TVET CERTIFICATE V in Telecommunication

Module Title: RF ANTENNA SYSTEM INSTALLATION

CodeT L C R F 4 0 1

Competence

Competence

Credits: 6

Learning hours: 60 hours

Sector: Technical services

Sub-sector: Telecommunication

Module Note Issue date: June, 2020

Purpose statement

This module describes the skills and knowledge required to install radio frequency (RF) antenna system. The module will allow the participant to prepare RF antenna system equipment, tools and consumables, and finally install RF antenna and interfaces.

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INTRODUCTION TO ANTENNA

An antenna is used to radiate electromagnetic energy efficiently and in desired directions. Antennas act as matching systems between sources of electromagnetic energy and space. The goal in using antennas is to optimize this matching. Here is a list of some of the properties of antennas:

1-Field intensity for various directions (antenna pattern).

2-Total power radiated when the antenna is excited by a current or voltage of known intensity.

3-Radiation efficiency which is the ratio of power radiated to the total power.

4-The input impedance of the antenna for maximum power transfer (matching).

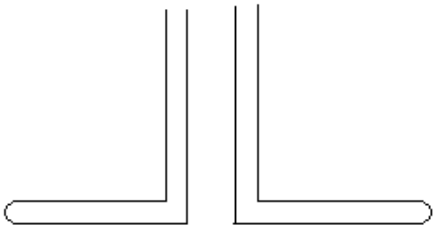
5-The bandwidth of the antenna or range of frequencies over which the above properties are nearly constant.

All antennas may be used to receive or radiate energy.

Different Types of Antennas

1-Dipole Antennas

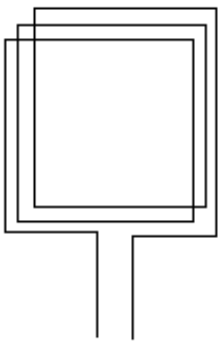
The dipole is one of the most common antennas. It consists of a straight conductor excited by a voltage from a transmission line or a waveguide. Dipoles are easy to make.



Dipole Antenna

2-Loop Antennas

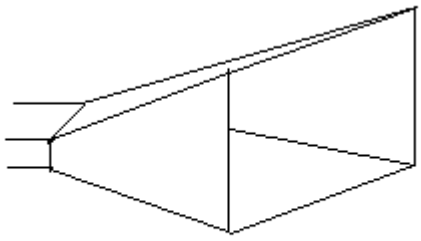
A loop of wire, with many turns, is used to radiate or receive electromagnetic energy.



Loop Antenna

3-**Aperture Antennas**

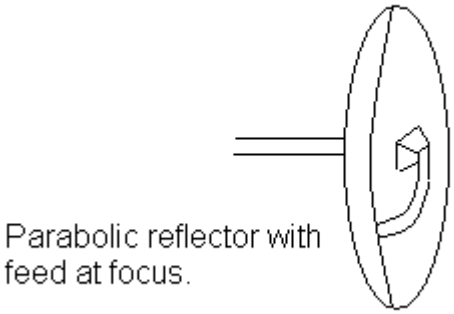
A horn as shown in the figure below is an example of an aperture antenna. These types of antennas are used in aircraft and spacecraft.



Horn Antenna

4-Reflector Antennas

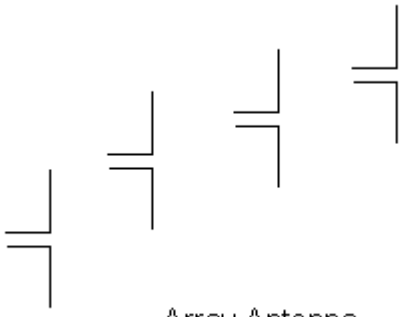
The parabolic reflector is a good example of reflectors at microwave frequencies. In the past, parabolic reflectors were used mainly in space applications but today they are very popular and are used by almost everyone who wishes to receive the large number of television channels transmitted all over the globe.



Parabolic reflector with feed at focus.

5-Array Antennas

A grouping of similar or different antennas form an array antenna. The control of phase shift from element to element is used to scan electronically the direction of radiation.



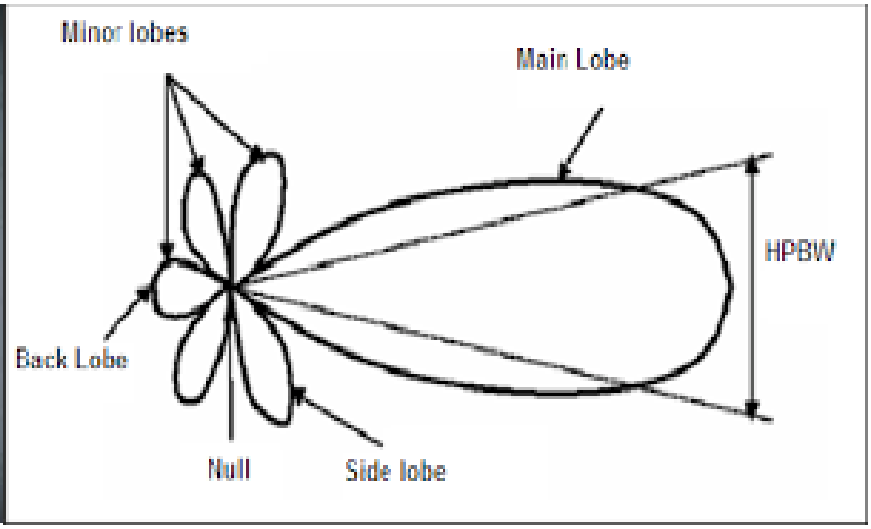
Array Antenna

LO 1.1 – Identify equipment of RF antenna system.

- Content/Topic 1 :Types of RF antenna according to coverage

Directive antennas

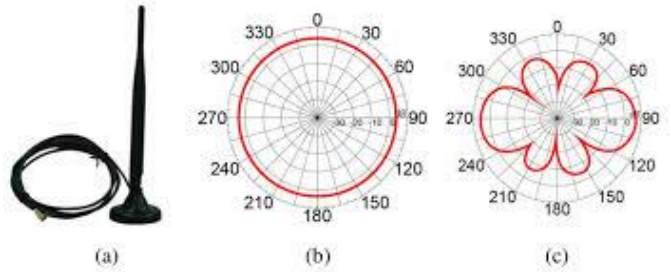
Directional and semi-directional antennas focus or radiated power into narrow beams, adding a significant amount of gain in the process. Antenna properties are also reciprocal. The characteristics of a transmitting antenna, such as impedance and gain, are also applicable to a receiving antenna. This is why the same antenna can be used for both sending and receiving. The gain of a highly directional parabolic antenna serves to amplify a weak signal; this is one reason why this type of antenna is frequently used for long distance links.



Omnidirectional antennas

This is the types of antenna used in radio communication but refer to the class of all antenna which radiates equally radio power in all directions perpendicular to an axis (AZIMUTHAL DIRECTIONS) with power varying with angle to the axis (ELEVATION ANGLE) declining to zero on the axis.

NOTE that this is different from an isotropic antenna because isotropic antenna radiates equal power in all directions, having a spherical radiation pattern. Omnidirectional antennas oriented vertically are widely used for non directional antennas on the surface of the earth because they radiate equally in all horizontal direction. Omnidirectional antennas are widely used for Radio broadcasting antennas and in mobile devices that use radio such as cell phones, FM radios, walkie-talkies, GPS, cordless phones, as well as for base stations that communicate with mobile radios, such as police and taxi dispatchers and aircraft communications.



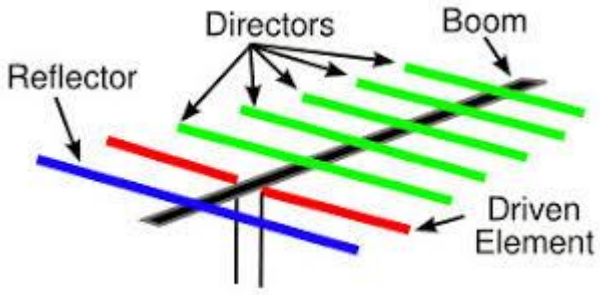
Sector Antenna

A sector antenna or "sector panel" is a directional antenna for outdoor applications. They are most often used by Base-Stations and can be seen, hung on cell phone towers. They are long, narrow antennas with high gains. Sector antennas consist of an array of dipoles placed in front of a shaped reflector. The size and shape of the reflector determines the performance of these antennas. The reflector is usually flat with some ridges or other features along the edges.

- Content/Topic 2 :Types of RF antenna according to frequency band

According to this type also some are: Single-band antennas, dual-band antennas and triple-band antennas.

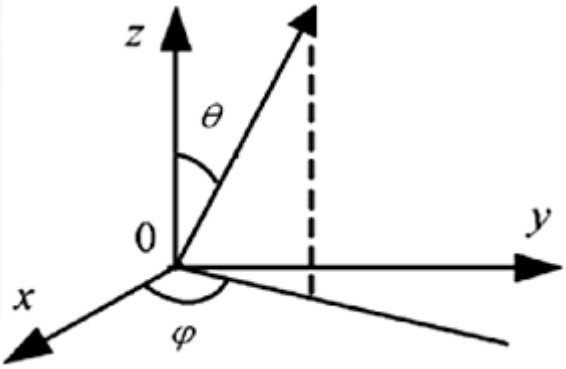
- What is and where you can find A dual-band antenna?: This is the type of blade antenna, a monopole whip antenna mounted on the outside of an aircraft in the form of a blade-shaped aerodynamic fairing to reduce its air drag. It is used by avionics radio communication systems. The dual band type uses a "plane and slot" design to get efficient Omni-directional coverage so that it can operate on two different radio bands.



- What is and where you can find A Single-band antennas?: A singleband antenna is one that operates on one frequency only.

- A single-band phone is one that operates on one frequency only. Simply let use a typical examples of router antennas in order to understand very well single band differ from dual band antennas, but first you know that router has antenna for transmitting wireless signs.
- Single-band router uses the 2.4GHz band and is limited to one wireless signal. Dual-band router uses two bands: 2.4GHz and 5GHz, which means that they transmit two simultaneous wireless signals, providing a better performance, and compared to a single band router, a dual-band router is easier to set up.

- What is triple-band antennas those are all antennas radiates in three sides that triple means three.



- Content/Topic 3 : RF antenna system installation support

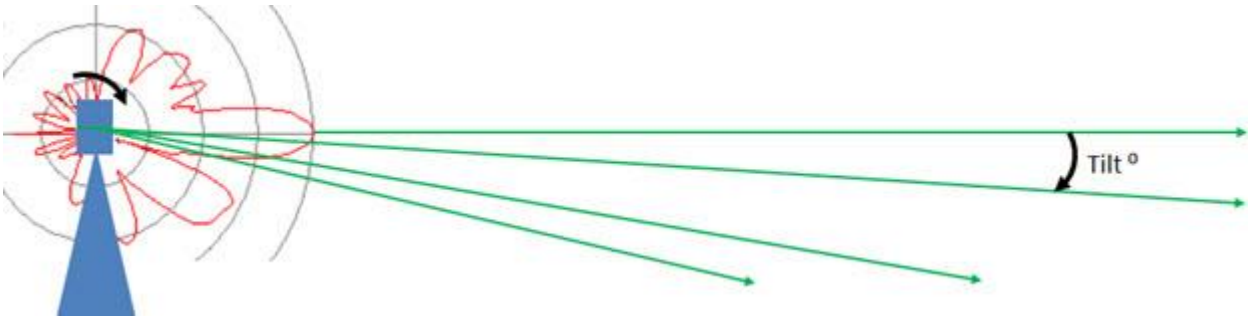
Antenna brackets

Antenna mechanical tilt Vs Electrical tilt

what is Tilt?

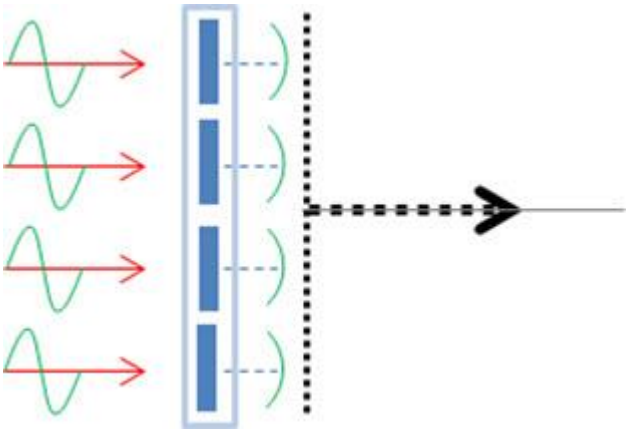
Right, now we can talk specifically about Tilt. Let's start reminding what is the Tilt of an antenna, and what is its purpose.

The tilt represents the inclination or angle of the antenna to its axis.



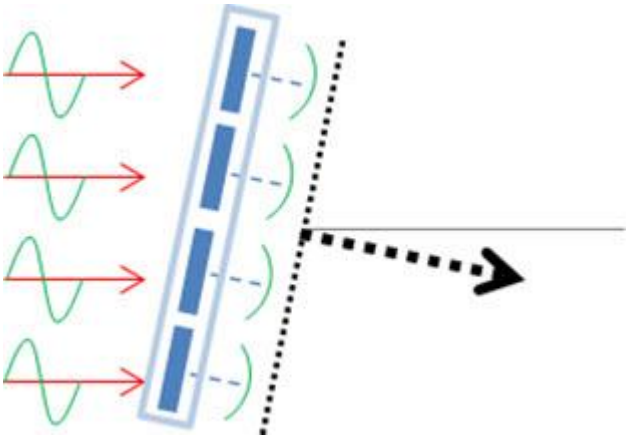
As we have seen, when we apply a tilt, we change the antenna radiation diagram.

For a standard antenna, without Tilt, the diagram is formed as we see in the following figure.

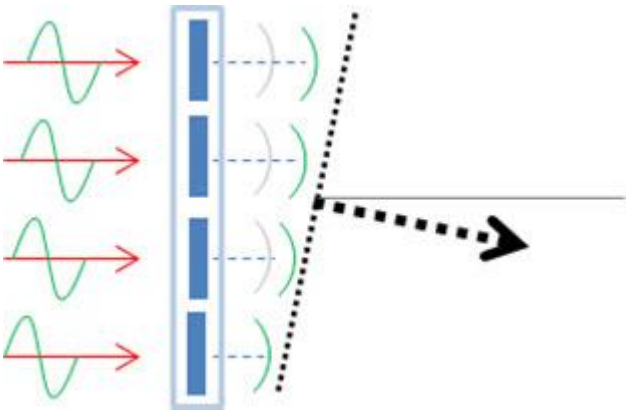


There are two possible types of Tilt (which can be applied together): the electrical Tilt and Mechanical Tilt.

The mechanical tilt is very easy to be understood: tilting the antenna, through specific accessories on its bracket, without changing the phase of the input signal, the diagram (and consequently the signal propagation directions) is modified.



And for the electrical tilt, the modification of the diagram is obtained by changing the characteristics of signal phase of each element of the antenna, as seen below.



Note : the electrical tilt can have a fixed value, or can be variable, usually adjusted through an accessory such as a rod or bolt with markings. This adjustment can be either manual or remote, in the latter case being known as 'RET' (Remote Electrical Tilt) – usually a small engine connected to the screw stem/regulator that does the job of adjusting the tilt.

- Content /Topic 4 : Antenna brackets mounting techniques

This techniques focused on:

According to the method of mounting on the mast tube

- right-side mounting
- left-side mounting

according to the method of mounting the FOD unit – antenna polarization

- horizontal mounting
- vertical mounting

In both cases mount the unit with the connectors facing downwards at an angle.

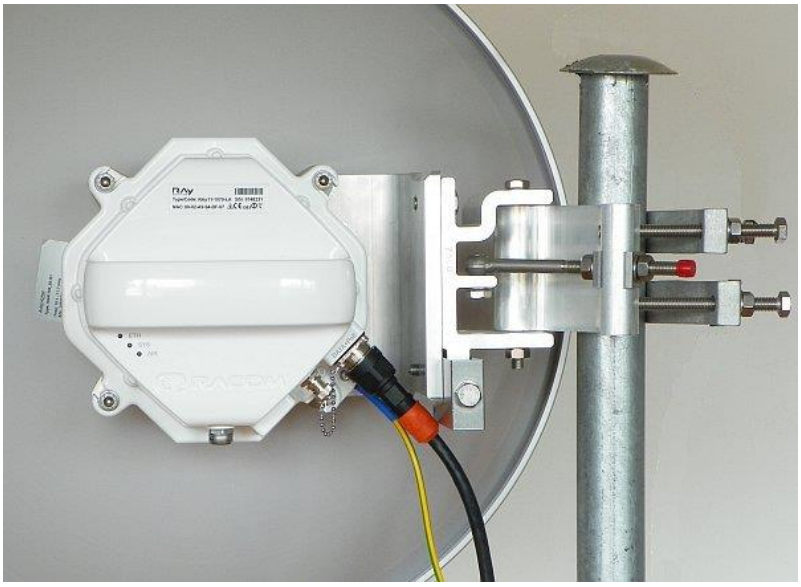


Fig.shows: Left-side mounting – horizontal polarization of receiving

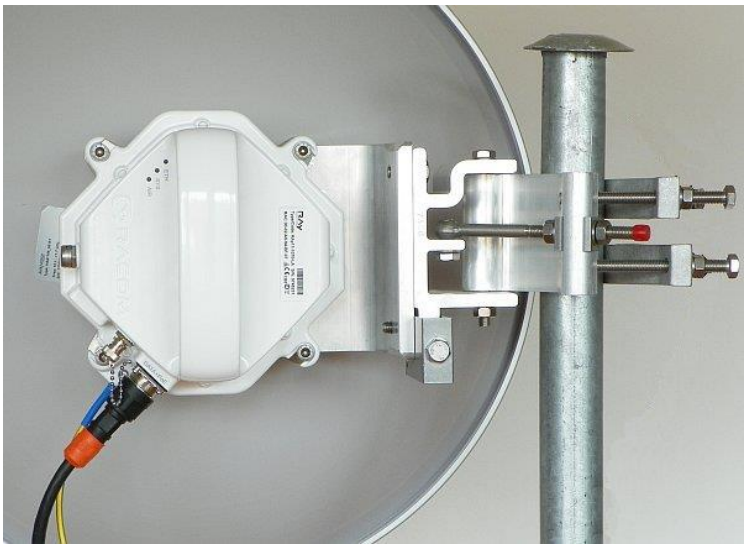


Fig. 5.2: Left-side mounting – vertical RX polarization

For making antenna installation antenna brackets support us in mounting to different sides after fixing antenna bracket you can do antenna mechanical tilt. Mechanical tilting the antenna, this is the activities to arrange, to fix all specific accessories on its bracket by making good polarization, without changing it's phase.

- Content/Topic 5: RF antenna installation tools

✓ Screw drivers set

✓ Allen keys

✓ Complete set of spanners

✓ Hacksaw

✓ Pliers set

✓ Side cutter

✓ Measuring tape

✓ Spirit level

✓ Cable ties

✓ Insulator tapes

✓ Screws

✓ Bolts

✓ Rope

LO 1.2 – Select appropriate tools

Similar to LO 1.1

LO 1.3 – Use RF antenna system tools

Similar to LO 1.2 and 1.2

Learning Unit 2 – Prepare RF antenna system consumable

LO 2.1 – Identify required consumables

- Content/Topic 1 : RF antenna installation consumables
- Cable ties
- Insulating tape
- Water proofing tape
- Marking set
- Cable/Feeder clamps
- Feeder cables
- Feeder connectors

LO 2.2 – Use consumables efficiently

Similar to LO 2.1

LO 2.3 – Manage waste materials

- Content/Topic 1 : collection and arrangement of materials

Physical arrangement refers to the physical order of the materials in the collection - how and where they are housed and stored. It is different from the intellectual arrangement, though physical arrangement and intellectual arrangement often mimic one another. Unlike intellectual arrangement, which is determined by the intellectual or informational relationships between records, physical arrangement is determined by the size, shape, type, and housing needs of the various records, regardless of the information provided therein.

- Content/Topic 2 : Management of remaining materials

How society uses materials fundamentally affects our economic and environmental future. Inefficient and wasteful use of materials now challenges the capacity of the Earth – air, water and land. We can fulfill our needs and prosper while using less material, reducing toxic, and recovering more of the material we consume.

- Content /Topic3 : Disposal of installation waste

Waste management or Waste disposal is all the activities and actions required to manage waste from its inception to its final disposal. This includes among other things, collection, transport, treatment and disposal of waste together with monitoring and regulation.

Learning Unit 3 – RF Antenna installation and interfaces

LO 3.1 – Assemble RF antenna.

- Content/Topic 1 : Assembling process of RF antenna

For this process refer to the video on YouTube as (https://www.youtube.com/watch?v=cg83nOQS6mY).

- Content /Topic 3 : user manual interpretation

The User manual contains all essential information for the user to make full use of the information system. This manual includes a description of the system functions and capabilities, contingencies and alternate modes of operation, and step-by-step procedures for system access and use. The manual format may be altered if another format is more suitable for the particular project.

- Content /Topic 4 : Assemble antenna parts according to user manual

Before you buy your antenna and spend your hard earned money you need to consider a few things. You need to find the type of antenna that you need, the location of your antenna, your budget, your skill level and the cost effectiveness of the project. Depending of the location of your home you may not benefit from getting your TV programming from a TV antenna if you don't get enough channels where you live or, if the channels available in your area don't appeal to you. Before you start you may want to search all the stations broadcasting where you live.

Step 1: Outdoor Antenna Versus Indoor Antenna

There are pros and cons from both types of antennas.

Indoor antennas are:

- Easy to install, almost right out of the box.
- Some have great receptivity wherever you place them in your home.

Some disadvantages of indoor antennas are:

- Some cheaper antennas have limited receptivity.

In contrast outdoor antennas have some benefits like:

- Choice of unidirectional or omnidirectional.
- Better and increased receptivity of digital signal.
- Usually located at the highest point on a structure, thus increasing reception.

Choice of shapes and sizes.

Some antennas look like arrows, some look like little satellite dishes, some look like grids and, some like flying saucers. The shape of the antenna is a result of its function. Unidirectional antennas look like arrows and some of the newer ones look like small satellite dishes. Omnidirectional antennas may look like grids or small flying saucers.

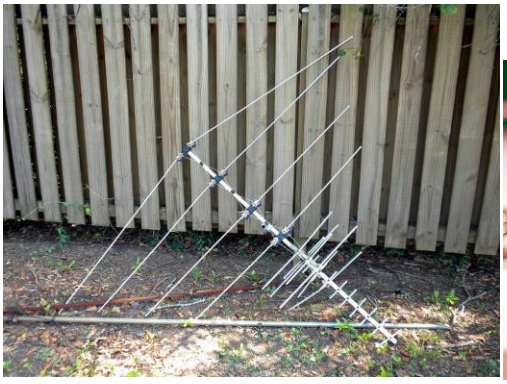
There are many different ways to install an outdoor antenna: gable install, roof, wall or, chimney. There are different installation kits available in almost every hardware store.

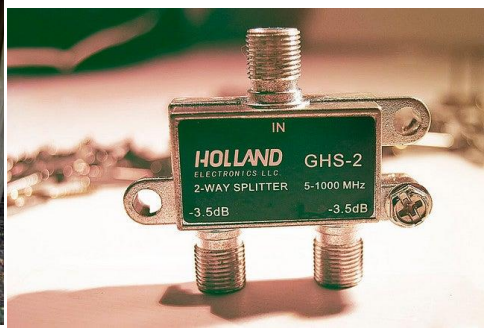
The disadvantages of the outdoor antennas are:

Unless you hire a professional installer, it requires you to climb ladders, use power drills and, walking on your roof. Caution should be taken to not install your antenna too close to electrical wires or, during wet, stormy or, snowy weather. Always observe the maximum weight capacity on your ladder, do not use unstable ladders and, never overextend your arms trying to reach anything.

Installation of an outdoor antenna requires grounding to discharge any electrostatic potential that will attract lightning.

Step 2: Materials





To install your antenna you will need the following:

1. Antenna of your choice.
2. 75 ohm to 300 ohm transformer (should come with new antenna)
3. Mounting kit (braces, u-bolts, etc.)
4. Mast (antenna must be 10 feet (3.04 meters) above roof, you will need a 12 feet (3.66 meters) mast or two 6 feet (1.83 meters masts if you add a rotator)
5. UV resistant outdoor coaxial cable (100 feet, 75 feet, 50 feet or 25 feet depending on your configuration with ground wire)
6. Grounding block.
7. Splitter (2 way, 4 way, etc., depending on how many TVs you want to connect).
8. One digital converter for every TV connected to the antenna.
9. Antenna rotator (optional, only if you pick an unidirectional antenna).
10. Hammer drill (for cement block or brick walls) or regular drill (for wood panel).
11. Masonry or regular drill bits.
12. Masonry or wood screws.
13. TV signal booster (optional).
14. Ty-wraps.

Step 3: Antenna Installation



If you chose to install your antenna using the wall mount

you need to drill pilot holes for the bolts that will anchor the braces to the wall. Do not drill on the brick but instead drill on the mortar which is softer than the brick. Make sure that you leave a space of approximately 12 to 14 inches between the brace on top and the one below. This will make sure that the mast will not sway with the wind. If one or two holes are too big for the bolt, which sometimes happens, simply use plastic expansions inside the pilot holes and screw the bolt again.

Assemble the antenna on the ground.

Secure all bolts and nuts and connect the transformer to the antenna if the antenna comes with the transformer. If the antenna comes with a coaxial connector outside the plastic casing simply connect the outdoor coaxial cable to the antenna. In some models the transformer is already built-in. Follow the manufacturer's instructions.
Carefully select the location of your aerial. Do not install too close to electrical wires or tree branches. You may need someone to help you hold the antenna while you secure all the u-bolts to the braces. Make sure that the antenna is at least 10 feet above the peak of your roof. Also the nuts that come with your mounting kit will have washers that will not creep out. Make sure to tighten them.
Once the antenna is in place, secure the cable to the mast using Ty-wraps. If you have a rotator, allow about a 2 feet loop of enough cable between masts. When the rotator gyrates the antenna while searching for more stations the coaxial cable might be pulled and stretched. It is very important to allow the cable not to be stretched by the action of the rotator.
You may want to disguise the coaxial cable the best you can for aesthetic reasons. I have hidden the coaxial cable behind the gutters. Use your imagination.
Next, connect the coaxial cable to the grounding block or the splitter depending on your configuration. In my case I connected the cable to a 4 way splitter and connected three coaxial cables to a grounding block that would accept the three segments of coaxial cable (see picture above). One of the segments went to my upstairs bedroom, the second entered the basement to come out of the living room floor and, the third is kept with a TV in the basement. Now I can watch the news anywhere in the house.

LO 3.2 –Install RF antenna.

- Content/Topic 1 : RF antenna installation techniques

1. Fix antenna bracket to the antenna
2. Fix tilting kit to the antenna
3. Install pulley and rope for antenna lifting
4. Lift antenna to planned height and
5. tight it with nuts using spanners
6. Set antenna on planned parameters (Azimuth/ Mechanical tilt/ Electrical tilt)
7. Label antenna system

LO 3.3 – Install RF antenna interfaces.

Content/Topic 1 : RF antenna interfaces installation techniques

1. Set feeder/cable clamps on feeder/cable path
2. Run/Roll feeder/cable from antenna to radio cabinet
3. Terminate feeder with connector
4. Interconnect feeder with jumpers
5. Connect jumpers to RF antenna and radio units (RUs)
6. Seal the junctions on feeder/cable and jumpers intersections using sealing sets (water proofing tape and scotch)
7. Seal antenna interconnection with jumper using sealing set

LO 3.3 – Verify layout implementation according to design.

Content/Topic 1 : Antenna height

The height of an antenna has a major impact on its performance. Aspects including the feed impedance, radiation diagram, radiation losses, distance from interference, reduction in possibility of exposure to RF radiation, etc.

In general the higher the antenna the better its performance will be, but sometimes there are some limits as there is a law of diminishing returns, but often this is outside the reach of amateur radio users but sometimes broadcasters will want particularly high antennas to gain the required coverage at VHF and UHF.

Broadcasters often invest in very high towers, especially for VHF and UHF broadcast transmissions. Gaining the greatest coverage area can often only be achieved by increasing the antenna height.

Content/Topic 1 : Antenna orientation

- Azimuth

The azimuth is the angle between a celestial body (sun, moon) and the North, measured clockwise around the observer's horizon.

- Elevation

The elevation is the vertical angular distance between a celestial body (sun, moon) and the observer's local horizon or, also called, the observer’s local plane.

- Antenna mechanical tilts

The mechanical tilt is very easy to be understood: tilting the antenna, through specific accessories on its bracket, without changing the phase of the input signal, the diagram (and consequently the signal propagation directions) is modified.

- Antenna electrical tilt

An antennas electrical tilt is defined as the angular shift in elevation of the direction of maximum gain of the antenna by a specific electrical design of the antenna. Electrical tilt can be fixed or variable.

Reference(s):

1. https://shodhganga.inflibnet.ac.in/bitstream/10603/100953/1/chapter%201.pdf

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