for vertical elevation values, HPBW = 60°. It exhibits apple shaped electric field pattern for different elevation and circular shaped for different azimuthal angles. The gain was 111.08 and directivity = 1.604 which is close to expected value of 1.64. Return loss was found to be 42.6dB and we expect to be as small as possible.

RERFERENCES:

1. Antenna Theory: Analysis and design, Constantine A. Balanis, 3rd Edition, John Wiley & Sons Ltd.
2. Principles of Antenna Theory, Kai Fong Lee, 1984, John Wiley and Sons Ltd. ISBN 0 471 90167 9.