Lab Assignment No.1

Title:

Trainer Description

These are the main units of trainer.

1. On-board Power DC Supply
2. RF Generator
3. Tone Generator
4. Directional Coupler
5. Matching stub
6. Goniometer
7. Detector Assembly

On-board Power DC Supply:

220 volt 50 Hz power is supplied to trainer. DC supply is generated by circuit built-in the trainer.

RF Generator:

Signal generators, also known variously as function generators, RF and microwave signal generators, pitch generators, arbitrary waveform generators, digital pattern generators or frequency generators are electronic devices that generate repeating or non-repeating electronic signals in either the analog or digital domains. They are generally used in designing, testing, troubleshooting, and repairing electronic or electroacoustic devices.

There are many different types of signal generators, with different purposes and applications and at varying levels of expense, in general, no device is suitable for all possible applications.

RF (radio frequency) and microwave signal generators are used for testing components, receivers and test systems in a wide variety of applications including cellular communications, WiFi, WiMAX, GPS, audio and video broadcasting, satellite communications, radar and electronic warfare. RF and microwave signal generators normally have similar features and capabilities, but are differentiated by frequency range.

RF signal generators typically range from a few kHz to 6 GHz, while microwave signal generators cover a much wider frequency range, from less than 1 MHz to at least 20 GHz. Some models go as high as 70 GHz with a direct coaxial output, and up to hundreds of GHz when used with external waveguide source modules.

RF generators deliver a test signal to feed the antennas under test. this generator operate at approximately 750MHz frequency. The reason being reduced sized for antennas, the higher is the frequency the smaller is the size of antennas and size of trainer as whole.

Features:

- Knob adjustable output power level.
- Facilitates the matched difference load.
- Modulating input AM which can be used with on board tone generator.
- Capability to stand indefinitely even heavily mismatched output.
- In extreme cases the generator starts oscillations and latches up in protection.
- Normal operation is stored by taking the level knob to zero or switch OFF the power and again switch ON.

Tone generator:

The tone generator created a tone based on the frequency of electrical pulses that it receives. The generator can produce tones in frequency from 500Hz to 2KHz. There is a diaphragm inside the generator that vibrates as pulses are received. The faster the pulses, the higher the pitch of tone created. The tone generator can be used to create one or several different notes. If you properly control the tone generator, you can play short songs by playing different notes for specific durations.

This provide amplitude adjustable sine wave of 1 KHz for modulation of RF generator.

Directional couplers:

Power dividers also power splitters and, when used in reverse, power combiners and directional couplers are passive devices used in the field of radio technology. They couple a defined amount of the electromagnetic power in a transmission line to a port enabling the signal to be used in another circuit.

An essential feature of directional couplers is that they only couple power flowing in one direction. Power entering the output port is coupled to the isolated port but not to the coupled port.

Directional couplers are most frequently constructed from two coupled transmission lines set close enough together such that energy passing through one is coupled to the other. This technique is favored at the microwave frequencies the devices are commonly employed with.

This allows separate metering of power flowing in the forward direction i.e. generator antenna and reverse direction i.e. antenna to generator.

This is used during the experiment to match the generator to the load and as a mean measure the standing wave ratio in the transmission line to the antennas.

Matching Stub:

Matching the impedance of a network to the impedance of a transmission line has two principal advantages. First, all the incident power is delivered to the network. Second, the generator is usually designed to work into an impedance close to common transmission line impedances. If it does so it is better behaved, the load impedance has no reactive part which can pull the generator frequency, and the VSWR on the line is unity or close to unity so the line length is immaterial and the line connecting the generator to the load is non-resonant.

Stubs are shorted or open circuit lengths of transmission line intended to produce a pure reactance at the attachment point, for the line frequency of interest. Any value of reactance can be made, as the stub length is varied from zero to half a wavelength.

This is a trunk of transmission line build on PCB provided with a slide cursor shortening the line at presentable length from the other end.

Goniometer:

A goniometer is an instrument that either measures an angle or allows an object to be rotated to a precise angular position. The term goniometry is derived from two Greek words, gōnia, meaning angle, and metron, meaning measure.

A positioning goniometer or goniometric stage is a device used to rotate an object precisely about a fixed axis in space. It is similar to a linear stage, however, rather than moving linearly with respect to its base, the stage platform rotates partially about a fixed axis above the mounting surface of the platform.

Positioning goniometers typically use a worm drive with a partial worm wheel fixed to the underside of the stage platform meshing with a worm in the base. The worm may be rotated manually or by a motor as in automated positioning systems.

This is a circular scale graded in 360O at the center of this located the BNC female connector. Reading the RF power to the antenna mast. The base of the mass has reference index mark matching the goniometer scale.

Detector Assembly:

This item is used to detect and measure the radiation pattern of antenna under study. It is completely passive element, no batteries are required, thus simplifying use and maintenance of the device. The unit offers possibility of hand-held use for approximate exploration of radiation patterns or mounted on base stand for precise orientation and stable measurement results.

The features of detector.

- Completely passive instruments.
- No Batteries are required.
- Simply used and maintenance of the unit.

Orientable fixing clamp allowing the detector to mount in vertically or horizontally on its base stand in order to detect vertically or horizontally polarized waves.

Questions

Define Antenna in detail also tell different type of antenna.

An antenna or aerial is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver.

Typically an antenna consists of an arrangement of metallic conductors elements, electrically connected often through a transmission line to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave.

Antenna Type:

Iso-tropic, Omni directional, Directional

Isotropic:

Radiate energy uniformly in all direction, e.g. Hertzian dipole.

Omni Directional:

Radiate energy in one plane, e.g. monopoles, dipoles

Directional:

Radiate energy in one particular direction, e.g. Yagi UDA, long periodic Helical.

What you know about transmitter and receiver antenna?

An antenna or aerial is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency i.e. a high frequency alternating current (AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

Give some detail on RF signals.

Radio frequency (RF) is a rate of oscillation in the range of around 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals. RF usually refers to electrical rather than mechanical oscillations.

The energy in an RF current can radiate off a conductor into space as electromagnetic waves, this is the basis of radio technology.

RF current does not penetrate deeply into electrical conductors but tends to flow along their surfaces; this is known as the skin effect. For this reason, when the human body comes in contact with high power RF currents it can cause superficial but serious burns called RF burns.

When conducted by an ordinary electric cable, RF current has a tendency to reflect from discontinuities in the cable such as connectors and travel back down the cable toward the source, causing a condition called standing waves, so RF current must be carried by specialized types of cable called transmission line.

What is the length of antenna to match 6215 KHz?

The formula for a half wave dipole, as we all should have learned is based on a constant number of 468, which is divided by the center frequency we wish to use for our dipole, giving us our total length in feet for the dipole.

468 / freq(MHz) = total feet length

468/6.215 = 75.30 feet

Explain input impedance of Balanced-pair transmission line.

In telecommunications and professional audio, a balanced line or balanced signal pair is a transmission line consisting of two conductors of the same type, each of which have equal impedances along their lengths and equal impedances to ground and to other circuits. The chief advantage of the balanced line format is good rejection of external noise when fed to a differential amplifier.

Lab Assignment No. 2:

Title:

To Study The Radiation Pattern Of Dipole Antenna Of Length λ/2

Objective:

To Plot The Radiation Pattern Of Dipole Antenna Of Length λ/2

Theory:

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency i.e. a high frequency alternating current (AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

Typically an antenna consists of an arrangement of metallic conductors (elements), electrically connected often through a transmission line to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave.

Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

Antennas can be designed to transmit and receive radio waves in all horizontal directions equally omnidirectional antennas, or preferentially in a particular direction.

Antenna Type:

Iso-tropic, Omni directional, Directional

Isotropic:

Radiate energy uniformly in all direction, e.g. Hertzian dipole.

Omni Directional:

Radiate energy in one plane, e.g. monopoles, dipoles.

Directional:

Radiate energy in one particular direction, e.g. Yagi UDA, long periodic Helical.

Simple Dipole:

Having two poles and various lengths, (λ, $\lambda/2$, $\lambda/4$, $3\lambda/2$), uniform radiation pattern is same in both reverse and forward direction.

In radio and telecommunications a dipole antenna or doublet is the simplest and most widely used class of antenna. It consists of two identical conductive elements such as metal wires or rods, which are usually bilaterally symmetrical. The driving current from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the two halves of the antenna. Each side of the feed line to the transmitter or receiver is connected to one of the conductors. This contrasts with a monopole antenna, which consists of a single rod or conductor with one side of the feed line connected to it, and the other side connected to some type of ground. A common example of a dipole is the "rabbit ears" television antenna found on broadcast television sets.

The most common form of dipole is two straight rods or wires oriented end to end on the same axis, with the feed line connected to the two adjacent ends. This is the simplest type of antenna from a theoretical point of view. Dipoles are resonant antennas, meaning that the elements serve as resonators, with standing waves of radio current flowing back and forth between their ends. So the length of the dipole elements is determined by the wavelength of the radio waves used. The most common form is the half-wave dipole, in which each of the two rod elements is approximately 1/4 wavelength long, so the whole antenna is a half-wavelength long.

Typically a dipole antenna is formed by two quarter-wavelength conductors or elements placed back to back for a total length of $L = \lambda/2$. A standing wave on an element of length approximately $\lambda/2$ yields the greatest voltage differential, as one end of the element is at a node while the other is at an antinode of the wave. The larger the differential voltage, the greater the current between the elements.

Table:

Reading of Angle on Goniometer (Degree)	Reading of Current (µA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (µA)	Current Reading in dB
0	20	22.27	180	46	28.9
10	40	26	190	71	33
20	55	32	200	84	37
30	65	35	210	92	38
40	72	36	220	101	39
50	86	37	230	100	40
60	77	38.6	240	89	40
70	69	37.7	250	76	38.9
80	78	36.7	260	61	37
90	57	37.8	270	45	35.7
100	32	35	280	30	33
110	38	30.6	290	29	29.5
120	28	31.6	300	12	29.5
130	12	28.9	310	6	21.5
140	4	21	320	2	16.3
150	3	12	330	1	6
160	9	9.5	340	5	13.9
170	28	19	350	13	22.27

Questions

What you know about dipole antenna?

In radio and telecommunications a dipole antenna or doublet is the simplest and most widely used class of antenna. It consists of two identical conductive elements such as metal wires or rods, which are usually bilaterally symmetrical. The driving current from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the two halves of the antenna. Each side of the feed line to the transmitter or receiver is connected to one of the conductors.

Why does a dipole antenna need insulation in the center and the ends?

A dipole should have insulators at its center and at the end, where ropes support the antenna. The center insulator serves two primary purposes.

It separates and supports the feed-line conductors, making for strong mechanical wire joints that minimize stress on solder joints.

It gives you a convenient place from which to support the dipole with a rope, if your dipole is center-supported.

End insulators serve another purpose.

They provide an isolated support point at the high voltage ends of the antenna wire.

What are the advantages of monopole antenna over dipole antenna?

It's shorter in length and has more gain than the standard half wave dipole.

In a simple half wave dipole the feeder connects to two elements radiating of the half wave dipole. In the monopole, one of those radiating elements is missing making the antenna reduced in length. This missing element is replaced by a ground plane that acts like a 'mirror' for the e/m wave and in effect replaces the missing radiating element. The ground plane may be a sheet or 3 or more radials normally at right angles to the radiating element. Typically, you can expect twice the gain over a half wave dipole (+3dB).

How was the 2.14dBi gain of dipole antenna over isotropic antenna derived?

Antennas are rated in comparison to isotropic or dipole antennas. An isotropic antenna is a theoretical antenna with a uniform three-dimensional radiation pattern similar to a light bulb with no reflector. In other words, a theoretical isotropic antenna has a perfect 360 degree vertical and horizontal beam width or a spherical radiation pattern. It is an ideal antenna which radiates in all directions and has a gain of 1 (0 dB), i.e. zero gain and zero loss. It is used to compare the power level of a given antenna to the theoretical isotropic antenna.

Antennas can be broadly classified as omnidirectional and directional antennas, which depends on the directionality. Unlike isotropic antennas, dipole antennas are real antennas. The dipole radiation pattern is 360 degrees in the horizontal plane and approximately 75 degrees in the vertical plane this assumes the dipole antenna is standing vertically and resembles a donut in shape. Because the beam is slightly concentrated, dipole antennas have a gain over isotropic antennas of 2.14 dB in the horizontal plane. Dipole antennas are said to have a gain of 2.14 dBi, which is in comparison to an isotropic antenna. The higher the gain of the antennas, the smaller the vertical beam width is.

Will a simple dipole antenna pickup digital TV?

Simple half-wave dipole antenna for VHF or UHF loop antennas that are made to be placed indoors are often used for television, these are often called "rabbit ears" or "bunny aerials". Because of their appearance. The length of the telescopic "ears" can be adjusted by the user, and should be about one half of the wavelength of the signal for the desired channel. These are not as efficient as an aerial rooftop antenna since they are less directional and not always adjusted to the proper length for the desired channel. Dipole antennas are bi-directional, that is, they receive evenly forward and backwards, and also cover a broader band than antennas with more elements.

Lab Assignment No. 3:

Title:

To Study The Radiation Pattern Of Dipole Antenna Of Length λ/4

Objective:

To Plot The Radiation Pattern Of Dipole Antenna Of Length λ/4

Theory:

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency i.e. a high frequency alternating current (AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

Typically an antenna consists of an arrangement of metallic conductors (elements), electrically connected often through a transmission line to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave. Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

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Radiate energy in one plane, e.g. monopoles, dipoles.

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The most common form of dipole is two straight rods or wires oriented end to end on the same axis, with the feed line connected to the two adjacent ends. This is the simplest type of antenna from a theoretical point of view. Dipoles are resonant antennas, meaning that the elements serve as resonators, with standing waves of radio current flowing back and forth between their ends. So the length of the dipole elements is determined by the wavelength of the radio waves used. The most common form is the half-wave dipole, in which each of the two rod elements is approximately 1/4 wavelength long, so the whole antenna is a half-wavelength long.

Table:

Reading of Angle on Goniometer (Degree)	Reading of Current (µA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (µA)	Current Reading in dB
0	0.2	13.97	180	0.2	13.97
10	0.6	4.43	190	0.1	20
20	0.7	3.09	200	0.1	20
30	0.8	1.93	210	0.1	20
40	0.6	4.43	220	0.1	20
50	0.5	6	230	0.1	20
60	0.2	13.97	240	0.1	20
70	0.3	10.45	250	0.1	20
80	0.2	13.97	260	0.2	13.97
90	0.1	20	270	0.20	13.97
100	0.1	20	280	0.2	13.97
110	0.2	13.97	290	0.2	13.97
120	0.2	13.97	300	0.2	13.97
130	0.2	13.97	310	0.1	20
140	0.1	20	320	0.1	20
150	0.2	13.97	330	0.3	10.45
160	0.2	13.97	340	0.4	7.95
170	0.2	13.97	350	0.2	13.97

Questions

Why is the half wave dipole antenna a much more practical antenna than the short dipole antenna?

The short dipole is a form of dipole antenna created by feeding a wire, typically in the centre with a signal. The electrical length of the overall radiating element typically has to be less than a tenth of a wavelength to make a short dipole antenna.

In practice, short antennas, and in this case the sort dipole antenna is rarely satisfactory from an efficiency viewpoint because much of the power entering it is dissipated as heat as the resistive losses are normally very high.

Current distribution for the short dipole follows the same sinusoidal curve as used for all other forms of dipole. However as only the end section of the sine curve is applicable, this can be equated to a straight line without introducing any major errors.

The half wave dipole is formed from a conducting element which is wire or metal tube which is an electrical half wavelength long. It is typically fed in the centre where the impedance falls to its lowest. In this way, the antenna consists of the feeder connected to two quarter wavelength elements in line with each other.

The voltage and current levels vary along the length of the radiating section of the antenna. This occurs because standing waves are set up along the length of the radiating element.

As the ends are open circuit current at these points is zero, but the voltage is at its maximum.

As the point at which these quantities is measured moves away from the ends, it is found that they vary sinusoidally: the voltage falling, but the current rising. The current then reaches a maximum and the voltage a minimum at a length equal to an electrical quarter wavelength from the ends. As it is a half wave dipole, this point occurs in the centre.

How does a dipole antenna work?

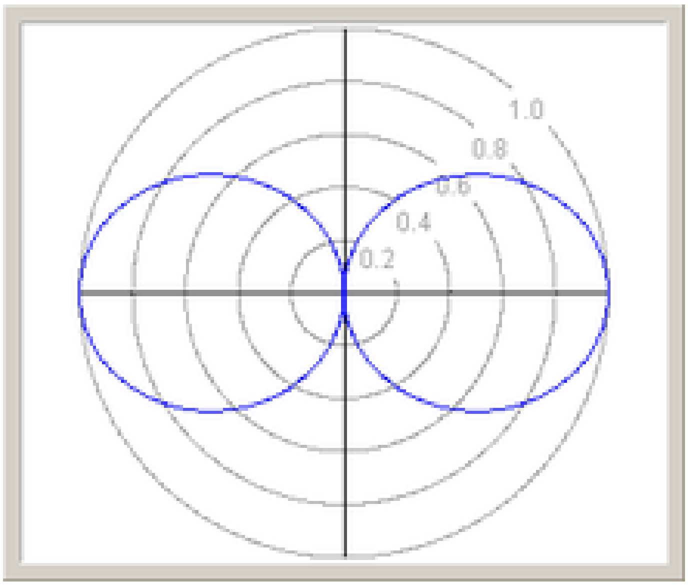
In radio and telecommunications a dipole antenna or doublet is the simplest and most widely used class of antenna. It consists of two identical conductive elements such as metal wires or rods, which are usually bilaterally symmetrical. The driving current from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the two halves of the antenna. Each side of the feed line to the transmitter or receiver is connected to one of the conductors. This contrasts with a monopole antenna, which consists of a single rod or conductor with one side of the feed line connected to it, and the other side connected to some type of ground. A common example of a dipole is the "rabbit ears" television antenna found on broadcast television sets.

The most common form of dipole is two straight rods or wires oriented end to end on the same axis, with the feed line connected to the two adjacent ends. This is the simplest type of antenna from a theoretical point of view.

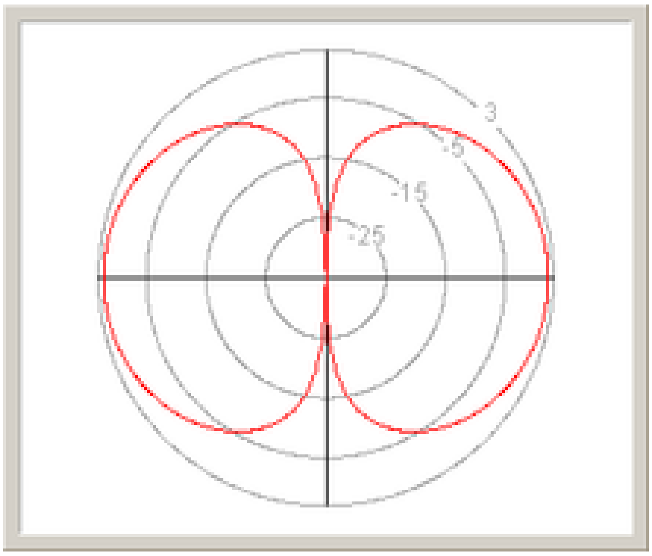
Dipoles are resonant antennas, meaning that the elements serve as resonators, with standing waves of radio current flowing back and forth between their ends. So the length of the dipole elements is determined by the wavelength of the radio waves used. The most common form is the half-wave dipole, in which each of the two rod elements is approximately 1/4 wavelength long, so the whole antenna is a half-wavelength long.

Discuss radiation pattern of dipole antenna.

Dipoles have a radiation pattern, shaped like a toroid (doughnut) symmetrical about the axis of the dipole. The radiation is maximum at right angles to the dipole, dropping off to zero on the antenna's axis. The theoretical maximum gain of a Hertzian dipole is 10 log 1.5 or 1.76 dBi. The maximum theoretical gain of a half-wave bipole is 10 log 1.64 or 2.15 dBi.



Radiation pattern of a half-wave dipole antenna. The scale is linear.



Gain of a half-wave dipole. The scale is in dBi.

Lab Assignment No. 4:

Title:

To Study The Radiation Pattern Of Folded Dipole Antenna

Objective:

To Plot The Radiation Pattern Of Folded Dipole Antenna

Theory:

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency i.e. a high frequency alternating current (AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

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the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

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Omni Directional:

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Directional:

Radiate energy in one particular direction, e.g. Yagi UDA, long periodic Helical.

Folded Dipole:

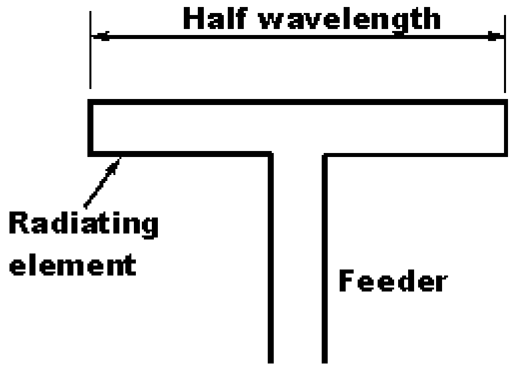
The standard dipole is widely used in its basic form. However under a number of circumstances a modification of the basic dipole, known as a folded dipole antenna provides a number of advantages.

The folded dipole antenna or folded dipole aerial is widely used, not only on its own, but also as the driven element in other antenna formats such as the Yagi antenna.

A folded dipole is a half-wave dipole with an additional wire connecting its two ends. If the additional wire has the same diameter and cross-section as the dipole, two nearly identical radiating currents are generated. The resulting far-field emission pattern is nearly identical to the one for the single-wire dipole described above, but at resonance its feed point impedance R_{fd} is four times the radiation resistance of a single-wire dipole. This is because for a fixed amount of power, the total radiating current I_0 is equal to twice the current in each wire and thus equal to twice the current at the feed point.

The folded dipole antenna uses an extra wire connecting both ends of dipole. Often this is achieved by using a wire or rod of the same diameter for all sections of the antenna, but this is not always the case. Also the wires or rods are typically equally spaced along the length of the parallel elements. This can be achieved in a number of ways.

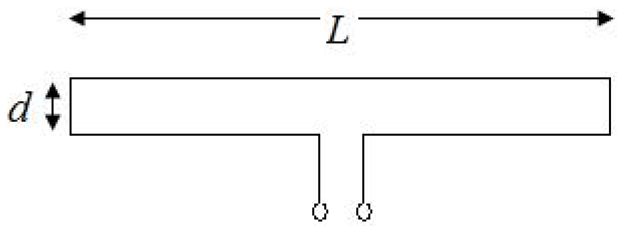
Often for VHF or UHF antennas the rigidity of the elements is sufficient, but at lower frequencies spacers may need to be employed. To keep the wires apart. Obviously if they are not insulated it is imperative to keep them from shorting. In some instances flat feeder can be used.



Another common place one can see dipoles is as antennas for the FM band, these are folded dipoles. The tips of the antenna are folded back until they almost meet at the feed point, such that the antenna comprises one entire wavelength. This arrangement has a greater bandwidth than a standard half-wave dipole. If the conductor has a constant radius and cross-section, at resonance the input impedance is four times that of a half-wave dipole.

Moreover, the folded dipole can be used for transforming the value of input impedance of the dipole over a broad range of step-up ratios by changing the thicknesses of the wire conductors for the fed- and folded-sides.

A folded dipole is a dipole antenna with the ends folded back around and connected to each other, forming a loop as shown in Figure.



Typically, the width d of the folded dipole antenna is much smaller than the length L. Because the folded dipole forms a closed loop, one might expect the input impedance to depend on the input impedance of a short-circuited transmission line of length L. However, the folded dipole antenna as two parallel short-circuited transmission lines of length L/2. It turns out the impedance of the folded dipole antenna will be a function of the impedance of a transmission line of length L/2.

Also, because the folded dipole is "folded" back on itself, the currents can reinforce each other instead of cancelling each other out, so the input impedance will also depend on the impedance of a dipole antenna of length L.

The folded dipole antenna is resonant and radiates well at odd integer multiples of a half-wavelength (0.5 λ , 1.5 λ , ...)

when the antenna is fed in the center. The input impedance of the folded dipole is higher than that for a regular dipole.

The folded dipole antenna can be made resonant at even multiples of a half-wavelength (1.0 λ , 2.0 λ ,...) by off setting the feed of the folded dipole.

One of the main reasons for using the folded dipole aerial is the increase in feed impedance that it provides. If the conductors in the main dipole and the second or "fold" conductor are the same diameter, then it is found that there is a fourfold increase i.e. two squared in the feed impedance. In free space, this gives an increase in feed impedance from 73Ω to around 300Ω ohms. Additionally the RF antenna has a wider bandwidth.

Folded dipole impedance:

In a standard dipole the currents flowing along the conductors are in phase and as a result there is no cancellation of the fields and radiation occurs. When the second conductor is added to make the folded dipole antenna this can be considered as an extension to the standard dipole with the ends folded back to meet each other. As a result the currents in the new section flow in the same direction as those in the original dipole. The currents along both the half-waves are therefore in phase and the antenna will radiate with the same radiation patterns etc. as a simple half-wave dipole.

The impedance increase can be deduced from the fact that the power supplied to a folded dipole antenna is evenly shared between the two sections which make up the antenna. This means that when compared to a standard dipole the current in each conductor is reduced to a half. As the same power is applied, the impedance has to be raised by a factor of four to retain balance in the equation Watts = $I^2 R$.

Folded dipole transmission line effect:

The folded element of the folded dipole antenna has a transmission line effect attached with it. It can be viewed that the impedance of the dipole appears in parallel with the impedance of the shorted transmission line sections.

The length is affected by this effect. Normally the wavelength of a standing wave in a feeder is affected by the velocity factor. If air is used, this will by around 95% of the free space value. However if a flat feeder with a lower velocity factor is used, then this will have the effect of shortening the required length.

The feeder effect also results in the folded dipole antenna having a flatter response, i.e. a wider bandwidth than a non-folded dipole. It occurs because at a frequency away from resonance, the reactance of the dipole is of the opposite form from that of the sorted transmission line and as a result there is some reactance cancellation at the feed point of the antenna.

Folded dipole advantages

There are a number of advantages or reasons for using a folded dipole antenna.

Increase in impedance: When higher impedance feeders need to be used, or when the impedance of the dipole is reduced by factors such as parasitic elements, a folded dipole provides a significant increase in impedance level that enables the antenna to be matched more easily to the feeder available.

Wide bandwidth: The folded dipole antenna has a flatter frequency response, this enables it to be used over a wider bandwidth.

Table:

Reading of Angle on Goniometer (Degree)	Reading of Current (µA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (µA)	Current Reading in dB
0	33	30.37	180	46	33.25
10	8	18.06	190	33	30.3
20	11	20.82	200	28	28.94
30	17	24.60	210	20	26.02
40	38	31.59	220	6	15.56
50	54	34.64	230	4.6	13.25
60	63	35.48	240	9	19.08
70	66	36.39	250	25	27.95
80	72	37.14	260	38	31.59
90	74	37.38	270	64	36.12
100	77	37.72	280	71	37.02
110	78	37.84	290	94	39.46
120	99	39.91	300	115	41.21
130	95	39.55	310	109	40.74
140	85	38.68	320	97	39.73
150	68	36.65	330	90	39.09
160	73	37.26	340	71	37.02
170	56	34.96	350	40	32.04

Questions

How can you make folded dipole antenna?

The folded dipole antenna uses an extra wire connecting both ends of dipole. Often this is achieved by using a wire or rod of the same diameter for all sections of the antenna, but this is not always the case. Also the wires or rods are typically equally spaced along the length of the parallel elements. This can be achieved in a number of ways.

A folded dipole is a dipole antenna with the ends folded back around and connected to each other.

Typically, the width d of the folded dipole antenna is much smaller than the length L. Because the folded dipole forms a closed loop, one might expect the input impedance to depend on the input impedance of a short-circuited transmission line of length L. However, the folded dipole antenna as two parallel short-circuited transmission lines of length L/2. It turns out the impedance of the folded dipole antenna will be a function of the impedance of a transmission line of length L/2.

What should be the length of antenna for a carrier wave of $6x10^8$ Hz

The formula for a half wave dipole, as we all should have learned is based on a constant number of 468, which is divided by the center frequency we wish to use for our dipole, giving us our total length in feet for the dipole.

468 / freq(MHz) = total feet length

468/60000 = 0.0078 feet

What is the difference between dipole and terminal pair antenna?

In radio and telecommunications a dipole antenna or doublet is the simplest and most widely used class of antenna. It consists of two identical conductive elements such as metal wires or rods, which are usually bilaterally symmetrical. The driving current from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the two halves of the antenna. Each side of the feed line to the transmitter or receiver is connected to one of the conductors.

A communications device comprises a loop antenna having a plurality of feed terminals defining at least two terminal pairs. A controller is provided for selecting one terminal pair to enable reception or transmission from the loop antenna using the selected terminal pair. The selection of terminal pair is made based on the measurement of at least one parameter which is responsive to the proximity to the antenna of, for example, a user of the device.

One terminal pair provides an antenna having matched impedance when the user is near the device, and the other terminal pair provides an antenna having matched impedance when the user is distant.

What is the difference between dipole and folded dipole antenna?

In radio and telecommunications a dipole antenna or doublet is the simplest and most widely used class of antenna. It consists of two identical conductive elements such as metal wires or rods, which are usually bilaterally symmetrical. The driving current from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the two halves of the antenna. Each side of the feed line to the transmitter or receiver is connected to one of the conductors.

The standard dipole is widely used in its basic form. However under a number of circumstances a modification of the basic dipole, known as a folded dipole antenna provides a number of advantages.

A folded dipole is a half-wave dipole with an additional wire connecting its two ends. If the additional wire has the same diameter and cross-section as the dipole, two nearly identical radiating currents are generated. The resulting far-field emission pattern is nearly identical to the one for the single-wire dipole described above, but at resonance its feed point impedance R_{fd} is four times the radiation resistance of a single-wire dipole. This is because for a fixed amount of power, the total radiating current I_0 is equal to twice the current in each wire and thus equal to twice the current at the feed point. The folded dipole antenna uses an extra wire connecting both ends of dipole.

What are the disadvantages and applications of dipole antenna?

Disadvantages:

A folded dipole has essentially the same gain as a standard dipole on the fundamental frequency. Your 40m folded dipole fed with twinlead won't work any differently on 40m than a normal dipole would, even one fed with coax, except that you would need to use a tuner with it.

A folded dipole steps the antenna impedance up by a factor of 4: in free space where an infinitely thin dipole is around 72 ohms, this would give 288 ohms at the feed point. As an inverted vee closer to the ground the impedance of a plain wire dipole will be about 50 ohms, so the folded dipole would be closer to 200 ohms. Depending on the length of the twinlead the impedance at the balun likely would be between 200 and 450 ohms.

The currents on each wire will begin to cancel each other out on even multiples of the cut frequency, so a 40 meter folded dipole should not be used on 14 MHz. On other bands even though the signal may cancel broad side to the antenna, you'll find that there is actually gain! This occurs about 45 degrees off broad side to the antenna. And this might make for interesting contacts.

Applications:

One of the main reasons for using the folded dipole aerial is the increase in feed impedance that it provides. If the conductors in the main dipole and the second or "fold" conductor are the same diameter, then it is found that there is a fourfold increase i.e. two squared in the feed impedance.

The folded dipole can be used for transforming the value of input impedance of the dipole over a broad range of step-up ratios by changing the thicknesses of the wire conductors for the fed- and folded-sides.

Another common place one can see dipoles is as antennas for the FM band, these are folded dipoles. The tips of the antenna are folded back until they almost meet at the feed point, such that the antenna comprises one entire wavelength. This arrangement has a greater bandwidth than a standard half-wave dipole.

Lab Assignment No. 5:

Title:

To Study The Radiation Pattern Between Transmitting And Receiving Antenna By Changing The Distance Between Them & Measure The Strength Of Radiation

Objective:

To Plot The Radiation Pattern Between Transmitting And Receiving Antenna

Theory:

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency i.e. a high frequency alternating current (AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

Typically an antenna consists of an arrangement of metallic conductors (elements), electrically connected often through a transmission line to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave. Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

Antennas can be designed to transmit and receive radio waves in all horizontal directions equally omnidirectional antennas, or preferentially in a particular direction.

Antenna Type:

Iso-tropic, Omni directional, Directional

Isotropic:

Radiate energy uniformly in all direction, e.g. Hertzian dipole.

Omni Directional:

Radiate energy in one plane, e.g. monopoles, dipoles.

Directional:

Radiate energy in one particular direction, e.g. Yagi UDA, long periodic Helical.

Folded Dipole:

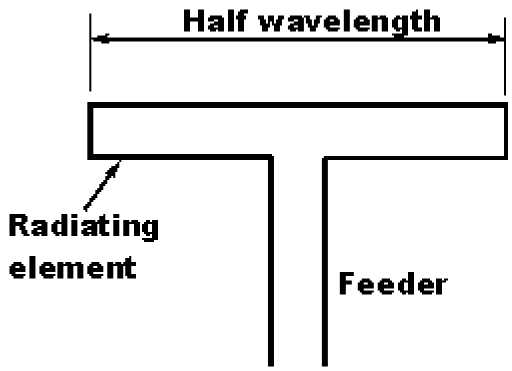
The standard dipole is widely used in its basic form. However under a number of circumstances a modification of the basic dipole, known as a folded dipole antenna provides a number of advantages.

The folded dipole antenna or folded dipole aerial is widely used, not only on its own, but also as the driven element in other antenna formats such as the Yagi antenna.

A folded dipole is a half-wave dipole with an additional wire connecting its two ends. If the additional wire has the same diameter and cross-section as the dipole, two nearly identical radiating currents are generated. The resulting far-field emission pattern is nearly identical to the one for the single-wire dipole described above, but at resonance its feed point impedance R_{fd} is four times the radiation resistance of a single-wire dipole. This is because for a fixed amount of power, the total radiating current I_0 is equal to twice the current in each wire and thus equal to twice the current at the feed point.

The folded dipole antenna uses an extra wire connecting both ends of dipole. Often this is achieved by using a wire or rod of the same diameter for all sections of the antenna, but this is not always the case. Also the wires or rods are typically equally spaced along the length of the parallel elements. This can be achieved in a number of ways.

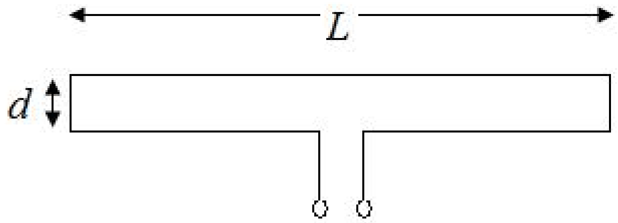
Often for VHF or UHF antennas the rigidity of the elements is sufficient, but at lower frequencies spacers may need to be employed. To keep the wires apart. Obviously if they are not insulated it is imperative to keep them from shorting. In some instances flat feeder can be used.



Another common place one can see dipoles is as antennas for the FM band, these are folded dipoles. The tips of the antenna are folded back until they almost meet at the feed point, such that the antenna comprises one entire wavelength. This arrangement has a greater bandwidth than a standard half-wave dipole. If the conductor has a constant radius and cross-section, at resonance the input impedance is four times that of a half-wave dipole.

Moreover, the folded dipole can be used for transforming the value of input impedance of the dipole over a broad range of step-up ratios by changing the thicknesses of the wire conductors for the fed- and folded-sides.

A folded dipole is a dipole antenna with the ends folded back around and connected to each other, forming a loop as shown in Figure.



Typically, the width d of the folded dipole antenna is much smaller than the length L. Because the folded dipole forms a closed loop, one might expect the input impedance to depend on the input impedance of a short-circuited transmission line of length L. However, the folded dipole antenna as two parallel short-circuited transmission lines of length L/2. It turns out the impedance of the folded dipole antenna will be a function of the impedance of a transmission line of length L/2.

Also, because the folded dipole is "folded" back on itself, the currents can reinforce each other instead of cancelling each other out, so the input impedance will also depend on the impedance of a dipole antenna of length L.

The folded dipole antenna is resonant and radiates well at odd integer multiples of a half-wavelength (0.5 λ , 1.5 λ , ...)

when the antenna is fed in the center. The input impedance of the folded dipole is higher than that for a regular dipole.

The folded dipole antenna can be made resonant at even multiples of a half-wavelength (1.0 λ , 2.0 λ ,...) by off setting the feed of the folded dipole.

One of the main reasons for using the folded dipole aerial is the increase in feed impedance that it provides. If the conductors in the main dipole and the second or "fold" conductor are the same diameter, then it is found that there is a fourfold increase i.e. two squared in the feed impedance. In free space, this gives an increase in feed impedance from 73Ω to around 300Ω ohms. Additionally the RF antenna has a wider bandwidth.

Folded dipole impedance:

In a standard dipole the currents flowing along the conductors are in phase and as a result there is no cancellation of the fields and radiation occurs. When the second conductor is added to make the folded dipole antenna this can be considered as an extension to the standard dipole with the ends folded back to meet each other. As a result the currents in the new section flow in the same direction as those in the original dipole. The currents along both the half-waves are therefore in phase and the antenna will radiate with the same radiation patterns etc. as a simple half-wave dipole.

The impedance increase can be deduced from the fact that the power supplied to a folded dipole antenna is evenly shared between the two sections which make up the antenna. This means that when compared to a standard dipole the current in each conductor is reduced to a half. As the same power is applied, the impedance has to be raised by a factor of four to retain balance in the equation Watts = $I^2 R$.

Folded dipole transmission line effect:

The folded element of the folded dipole antenna has a transmission line effect attached with it. It can be viewed that the impedance of the dipole appears in parallel with the impedance of the shorted transmission line sections.

The length is affected by this effect. Normally the wavelength of a standing wave in a feeder is affected by the velocity factor. If air is used, this will by around 95% of the free space value. However if a flat feeder with a lower velocity factor is used, then this will have the effect of shortening the required length.

The feeder effect also results in the folded dipole antenna having a flatter response, i.e. a wider bandwidth than a non-folded dipole. It occurs because at a frequency away from resonance, the reactance of the dipole is of the opposite form from that of the sorted transmission line and as a result there is some reactance cancellation at the feed point of the antenna.

Table:

Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB
0	33	30.37	180	46	33.25
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20	11	20.82	200	28	28.94
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50	54	34.64	230	4.6	13.25
60	63	35.48	240	9	19.08
70	66	36.39	250	25	27.95
80	72	37.14	260	38	31.59
90	74	37.38	270	64	36.12
100	77	37.72	280	71	37.02
110	78	37.84	290	94	39.46
120	99	39.91	300	115	41.21
130	95	39.55	310	109	40.74
140	85	38.68	320	97	39.73
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170	56	34.96	350	40	32.04

Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB
0	38	31.59	180	52	34.32
10	39	31.82	190	45	33.06
20	24	27.6	200	9	19.08
30	21	26.44	210	13	22.27
40	36	31.12	220	15	23.52
50	56	34.96	230	35	30.88
60	71	37.02	240	55	34.8
70	91	39.18	250	76	37.61
80	90	39.08	260	85	38.58
90	101	40.08	270	108	40.66
100	111	40.9	280	117	41.36
110	127	42.07	290	113	41.06
120	123	41.79	300	124	41.86
130	111	40.9	310	107	40.58
140	103	40.25	320	92	39.27
150	89	38.98	330	83	38.38
160	79	37.95	340	65	36.25
170	71	37.02	350	57	35.11

Questions

Explain radiation in detail.

In physics, radiation is a process in which electromagnetic waves (EMR) travel through a vacuum or through matter-containing media; the existence of a medium to propagate the waves is not required.

Radiation is a subset of these electromagnetic waves combined with a class of energetic subatomic particles with very high kinetic energies; these are called ionizing radiation, and the particles are termed particle radiation. Other sorts of waves, such as acoustic, seismic, hydraulic and so on are not usually considered to be forms of "radiation" in either sense.

EMR is energy transferred by waves of combined electric charge and magnetic monopole, capable of traveling through a vacuum and traveling at the universal speed of light in whatever media it is passing through; the speed is dependent on the media, and is fastest in vacuum. In quantum mechanics these waves have been shown to have particle structure as well as wave structure, these particles are called photons. EMR includes radio and microwave signals, infrared, visible light and ultraviolet, and x-rays and gamma rays. These are differentiated from one another by the frequency of the waves, which directly correlates with the energy carried in each type's photons.

How long does it take for radiation to lose its strength?

In physics, an inverse-square law is any physical law stating that a specified physical quantity orintensity is inversely proportional to the square of the distance from the source of that physical quantity. In equation form:

The intensity or illuminance or irradiance of light or other linear waves radiating from a point source energy per unit of area perpendicular to the source is inversely proportional to the square of the distance from the source.

So an object (of the same size) twice as far away, receives only one-quarter the energy (in the same time period).

For example, the intensity of radiation from the Sun is 9126 watts per square meter at the distance of Mercury (0.387 AU); but only 1367 watts per square meter at the distance of Earth (1 AU)—an approximate threefold increase in distance results in an approximate nine fold decrease in intensity of radiation.

For non isotropic radiators such as parabolic antennas, headlights, and lasers, the effective origin is located far behind the beam aperture. If you are close to the origin, you don't have to go far to double the radius, so the signal drops quickly. When you are far from the origin and still have a strong new signal, like with a laser, you have to travel very far to double the radius and reduce the signal. This means you have a stronger signal or have antenna gain in the direction of the narrow beam relative to a wide beam in all directions of an isotropic antenna.

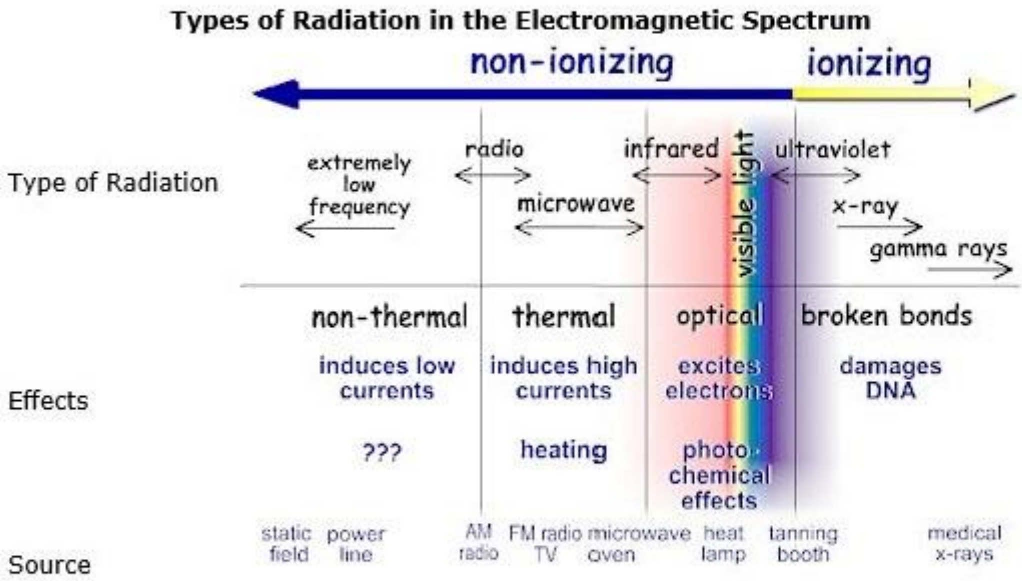
The fractional reduction in electromagnetic fluence (Φ) for indirectly ionizing radiation with increasing distance from a point source can be calculated using the inverse-square law. Since emissions from a point source have radial directions, they intercept at a perpendicular incidence. The area of such a shell is $4\pi r^2$ where r is the radial distance from the center.

What is the dangerous strength of electromagnetic radiation?

There is no real "safe" levels of radiation exposure. When it comes to Electromagnetic Radiation from electronic devices like laptops and tablets, exposure is just an inevitable part of life. To be safe, experts recommend limiting Extremely Low Frequency (ELF) exposure to below 2 mG and Radio Frequency (RF) exposure to under .6 V/m.

As we continue to learn more about health dangers from non-ionizing Electromagnetic Radiation contact, we should do everything we can to limit our personal exposure with EMF protection.

Nuclear radiation is the most dangerous kind of electromagnetic radiation (although they can all be dangerous). So it's quite important to make sure that you are not exposed to more than your body can handle!



What is the difference between heat and radiation?

Heat is thermal energy. It is the collective energy of movements of atoms, molecules, and electrons within, and dependent upon, a bounded system of matter. This form of energy is not capable of moving through a vacuum.

Radiation is a process in which electromagnetic waves (EMR) travel through a vacuum or through matter-containing media; the existence of a medium to propagate the waves is not required.

Lab Assignment No. 6:

Title:

To Study The Radiation Pattern Of 3-Element Yagi UDA Antenna

Objective:

To Plot The Radiation Pattern Of 3-Element Yagi UDA Antenna

Theory:

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency i.e. a high frequency alternating current (AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

Typically an antenna consists of an arrangement of metallic conductors (elements), electrically connected often through a transmission line to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave. Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in

the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

Antennas can be designed to transmit and receive radio waves in all horizontal directions equally omnidirectional antennas, or preferentially in a particular direction.

Antenna Type:

Iso-tropic, Omni directional, Directional

Isotropic:

Radiate energy uniformly in all direction, e.g. Hertzian dipole.

Omni Directional:

Radiate energy in one plane, e.g. monopoles, dipoles.

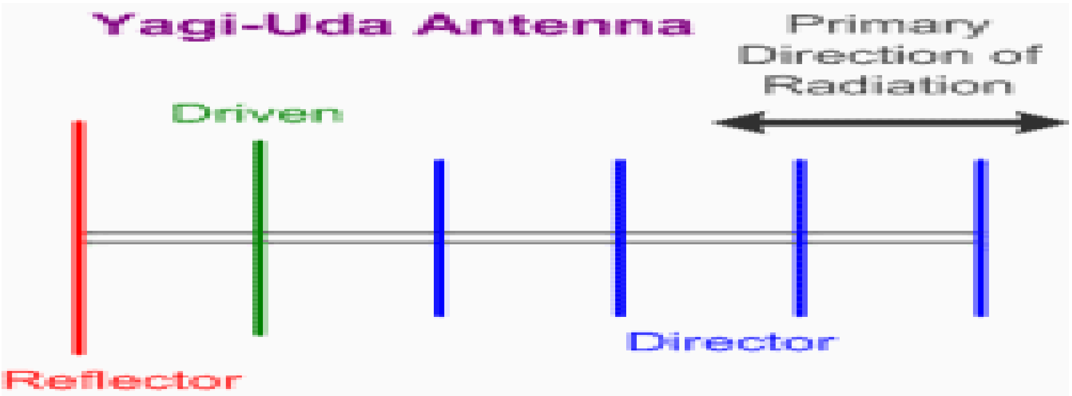
Directional:

Radiate energy in one particular direction, e.g. Yagi UDA, long periodic Helical.

Yagi UDA:

A Yagi-Uda array, commonly known simply as a Yagi antenna, is a directional antenna consisting of a driven element typically a dipole or folded dipole and additional parasitic elements usually a so-called reflector and one or more directors. The reflector element is slightly longer typically 5% longer than the driven dipole, whereas the so-called directors are a little shorter typically 5% shorter. This design achieves a very substantial increase in the antenna's directionality and gain compared to a simple dipole.

Highly directional antennas such as the Yagi-Uda are commonly referred to as "beam antennas" due to their high gain. However, the Yagi-Uda design only achieves this high gain over a rather narrow bandwidth, making it useful for specific communications bands. Yagi antennas were first widely used during World War II for radar systems.



The bandwidth of a Yagi-Uda antenna refers to the frequency range over which its directional gain and impedance match are preserved to within a stated criterion.

The Yagi-Uda array in its basic form is very narrowband, with its performance already compromised at frequencies just a few percent above or below its design frequency. For applications that require wider bandwidths, such as terrestrial television, Yagi-Uda antennas commonly feature trigonal reflectors, traps, and larger diameter conductors, in order to cover the relevant portions of the VHF and UHF bands.

Consider a Yagi-Uda consisting of a reflector, driven element and a single director. The driven element is typically a λ/2 dipole or folded dipole and is the only member of the structure that is directly excited electrically connected to the feed line. All the other elements are considered parasitic. That is, they reradiate power which they receive from the driven element they also interact with each other.

A dipole element to be a normal parasitic element with a gap at its center, the feed point. Now instead of attaching the antenna to a load such as a receiver we connect it to a short circuit. As is well known in transmission line theory, a short circuit reflects all of the incident power 180 degrees out of phase. So one could as well model the operation of the parasitic element as the superposition of a dipole element receiving power and sending it down a transmission line to a matched load, and a transmitter sending the same amount of power down the transmission line back toward the antenna element. If the wave from the transmitter were 180 degrees out of phase with the received wave at that point, it would be equivalent to just shorting out that dipole at the feed point making it a solid element, as it is.

The fact that the parasitic element involved is not exactly resonant but is somewhat shorter or longer than $\lambda/2$ modifies the phase of the element's current with respect to its excitation from the driven element. The so-called reflector element, being longer than $\lambda/2$, has an inductive reactance which means the phase of its current lags the phase of the open-circuit voltage that would be induced by the received field.

The director element, on the other hand, being shorter than $\lambda/2$ has a capacitive reactance with the voltage phase lagging that of the current. If the parasitic elements were broken in the center and driven with the same voltage applied to the center element, then such a phase difference in the currents would implement an end-fire phased array, enhancing the radiation in one direction and decreasing it in the opposite direction. Thus, one can appreciate the mechanism by which parasitic elements of unequal length can lead to a unidirectional radiation pattern.

Table:

Reading of Angle on Goniometer (Degree)	Reading of Current (µA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (µA)	Current Reading in dB
0	40	32.04	180	57	35.11
10	30	29.54	190	22	36.62
20	12	21.58	200	30	35.11
30	14	22.92	210	36	31.12
40	20	26.02	220	26	28.29
50	10	20	230	18	25.10
60	8	18.06	240	6	15.56
70	10	20	250	3	9.54
80	12	21.58	260	8	18.06
90	6	15.56	270	5	13.97
100	10	20	280	6	15.56
110	10	20	290	11	20.82
120	12	21.58	300	21	26.44
130	31	29.82	310	37	31.36
140	30	29.54	320	43	32.66
150	45	33.06	330	51	34.15
160	48	39.62	340	52	34.32
170	53	34.48	350	47	33.44

Questions

Which one is better? A Yagi antenna or a parabolic antenna.

A parabolic antenna is an antenna that uses a parabolic reflector, a curved surface with the cross-sectional shape of a parabola, to direct the radio waves. The most common form is shaped like a dish and is popularly called a dish antenna or parabolic dish. The main advantage of a parabolic antenna is that it has high directivity. It functions similarly to a searchlight or flashlight reflector to direct the radio waves in a narrow beam, or receive radio waves from one particular direction only. Parabolic antennas have some of the highest gains, that is, they can produce the narrowest beam widths, of any antenna type. In order to achieve narrow beam widths, the parabolic reflector must be much larger than the wavelength of the radio waves used, so parabolic antennas are used in the high frequency part of the radio spectrum, at UHF and microwave (SHF) frequencies, at which the wavelengths are small enough that conveniently-sized reflectors can be used.

A Yagi-Uda array, commonly known simply as a Yagi antenna, is a directional antenna consisting of a driven element typically a dipole or folded dipole and additional parasitic elements usually a so-called reflector and one or more directors. The reflector element is slightly longer typically 5% longer than the driven dipole, whereas the so-called directors are a little shorter. This design achieves a very substantial increase in the antenna's directionality and gain compared to a simple dipole.

Highly directional antennas such as the Yagi-Uda are commonly referred to as "beam antennas" due to their high gain. However, the Yagi-Uda design only achieves this high gain over a rather narrow bandwidth, making it useful for specific communications bands.

A yagi is a series of elements one reflector, one driver this is the only element that has the feed line hooked to it, and one or more directors. The more elements there are the higher the gain and the tighter the beam.

A parabolic dish is just that a concave saucer like collector and a feed horn that is hooked to the feed line. If you go with the parabolic you will be more than doubling your gain across the frequency range, every 3 dB step doubles your gain, so the parabolic has more than twice as much gain as the Yagi.

How do you design & construct Yagi UDA antenna array?

The maximum gain of a Yagi-Uda is limited to an amount given approximately by the gain of a dipole 1.66 numerical times the total number of elements. In an end-fire array of N elements the gain is proportional to N.

Consider N isotropic sources, all phased such that the field contributions in the end-fire direction from each element all add up in phase in the far field. The field strength E-field or H-field of the sum of the phasors will be N times the field from a single element, so the radiated power density, which is proportional to the square of the fields, will be N^2 times larger. However, the total POWER delivered to the N elements will be N times larger than that delivered to a single element, so the power gain in the far field is $(N^2)/N = N$.

Now this argument becomes suspect when the radiation resistance of an element in the array is different from the radiation resistance of an isolated element, for it is the currents in the elements which contribute to the far field strengths. In a longish Yagi-Uda, however, the end elements will not see a very different environment for the addition of an element in the middle of the directors.

And the elements in the middle of the directors are not much affected by how long the array may be. Thus, as a rough "rule of thumb", the factor N which is empirically about right may be justified theoretically.

There are no simple formulas for designing Yagi-Uda antennas due to the complex relationships between physical parameters such as element length, spacing, and diameter, and performance characteristics such as gain and input impedance. But using the above sort of analysis one can calculate the performance given a set of parameters and adjust them to optimize the gain. Since with an N element Yagi-Uda antenna, there are 2N-1 parameters to adjust, this is not a straightforward problem at all. The mutual impedances plotted above only apply to $\lambda/2$ length elements, so these might need to be recomputed to get good accuracy.

What is directivity of Yagi directional antenna?

In the radiofrequency regime, a typical antenna design for high directivity is the Yagi–Uda antenna, which essentially consists of a one-dimensional array of antenna elements driven by a single feed element.

The Yagi or Yagi-Uda antenna is used in a wide variety of applications where an RF antenna design with gain and directivity is required.

Highly directional antennas such as the Yagi-Uda are commonly referred to as "beam antennas" due to their high gain. However, the Yagi-Uda design only achieves this high gain over a rather narrow bandwidth, making it useful for specific communications bands.

What is Yagi Wifi antenna?

This Yagi is a great directional WiFi Antenna. It is an excellent choice anyone who needs to extend their wireless LAN or share high speed internet over WiFi. These directional Yagi antenna solutions provide precise, narrow radio beam width connectivity.

Tell the frequency band, in which Yagi antenna can be used.

HF band 3MHz-30MHz

VHF 30MHz-300MHz

UHF 300MHz-3000MHz

Lab Assignment No. 7:

Title:

To Study The Radiation Pattern Of 5-Element Yagi UDA Antenna

Objective:

To Plot The Radiation Pattern Of 5-Element Yagi UDA Antenna

Theory:

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency i.e. a high frequency alternating current (AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

Typically an antenna consists of an arrangement of metallic conductors (elements), electrically connected often through a transmission line to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave. Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in

the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

Antennas can be designed to transmit and receive radio waves in all horizontal directions equally omnidirectional antennas, or preferentially in a particular direction.

Antenna Type:

Iso-tropic, Omni directional, Directional

Isotropic:

Radiate energy uniformly in all direction, e.g. Hertzian dipole.

Omni Directional:

Radiate energy in one plane, e.g. monopoles, dipoles.

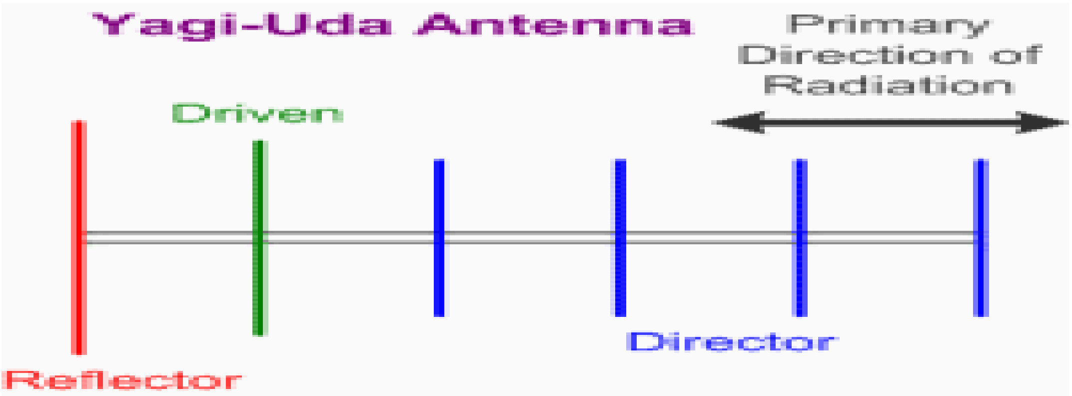
Directional:

Radiate energy in one particular direction, e.g. Yagi UDA, long periodic Helical.

Yagi UDA:

A Yagi-Uda array, commonly known simply as a Yagi antenna, is a directional antenna consisting of a driven element typically a dipole or folded dipole and additional parasitic elements usually a so-called reflector and one or more directors. The reflector element is slightly longer typically 5% longer than the driven dipole, whereas the so-called directors are a little shorter typically 5% shorter. This design achieves a very substantial increase in the antenna's directionality and gain compared to a simple dipole.

Highly directional antennas such as the Yagi-Uda are commonly referred to as "beam antennas" due to their high gain. However, the Yagi-Uda design only achieves this high gain over a rather narrow bandwidth, making it useful for specific communications bands. Yagi antennas were first widely used during World War II for radar systems.



The bandwidth of a Yagi-Uda antenna refers to the frequency range over which its directional gain and impedance match are preserved to within a stated criterion.

The Yagi-Uda array in its basic form is very narrowband, with its performance already compromised at frequencies just a few percent above or below its design frequency. For applications that require wider bandwidths, such as terrestrial television, Yagi-Uda antennas commonly feature trigonal reflectors, traps, and larger diameter conductors, in order to cover the relevant portions of the VHF and UHF bands.

Consider a Yagi-Uda consisting of a reflector, driven element and a single director. The driven element is typically a λ/2 dipole or folded dipole and is the only member of the structure that is directly excited electrically connected to the feed line. All the other elements are considered parasitic. That is, they reradiate power which they receive from the driven element they also interact with each other.

A dipole element to be a normal parasitic element with a gap at its center, the feed point. Now instead of attaching the antenna to a load such as a receiver we connect it to a short circuit. As is well known in transmission line theory, a short circuit reflects all of the incident power 180 degrees out of phase. So one could as well model the operation of the parasitic element as the superposition of a dipole element receiving power and sending it down a transmission line to a matched load, and a transmitter sending the same amount of power down the transmission line back toward the antenna element. If the wave from the transmitter were 180 degrees out of phase with the received wave at that point, it would be equivalent to just shorting out that dipole at the feed point making it a solid element, as it is.

The fact that the parasitic element involved is not exactly resonant but is somewhat shorter or longer than $\lambda/2$ modifies the phase of the element's current with respect to its excitation from the driven element. The so-called reflector element, being longer than $\lambda/2$, has an inductive reactance which means the phase of its current lags the phase of the open-circuit voltage that would be induced by the received field.

The director element, on the other hand, being shorter than $\lambda/2$ has a capacitive reactance with the voltage phase lagging that of the current. If the parasitic elements were broken in the center and driven with the same voltage applied to the center element, then such a phase difference in the currents would implement an end-fire phased array, enhancing the radiation in one direction and decreasing it in the opposite direction. Thus, one can appreciate the mechanism by which parasitic elements of unequal length can lead to a unidirectional radiation pattern.

Table:

Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB
0	14.3	23.11	180	11	39
10	9	19.08	190	15.2	33
20	6.9	16.77	200	13.2	32
30	5.3	26	210	18	32
40	4.1	20	220	19.4	29
50	3.2	18	230	20.6	10
60	2.8	20	240	18.4	15
70	2	20	250	0.7	9
80	2.3	20	260	0.6	12
90	2.9	20	270	0.9	7
100	3.1	20	280	1.3	5
110	7.5	20	290	1.8	14
120	14.3	23.11	300	3	24
130	11	30	310	6.6	27
140	15.2	29	320	9.3	31
150	13.2	33	330	10	35
160	18	34	340	9.7	35
170	19.4	37	350	10.3	33

Questions

Which one is better? A Yagi antenna or a parabolic antenna.

A parabolic antenna is an antenna that uses a parabolic reflector, a curved surface with the cross-sectional shape of a parabola, to direct the radio waves. The most common form is shaped like a dish and is popularly called a dish antenna or parabolic dish. The main advantage of a parabolic antenna is that it has high directivity. It functions similarly to a searchlight or flashlight reflector to direct the radio waves in a narrow beam, or receive radio waves from one particular direction only. Parabolic antennas have some of the highest gains, that is, they can produce the narrowest beam widths, of any antenna type. In order to achieve narrow beam widths, the parabolic reflector must be much larger than the wavelength of the radio waves used, so parabolic antennas are used in the high frequency part of the radio spectrum, at UHF and microwave (SHF) frequencies, at which the wavelengths are small enough that conveniently-sized reflectors can be used.

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Highly directional antennas such as the Yagi-Uda are commonly referred to as "beam antennas" due to their high gain. However, the Yagi-Uda design only achieves this high gain over a rather narrow bandwidth, making it useful for specific communications bands.

A yagi is a series of elements one reflector, one driver this is the only element that has the feed line hooked to it, and one or more directors. The more elements there are the higher the gain and the tighter the beam.

A parabolic dish is just that a concave saucer like collector and a feed horn that is hooked to the feed line. If you go with the parabolic you will be more than doubling your gain across the frequency range, every 3 dB step doubles your gain, so the parabolic has more than twice as much gain as the Yagi.

How do you design & construct Yagi UDA antenna array?

The maximum gain of a Yagi-Uda is limited to an amount given approximately by the gain of a dipole 1.66 numerical times the total number of elements. In an end-fire array of N elements the gain is proportional to N.

Consider N isotropic sources, all phased such that the field contributions in the end-fire direction from each element all add up in phase in the far field. The field strength E-field or H-field of the sum of the phasors will be N times the field from a single element, so the radiated power density, which is proportional to the square of the fields, will be N^2 times larger. However, the total POWER delivered to the N elements will be N times larger than that delivered to a single element, so the power gain in the far field is $(N^2)/N = N$.

Now this argument becomes suspect when the radiation resistance of an element in the array is different from the radiation resistance of an isolated element, for it is the currents in the elements which contribute to the far field strengths. In a longish Yagi-Uda, however, the end elements will not see a very different environment for the addition of an element in the middle of the directors.

And the elements in the middle of the directors are not much affected by how long the array may be. Thus, as a rough "rule of thumb", the factor N which is empirically about right may be justified theoretically.

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What is Yagi Wifi antenna?

This Yagi is a great directional WiFi Antenna. It is an excellent choice anyone who needs to extend their wireless LAN or share high speed internet over WiFi. These directional Yagi antenna solutions provide precise, narrow radio beam width connectivity.

Tell the frequency band, in which Yagi antenna can be used.

HF band 3MHz-30MHz

VHF 30MHz-300MHz

UHF 300MHz-3000MHz

Lab Assignment No. 8:

Title:

To Study The Radiation Pattern Of Broad-side Array

Objective:

To Plot The Radiation Pattern Of Broad-side Array

Theory:

An antenna array is a set of individual antennas used for transmitting and/or receiving radio waves, connected together in such a way that their individual currents are in a specified amplitude and phase relationship. This allows the array to act as a single antenna, generally with improved directional characteristics (thus higher antenna gain) than would be obtained from the individual elements. The resulting array in fact is often referred to and treated as "an antenna," particularly when the elements are in rigid arrangement with respect to each other, and when the ratio of currents (and their phase relationships) are fixed. On the other hand, a steerable array may be fixed physically but has electronic control over the relationship between those currents, allowing for adjustment of the antenna's directionality without requiring physical motion.

The array uses electromagnetic wave interference to enhance the radiative signal in one desired direction at the expense of other directions. It may also be used to null the radiation pattern in one particular direction, especially for a receiving antenna in the face of a particular interfering source.

Broadside Array:

Physically, it looks somewhat like a ladder. When the array and the elements in it are polarized horizontally, it looks like an upright ladder. When the array is polarized vertically, it looks like a ladder lying on one side.

Horizontally polarized arrays using more than two elements are not common. This is because the requirement that the bottom of the array be a significant distance above the earth presents construction problems. Compared with collinear arrays, broadside arrays tune sharply, but lose efficiency rapidly when not operated on the frequencies for which they are designed.

The physical disposition of dipoles operated broadside to each other allows for much greater coupling between them than can occur between collinear elements. Moving the parallel antenna elements closer together or farther apart affects the actual impedance of the entire array and the overall radiation resistance as well. As the spacing between broadside elements increases, the effect on the radiation pattern is a sharpening of the major lobes. When the array consists of only two dipoles spaced exactly 1/2 wavelength apart, no minor lobes are generated at all. Increasing the distance between the elements beyond that point, however, tends to throw off the phase relationship between the original current in one element and the current induced in it by the other element. The result is that, although the major lobes are sharpened, minor lobes are introduced, even with two elements. These, however, are not large enough to be of concern.

If you add the same number of elements to both a broadside array and a collinear array, the gain of the broadside array will be greater. Reduced radiation resistance resulting from the efficient coupling between dipoles accounts for most of this gain. However, certain practical factors limit the number of elements that may be used. The construction problem increases with the number of elements, especially when they are polarized horizontally.

Table:

Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB
0	14.3	23.11	180	11	39
10	9	19.08	190	15.2	33
20	6.9	16.77	200	13.2	32
30	5.3	26	210	18	32
40	4.1	20	220	19.4	29
50	3.2	18	230	20.6	10
60	2.8	20	240	18.4	15
70	2	20	250	0.7	9
80	2.3	20	260	0.6	12
90	2.9	20	270	0.9	7
100	3.1	20	280	1.3	5
110	7.5	20	290	1.8	14
120	14.3	23.11	300	3	24
130	11	30	310	6.6	27
140	15.2	29	320	9.3	31
150	13.2	33	330	10	35
160	18	34	340	9.7	35
170	19.4	37	350	10.3	33

Questions

What do you understand by broadside array?

An antenna in the form of an array of radiators, most often balanced dipoles or slot radiators, which are excited in the same phase by high-frequency currents. The maximum radiation intensity is in the direction perpendicular to the plane of the array because the fields of all the radiators are in phase in that direction. The directional pattern of a broadside array in any plane perpendicular to the plane of the array consists of a main lobe and many side lobes with widths that depend on the linear dimensions of the array. In order to obtain unidirectional radiation from a broadside array, the array is supplemented with a tuned or a periodic reflector. In cases where it is necessary to simplify the feed system of a broadside array, a unidirectional traveling-wave antenna having a small gain is used as a radiator; a director antenna, helical antenna, or log-periodic antenna may be used in such cases, obviating the need for a reflector. Broadside arrays are used for a wide range of radio waves. At decameter (short) wavelengths, they are used chiefly for radio broadcasting over long distances.

How is current induced in antenna when placed in electromagnetic field?

Electromagnetic induction is the production of an electromotive force across a conductor when it is exposed to a varying magnetic field. It is described mathematically by Faraday's law of induction, named after Michael Faraday who is generally credited with the discovery of induction in 1831.

How to increase the current of loop antenna?

Of course, in certain loop structures the size of the currents in different elements of length along the loop wire will vary. Thus, loop antennas which have a total wire length approaching or exceeding an appreciable fraction of a wavelength can be efficient radiators with radiation resistance that approaches a match to common feed-line impedances. It is only in vanishingly small loop antennas that we are justified in assuming that the current is the same at every point along the loop wire.This may sometimes be a justifiable approximation, but certain textbooks which treat a circular loop antenna of radius lambda/25 (which has a loop wire length of about lambda/4) as if the approximation were sufficiently valid, may be in serious error. It is partly for this reason that there is some controversy about the radiation resistance of intermediate-sized loop antennas.

Lab Assignment No. 9:

Title:

To Study The Radiation Pattern Of Log periodic Antenna

Objective:

To Plot The Radiation Pattern Of Log periodic Antenna

Theory:

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency i.e. a high frequency alternating current (AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

Typically an antenna consists of an arrangement of metallic conductors (elements), electrically connected often through a transmission line to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave. Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in

the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

Antennas can be designed to transmit and receive radio waves in all horizontal directions equally omnidirectional antennas, or preferentially in a particular direction.

Antenna Type:

Iso-tropic, Omni directional, Directional

Isotropic:

Radiate energy uniformly in all direction, e.g. Hertzian dipole.

Omni Directional:

Radiate energy in one plane, e.g. monopoles, dipoles.

Directional:

Radiate energy in one particular direction, e.g. Yagi UDA, long periodic Helical.

Log Periodic Antenna:

A log-periodic antenna (LP), also known as a log-periodic array or aerial, is a multi-element, directional, narrow-beam antenna that operates over a broad band of frequencies. A particular form of the log-periodic design, the log-periodic dipole array or LPDA, is often used in television antennas that work in the VHF band. The log-periodic design looks very similar to the Yagi antenna, but is very different electrically. LPDA and Yagis are often combined in television antennas that cover both VHF and UHF.

The LPDA normally consists of a series of dipoles known as "elements" positioned along a support boom lying along the antenna axis. The elements are spaced at intervals following a logarithmic function of the frequency, known as d or sigma. The length of each element is a function of the desired frequency response; for broadband reception this leads to a series of ever-shorter dipoles towards the "front" of the antenna. The relationship between the lengths is a function known as tau. The ever-decreasing lengths makes the LPDA look, when viewed from the top, like a triangle or arrow with the tip pointed towards the transmitter. Sigma and tau are the key design elements of the LPDA design.

Every element in the log-periodic design is "active", connected electrically to the other elements. It is normal to drive alternating elements with 180° (π radians) of phase shift from one another. This is normally done by connecting individual elements to alternating wires of a balanced transmission line. Often the transmission line can be seen zig-zagging across the support boom holding the elements. A common design element is to use two booms that also acts as the transmission line, mounting the dipoles on the alternate booms. Other forms of the log-periodic design replace the dipoles with the transmission line itself, forming the log-periodic zig-zag antenna. Many other forms using the transmission wire as the active element also exist.

Yagis and log-periodic designs look very similar at first glance, as both consist of a number of dipole elements spaced out along a support boom. The Yagi, however, has only a single dipole connected to the transmission line, normally one close to the back of the array. The other dipoles on the boom are passive, acting as "directors" or "reflectors" depending on their position relative to the "driven element". This is often only visible by examining the wiring.

A more obvious difference is the length of the dipoles; LPDA designs have shorter dipoles towards the front of the antenna, forming a triangular shape as seen from the top. Another visible difference is the spacing between the elements, which remains constant in the Yagi but becomes wider towards the rear of the LPDA.

Table:

Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB
0	14.3	23.11	180	11	39
10	9	19.08	190	15.2	33
20	6.9	16.77	200	13.2	32
30	5.3	26	210	18	32
40	4.1	20	220	19.4	29
50	3.2	18	230	20.6	10
60	2.8	20	240	18.4	15
70	2	20	250	0.7	9
80	2.3	20	260	0.6	12
90	2.9	20	270	0.9	7
100	3.1	20	280	1.3	5
110	7.5	20	290	1.8	14
120	14.3	23.11	300	3	24
130	11	30	310	6.6	27
140	15.2	29	320	9.3	31
150	13.2	33	330	10	35
160	18	34	340	9.7	35
170	19.4	37	350	10.3	33

Lab Assignment No. 10:

Title:

To Study The Reciprocity Theorem Of Antenna

Objective:

To Plot The Reciprocity Theorem Of Antenna

Theory:

In classical electromagnetism, reciprocity refers to a variety of related theorems involving the interchange of time-harmonic electric current densities (sources) and the resulting electromagnetic fields in Maxwell's equations for time-invariant linear media under certain constraints. Reciprocity is closely related to the concept of Hermitian operators from linear algebra, applied to electromagnetism.

Specifically, suppose that one has a current density that produces an electric field and a magnetic field , where all three are periodic functions of time with angular frequency ω, and in particular they have time-dependence . Suppose that we similarly have a second current at the same frequency ω which (by itself) produces fields and . The Lorentz reciprocity theorem then states, under certain simple conditions on the materials of the medium described below, that for an arbitrary surface S enclosing a volume V.

Table:

Receiver antenna = yagi uda

Transmitter antenna = folded dipole antenna

Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB
0	30	29	180	31	30
10	12	21	190	30	29
20	14	20	200	45	33
30	20	26	210	47	34
40	10	20	220	53	37
50	8	18	230	31	30
60	10	20	240	30	29
70	12	20	250	3	9
80	6	20	260	8	12
90	10	20	270	5	7
100	10	20	280	6	5
110	12	20	290	11	14
120	30	29	300	21	24
130	12	21	310	37	27
140	14	20	320	43	31
150	20	26	330	51	35
160	10	20	340	50	35
170	8	18	350	45	33

Transmitter antenna = yagi uda

Receiver antenna = folded dipole antenna

Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB	Reading of Angle on Goniometer (Degree)	Reading of Current (μA)	Current Reading in dB
0	30	29	180	57	39
10	31	29	190	44	33
20	14	21	200	38	32
30	15	20	210	36	32
40	20	26	220	25	29
50	11	20	230	18	10
60	8	18	240	6	15
70	12	20	250	3	9
80	10	20	260	8	12
90	6	20	270	5	7
100	10	20	280	6	5
110	10	20	290	10	14
120	12	20	300	20	24
130	31	30	310	37	27
140	30	29	320	44	31
150	45	33	330	53	35
160	47	34	340	51	35
170	53	37	350	46	33

Questions

Explain reciprocity theorem in detail?

Specifically, suppose that one has a current density that produces an electric field and a magnetic field , where all three are periodic functions of time with angular frequency ω, and in particular they have time-dependence .

Suppose that we similarly have a second current at the same frequency ω which (by itself) produces fields and . The Lorentz reciprocity theorem then states, under certain simple conditions on the materials of the medium described below, that for an arbitrary surface S enclosing a volume V:

What are the limitations of reciprocity theorem?

It is applicable on linear media only. For non linear circuits, it doesn't hold.

Give detail on quadratic reciprocity?

In number theory, the law of quadratic reciprocity is a theorem about modular arithmetic that gives conditions for the solvability of quadratic equations modulo prime numbers. There are a number of equivalent statements of the theorem.

Although the law can be used to tell whether any quadratic equation modulo a prime number has a solution, it does not provide any help at all for actually finding the solution.

What do you mean by Yagi antenna?

A Yagi antenna, also known as a Yagi-Uda array or simply a Yagi, is a directional antenna commonly used in communications when a frequency is above 10 MHz. This type of antenna is popular among Amateur Radio and Citizens Band radio operators. It is used at some surface installations in satellite communications systems.

Can yagi antenna transmit non-sinusoidal waves?

Yes, it would radiate off the end of a coat hanger, the antenna style is usually associated with directionality and or gain factors.