TVET CERTIFICATE V in Telecommunication

MICROWAVE ANTENNA SYSTEM INSTALLATION

TLCMS401

Install Microwave Antenna

Competence

Credits: 8

Learning hours: 80

Sector: TECHNICAL SERVICES

Sub-sector: TELECOMMUNICATION

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Purpose statement

This module describes the skills and knowledge required to install microwave antenna system. The module will allow the participant to conduct, prepare microwave antenna system equipment, tools and consumables, install microwave IDU, interconnect microwave antenna equipment and finally test the microwave link.

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Total Number of Pages: 20

INTRODUCTION TO MICROWAVE

Example of a CableFree Microwave Link Installation

Microwave is a line-of-sight wireless communication technology that uses high frequency beams of radio waves to provide high speed wireless connections that can send and receive voice, video, and data information.

Microwave links are are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Another advantage is that the high frequency of microwaves gives the microwave band a very large information-carrying capacity; the microwave band has a bandwidth 30 times that of all the rest of the radio spectrum below it.

Microwave radio transmission is commonly used in point-to-point communication systems on the surface of the Earth, in satellite communications, and in deep space radio communications. Other parts of the microwave radio band are used for radars, radio navigation systems, sensor systems, and radio astronomy.

The higher part of the radio electromagnetic spectrum with frequencies are above 30 GHz and below 100 GHz, are called “millimeter waves” because their wavelengths are conveniently measured in millimeters, and their wavelengths range from 10 mm down to 3.0 mm. Radio waves in this band are usually strongly attenuated by the Earthly atmosphere and particles contained in it, especially during wet weather. Also, in wide band of frequencies around 60 GHz, the radio waves are strongly attenuated by molecular oxygen in the atmosphere. The electronic technologies needed in the millimeter wave band are also much more complex and harder to manufacture than those of the microwave band, hence cost of Millimeter Wave Radios are generally higher.

LO 1.1 – Identify Microwave link antenna equipment.

- Content/Topic 1: Essential of ODU microwave link antenna system

Reflector dish (Parabolic Reflector Antenna: Dish Antenna)

The parabolic reflector antenna which is often called the dish antenna provides an antenna solution applicable for VHF and above where high gain and directivity are needed.

The parabolic reflector or dish antenna is the form of antenna which finds many uses in domestic satellite television reception, terrestrial microwave data links, general satellite communications and many more. Its size means that it is generally limited to use above 1GHz, although larger antennas may be used for frequencies down to about 100MHz.The parabolic reflector antenna or dish antenna is known for its distinctive shape, its high gain, and narrow beamwidths. It is the performance which can be achieved by using one is the reason it is so widely used at higher frequencies.

Fig . Two parabolic reflectors used for commercial / research applications

Parabolic reflector antenna advantages & disadvantages

When selecting the type of antenna to be used for any given application, it is always necessary to look at the characteristics for that type of antenna. The parabolic reflector has both advantages and disadvantages. These make it suitable for use in some applications but not in others.

Advantages:

Some of the major advantages of the parabolic reflector antenna include the following:

High gain: Parabolic reflector antennas are able to provide very high levels of gain. The larger the 'dish' in terms of wavelengths, the higher the gain.

High directivity: As with the gain, so too the parabolic reflector or dish antenna is able to provide high levels of directivity. The higher the gain, the narrower the beamwidth. This can be a significant advantage in applications where the power is only required to be directed over a small area. This can prevent it, for example causing interference to other users, and this is important when communicating with satellites because it enables satellites using the same frequency bands to be separated by distance or more particularly by angle at the antenna.

Disadvantages:

Like all forms of antenna, the parabolic reflector has its limitations and drawbacks:

Requires reflector and drive element: the parabolic reflector itself is only part of the antenna. It requires a feed system to be placed at the focus of the parabolic reflector.

Cost : The antenna needs to be manufactured with care. A paraboloid is needed to reflect the radio signals which must be made carefully. In addition to this a feed system is also required. This can add cost to the system

Size: The antenna is not as small as some types of antenna, although many used for satellite television reception are quite compact.

Parabolic reflector antenna applications

There are many areas in which the parabolic dish antenna is used. In some areas it is the form of antenna that is used virtually exclusively because of its characteristics.

Direct broadcast television: Direct broadcast or satellite television has become a major form of distribution for television content. The wide and controllable coverage areas available combined with the much larger bandwidths enable more channels to be broadcast and this makes satellite television very attractive.

Fig. : Domestic satellite television parabolic reflector antenna showing the offset feed arrangement to reduce aperture block which reduces the antenna gain.

Microwave links: Terrestrial microwave links are used for many applications. Often they are used for terrestrial telecommunications infrastructure links. One of the major areas where they are used these days is to provide the backhaul for mobile telecommunications systems.

Fig. : A variety of microwave parabolic reflector antennas mounted on a mobile phone tower

Satellite communications: Many satellite uplinks, or those for communication satellites require high levels of gain to ensure the optimum signal conditions and that transmitted power from the ground does not affect other satellites in close angular proximity. Again the ideal antenna for most applications is the parabolic reflector antenna.

Radio astronomy: Radio astronomy is an area where very high levels of gain and directivity are required. Accordingly the parabolic reflector antenna is an ideal choice.

In all these applications very high levels of gain are required to receive the incoming signals that are often at a very low level. For transmitting this type of RF antenna design is able to concentrate the available radiated power into a narrow beamwidth, ensuring all the available power is radiated in the required direction.

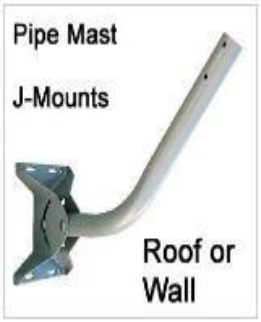
Feed horn

A Feed Horn is basically a horn antenna that lies between the transceiver and the antenna reflector in a satellite dish system.

When receiving a signal from the satellite, the signal is reflected from the parabolic dish to the feed horn which then passes it on to the Low Noise Block (LNB) where it is down converted and processed further. The feed horn provides some level of gain and is designed to support a particular type of polarization, this way it can filter out unwanted signals by only allowing specific polarity waves depending on the polarization of the horn antenna.

Feed Horn is always located at the focal point of the parabolic dish and is simply attached to the LNB. An LNB with an integrated feed horn is called as an LNBF..

Antenna mounting Pole

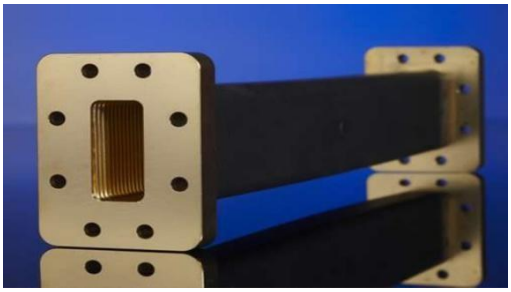


Splitter

An antenna splitter converts one input signal into multiple antenna output signals. An antenna splitter is described as active or passive depending on whether or not it is equipped with an amplifier.

Waveguide

A device that confines electromagnetic energy and channels it from one point to another.



Types of Waveguide

1. Rectangular Waveguide

2. Circular Waveguide

Rectangular Waveguide

1. Dominant mode is TE10
2. Supports TM and TE modes but not TEM waves
3. There is only one conductor

Circular Waveguide

1. Dominant mode is TE11.

Modes of Waveguide

1. TE Mode

2. TM Mode

3. TEM Mode

TE (Transverse Electric) Mode

2. Electric field is perpendicular to direction of propagation.
3. Magnetic components are in the direction of propagation.
4. TE modes (transverse electric) have no electric field in the direction of propagation.
5. TE mode is subdivided into TE10, TE11, TE20, and TE01

TM (Transverse Magnetic) Mode

1. Magnetic field is perpendicular to direction of propagation.
2. Electric components are in the direction of propagation.
3. TM modes have no magnetic field in the direction of propagation.
4. TM mode is subdivided into TM11, TM21

TEM (Transverse Electric Magnetic) Mode

1. Both Electric & Magnetic field of signal is perpendicular to direction of propagation.
2. In TM modes both electric and magnetic field are directed components
3. TEM mode is subdivided into TM11, TM21

Uses of Waveguide

1. To carry high frequency radio waves, particularly microwaves.
2. It is used to handle high power energy.
3. Waveguide is used in communication system.
4. It is mostly used in airborne radar.
5. Waveguide is used in the devices of navigation aids.

Dish Brackets

IF Cable

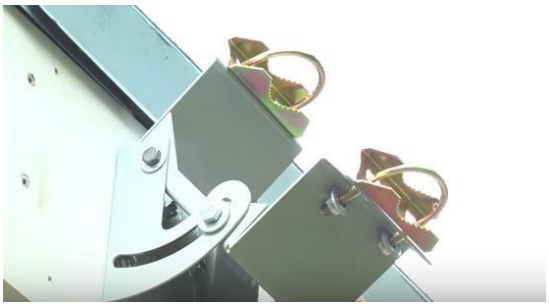
1/2 inch cable is used for the distance between 180m and 300m. In communications and electronic engineering, an **intermediate frequency**(**IF**) is a frequency to which a carrier frequency is shifted as an intermediate step in transmission or reception. The intermediate frequency is created by mixing the carrier signal with a local oscillator signal in a process called heterodyning, resulting in a signal at the difference or beat frequency.

IF Connector

IF Connector: The part of a cable that plugs into a port or interface to connect one device to another. Most connectors are either male (containing one or more exposed pins) or female (containing holes in which the male connector can be inserted).

Antenna brackets

The mounting **bracket** is used to attach a short mast to a rafter or rafter support.



- Content/Topic 2: Microwave link parameters consideration

1. Antenna diameter
2. Feed horn frequency
3. **DU (Outdoor Unit) Frequency bands and sub-bands**

Each ODU is designed to operate over a predefined frequency sub-band. For example 21.2 – 23.6GHz for a 23GHz system, 17.7 – 19.7GHz for a 18GHz system and 24.5 – 26.5GHz for a 26GHz system as for ODUs. The sub-band is set in hardware (filters, diplexer) at time of manufacture and cannot be changed in the field.

- Content/Topic 2 : Link protection techniques

Unprotected: Microwave links where there is no diversity or protection are classified as Unprotected and also as 1+0. There is one set of equipment installed, and no diversity or backup

Hot Standby: Two sets of microwave equipment (ODUs(Outdoor Units) , or active radios) are installed generally connected to the same antenna, tuned to the same frequency channel. One is "powered down" or in standby mode, generally with the receiver active but transmitter muted. If the active unit fails, it is powered down and the standby unit is activated. Hot Standby is abbreviated as HSB, and is often used in 1+1 configurations (one active, one standby).

LO 1.2 – Fix Microwave link antenna supports.

- Content/Topic 1 : Microwave link antenna system supports

Antenna brackets

The mounting bracket is used to attach a short mast to a rafter or rafter support.

Antenna tilting arm (updown direction)

LO 1.3 – Prepare ODU(Outdoor Unit) supports for Microwave link antenna.

- Content/Topic 1: Pole fixing on tower

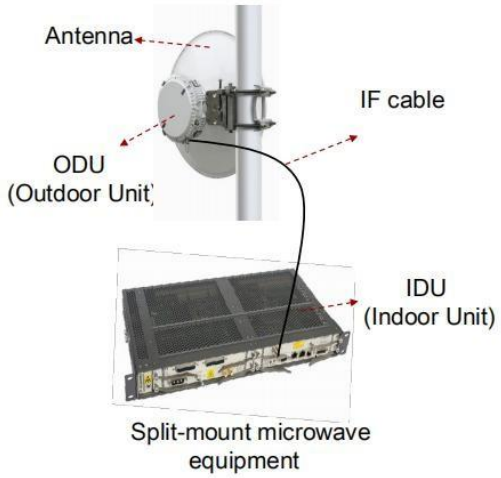
Towers, masts, and poles are used to provide elevation, stabilized support, or position control for personnel or equipment. They provide a line of sight for viewing and illumination as well as the transmission and reception of signals.

- Content/Topic 2 : Splitter connection (for 1+1 Link)

For resilient networks there are several different configurations. 1+1 in "Hot Standby" is common and typically has a pair of ODUs (one active, one standby) connected via a Microwave Coupler to the antenna. There is typically a 3dB or 6dB loss in the coupler which splits the power either equally or unequally between the main and standby path.

- Content /Topic3 : Waveguide for linking antenna to ODUs

Often the ODU is direct mounted to a microwave antenna using "Slip fit" waveguide connection. In some cases, a Flexible Waveguide jumper is used to connect from the ODU to the antenna.



LO 1.4 – Select tools for microwave link antenna installation.

- Content /Topic1 : Microwave link antenna installation tools

- ❖ Flat screw drivers
- ❖ Star screw drivers
- ❖ Allen keys
- ❖ Complete set of
- ❖ spanners
- ❖ Adjustable spanner
- ❖ Universal pliers
- ❖ Cutting pliers
- ❖ Side cutter

- ❖ Measuring tape
- ❖ Marker pen
- ❖ Spirit level
- ❖ Screws
- ❖ Bolts
- ❖ Rope

LO 1.5 – Identify required consumables for microwave link antenna installation.

- Content /Topic1 : Microwave link antenna installation consumables

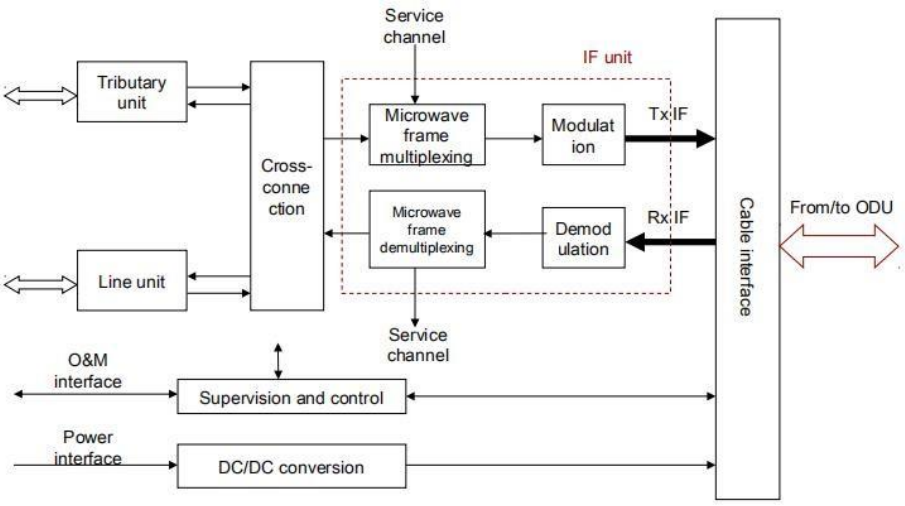
- ✓ Cable ties
- ✓ Insulating tape
- ✓ Water proofing tape
- ✓ Marking set
- ✓ IF cable clamps
- ✓ IF cable connectors
- ✓ IF cable

Learning Unit 2 – Install microwave IDU

LO 2.1 – Install Microwave IDU into rack/cabinet.

- Content/Topic 1: Essentials of microwave IDU

All active components are located inside a building or shelter, allowing easy maintenance and upgrades—without requiring tower climbs, for instance. Being farther from the antenna may introduce higher transmission line losses than other configurations, however. IDU, Performs access, dispatch, multiplex/demultiplex, and modulation/demodulation for services.



- Content/Topic 2 :Assembling process of IDU magazine

❖ **Insert PFU (Power Filter Unit)**

❖ **Insert the FAU (fan unit card)**

❖ **Insert LTU (Line Termination Unit)**

A plug-in unit that provides PDH or SDH traffic interfaces. The following LTUs with E1 interfaces are available:

LTU 12x2 (Fits in an AMM 2p. For sites where the four E1 interfaces on the NPU2 are insufficient, the LTU 12x2 provides 12 additional E1 interfaces.)

LTU 16x2 (Fits in an AMM 6p and AMM 20p. For sites where the eight E1 interfaces on the NPU 8x2 are insufficient, the LTU 16x2 provides 16 additional E1 interfaces.)

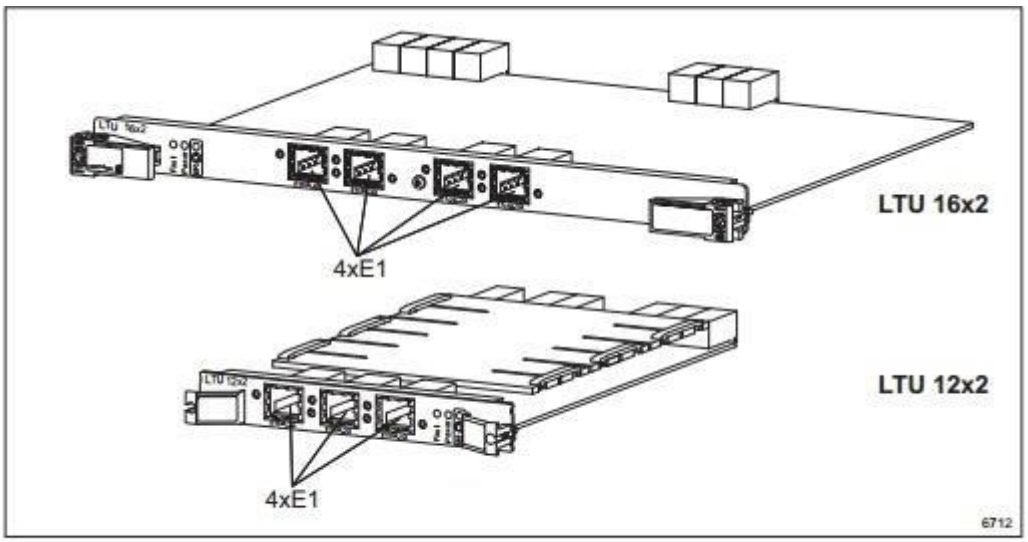


Figure LTUs with E1 interfaces

❖ **Insert NPU (Node Processor Unit)**

The NPU implements the system's main traffic and control functions. One NPU is always required in the AMM. The NPU also provides E1, DCN and management interfaces.

The following NPUs are available:

NPU2 (Fits in an AMM 2p)

NPU 8x2 (Fits in an AMM 6p and 20p)

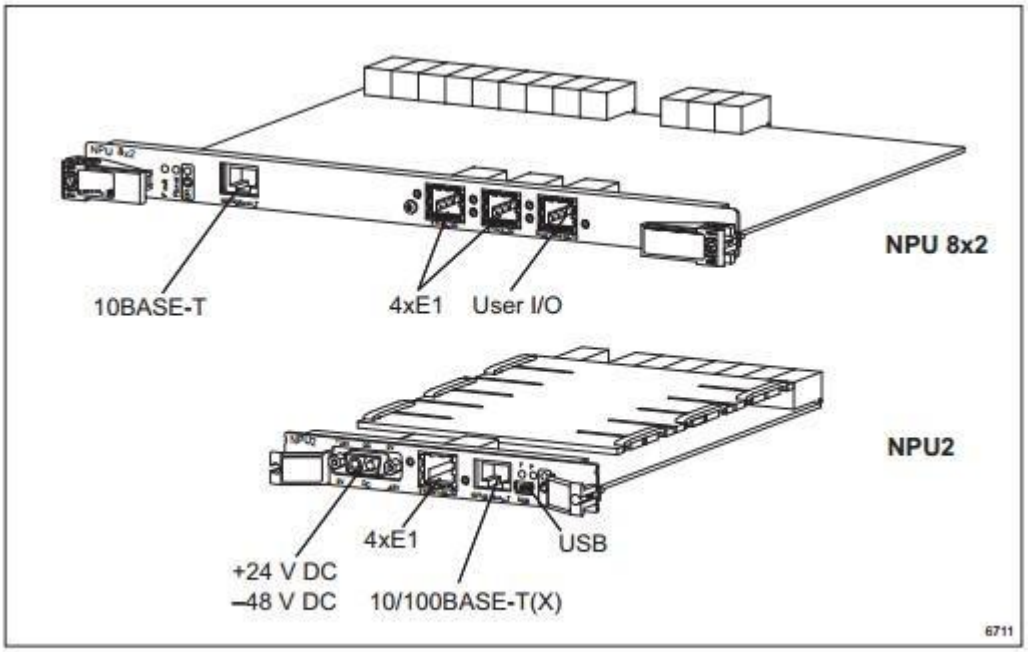


Figure NPUs

Node Processor units

The following summarizes the common functions of the NPUs:

- Traffic handling
- System control and supervision
- DCN handling
- SNMP Master Agent
- 10BASE-T Ethernet interface for connection to a site LAN
- Storage and administration of inventory and configuration data

- **Insert MMU (Multiplexing Module Unit)**
- **Insert the assembled magazine into rack/cabinet**

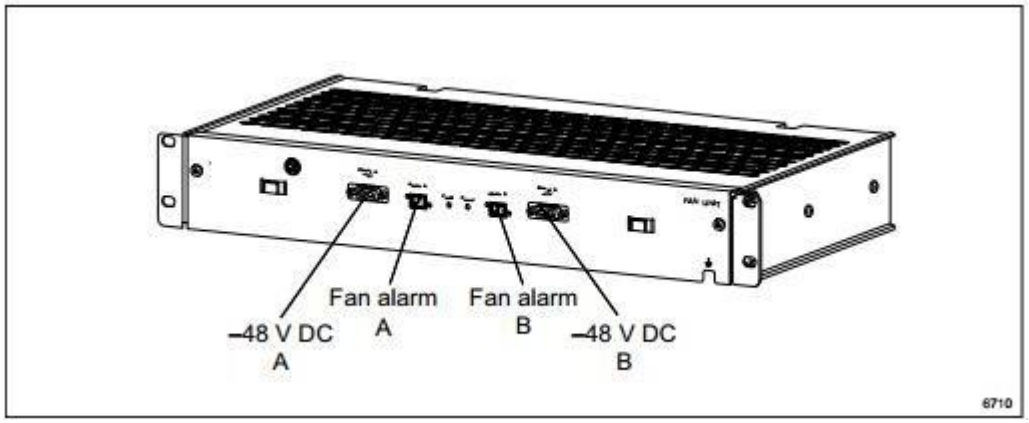
LO 2.2 – Connect microwave IDU interfaces

- Content /Topic3 : Connect microwave IDU interfaces.

❖ **Connection of PFU power cable to DC power system**

❖ **FAU(Fan Unit) powering**

Provides cooling for the indoor part. FAU1 has an automatic fan speed control and holds three internal fans. FAU1 has two –48 V DC connectors for redundant power supply. Two connectors are also available for export of alarms to PFU1.



❖ Connection of LTU or NPU E1 cables to DDF (Digital Distribution Frames/ Krone Blocks)

Connection of MMU to slot of IDU

Magazine modem unit(MMU) modulate the signal from the Base band to IF band and vice versa. Other hand, supply dc power to RAU. Also Determine the link modulation scheme and bandwidth.

Both MMU 2H & 2D support modulation up to128 QAM . they also support adaptive modulation (Lowering the modulation scheme to became more robust to against fading).

Only MMU 2H supports XPIC and MMU is also mandatory unit.

MMU2D

MMU2H

LO 2.3 – Connect microwave IDU to ODU.

- Content/Topic 1: Microwave IDU connection to ODU process

❖ Terminate connectors to IF cable on both ends

❖ Run/Roll IF cable from ODU to IDU

❖ Make earthing of IF cable

❖ Connect IF cable to MMU card of IDU

❖ Connect IF cable to ODU

❖ Seal the junction of IF connector and ODU using waterproofing tape and insulating tape

Learning Unit 3 – Test the microwave link

LO 3.1 – Verify microwave link layout implementation.

- Content/Topic 1: Interpretation of site layout

❖ Symbols

❖ Title block

❖ Site block diagram

- Content/Topic 2 : Analysis of implementation data

❖ Microwave link height

❖ Microwave dish azimuth

❖ Microwave ODU polarization

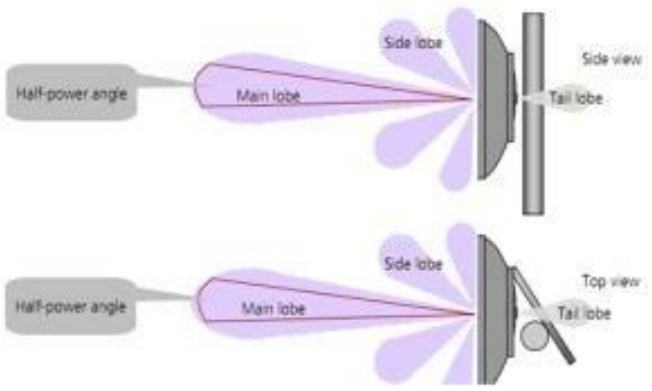
❖ Check if ODU is ON

❖ Check if IDU is ON

LO 3.2 – Align microwave link toward getting the expected signal strength.

- Content/Topic 1 : Microwave link antenna alignment

Alignment of Microwave Antennas for Digital Microwave Transmission Systems



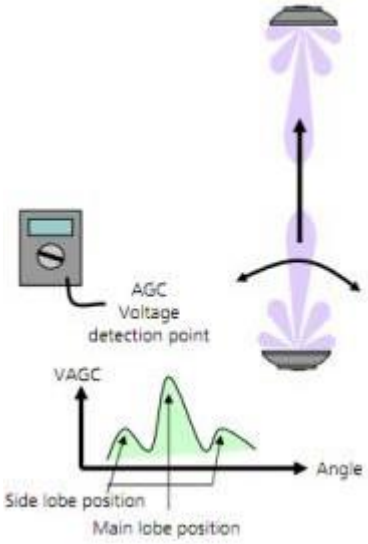
CableFree Microwave Antenna Alignment

Antenna Alignment for Microwave Links

This guide explains how to achieve the optimal antenna alignment of microwave antennas when used with modern digital microwave products. Before attempting to do the alignment it is highly recommended that you read this guide in detail. For specific commands please consult the manual of the product being installed

Step 1: Preparation:

Mount the antenna on the tower according to the antenna installation instructions: Ensure that the adjustment bolts move smoothly and the range of motion is sufficient for the expected angle of up and down (elevation) tilt. Ensure that the mount itself is attached securely and all safety precautions have been taken.



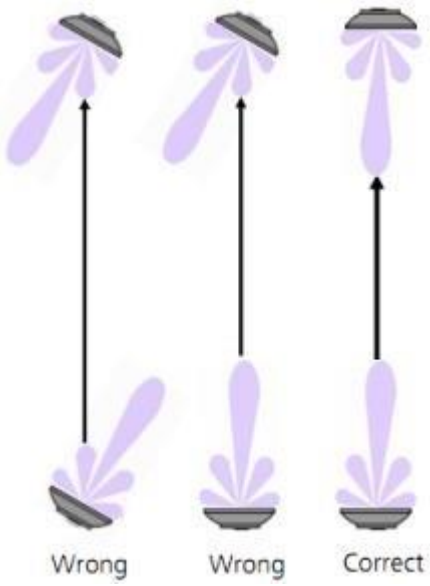
CableFree Microwave Antenna Alignment using DVM

Step 2: Coarse Alignment:

Visually align the antenna with the far end. The most common ways to do this are :

1) If the visibility is good and the sun is in the correct position, have someone at the far end location reflect the sun with a mirror so the location is obvious.

2) If visibility is poor, use GPS coordinates and a GPS compass to aim the antenna coarsely.



CableFree Microwave Antenna Alignment avoiding Sidelobes

Step 3: Fine Alignment.

Before conducting fine alignment, the ODUs at both ends of the link must be attached properly to the antenna via the direct mount or remote mount (using Waveguide) and the far end ODU must be powered on and transmitting. The ODU lightning surge suppressors and grounding provisions should be put in place as well before alignment. The local ODU must be powered on, but need not be transmitting.

Ensure that:

1) Frequency of the far end transmitter matches the frequency of the local receiver.

2) The TX output power is not set above the level of the license.

3) ATPC is turned OFF on the far end.

4) Alignment mode is ON for SP ODUs – Display on ODU and IDU will update at 5 times per second.

FINE ALIGNMENT PROCEDURE

1) Adjust the azimuth over a 30 degree sweep by turning the adjustment bolt in increments of 1/10th turn to avoid missing the main lobe. When the highest signal has been found for azimuth, repeat for the elevation adjustment.

2) Turn the local transmitter on to allow alignment at the far end.

3) Move to the far end of the link and repeat step 1.

4) Lock down the antenna so no further movement can occur.

5) Install the antenna side struts supplied with the antenna.

6) Verify the RSSI remains the same and is within 2-4 dB of the expected levels.

7) Check the ODU connector seals.

8) Turn alignment mode OFF

9) The alignment is complete.

LO 3.3 – Lock the microwave link installation.

- Content/Topic 1 : Fastening antenna supports

❖ Fasten brackets lock nuts

❖ Fasten paning arm lock nuts(left-right and up-down)

❖ 8Labelling of IF cable

Refer to YouTube videos for more information (https://www.youtube.com/watch?v=NMw_qEbdPPM).

- Content/Topic 2 : Labelling of microwave ODU

✓ Near end dish antenna ID

✓ Far end dish antenna ID

Reference(s):

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