MICROWAVE LINK
INSTALLATION and ALIGNMENT

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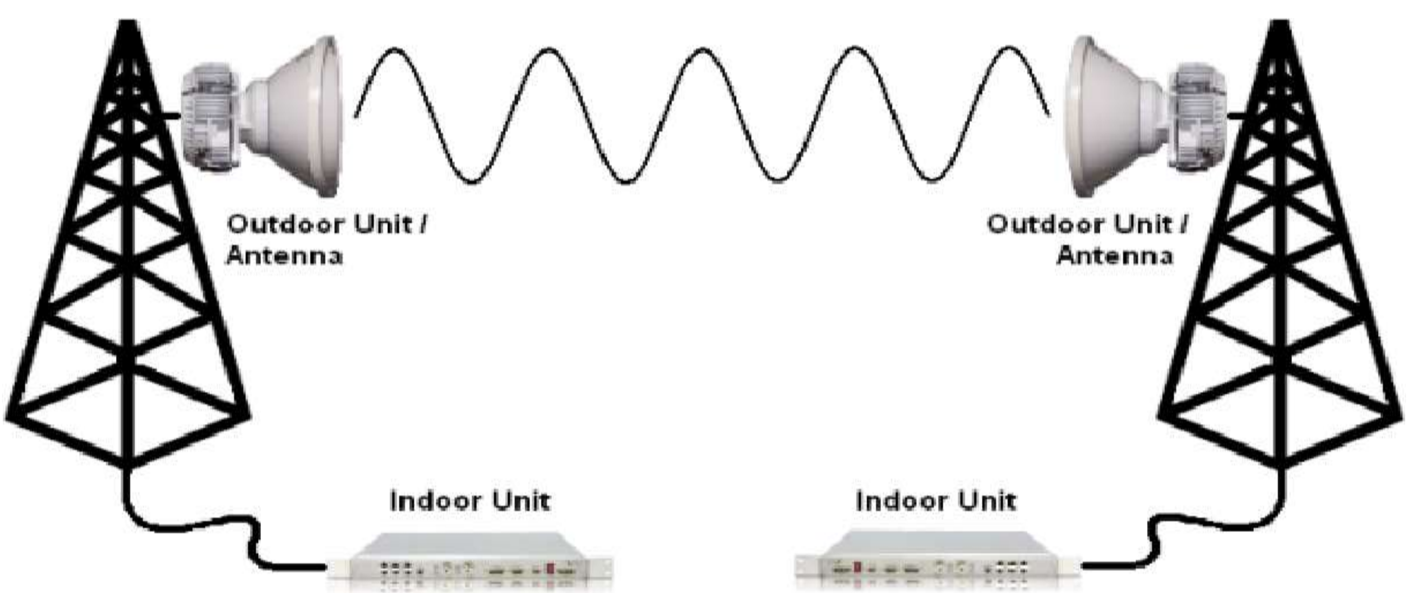
MW antenna: A microwave antenna is a physical transmission device used to broadcast microwave transmissions between two or more locations. In addition to broadcasting, antennas are also used in radar, radio astronomy and electronic warfare.

Uses as shown below:

a. One-way (e.g. television broadcasting) and two-way telecommunication using communications satellites.
b. Terrestrial microwave relay links in telecommunications networks including backbone or backhaul carriers in cellular networks linking BTS-BSC and BSC-MSC.
c. Radar.
d. Radio astronomy.
e. Communications intelligence.
f. Electronic warfare.

MW link: A microwave link is a communications system that uses a beam of radio waves in the microwave frequency range to transmit information between two fixed locations on the earth. They are crucial to many forms of communication and impact a broad range of industries.

Microwave transmission is the method of transmitting information using microwaves, a type of electromagnetic radiation. This method is commonly used in wireless communication systems such as cell phones, television and radio broadcasting, and satellite communication.



The followings are the advantages and disadvantages of Microwave Transmission:

Advantages	Disadvantages
Speed	Weather interference
Distance	Line-of-sight requirement
Reliability	Limited bandwidth

Advantages of Microwave Transmission:

1. Speed – Microwave transmission allows for very fast data transfer, making it useful for things like live television broadcasts and internet connections.
2. Distance – Microwave transmission can cover long distances, making it useful for connecting remote areas to the rest of the world.
3. Reliability – microwave transmission is often more reliable than other forms of wireless communication, such as satellite or cellular connections.
4. Cost-effectiveness – Setting up a microwave transmission system can be less expensive than laying cables or building towers for other types of transmission.
5. Security – Microwave transmissions can be encrypted, making them more secure than some other forms of wireless communication.

Disadvantages of Microwave Transmission:

1. Weather interference – Heavy rain, snow, or fog can interfere with microwave transmission and cause disruptions in service.
2. Line-of-sight requirement – Microwave transmission requires a clear line of sight between the transmitter and receiver, which can be affected by buildings or natural obstacles.
3. Limited bandwidth – The amount of information that can be sent through a microwave transmission is limited by the available bandwidth.
4. Health concerns – Some studies have suggested that prolonged exposure to microwaves from transmission towers could be harmful to human health.
5. Vulnerability to interference – Microwave transmissions can be disrupted by other electronic devices, such as radar systems or cell phones, that operate on the same frequency.

Microwave link installation includes:

- Rooftop, tower or monopole locations through use of riggers (crane, bucket extra)
- Installation of dish antenna on existing antenna mast
- Installation of ODUs and IDUs as per link design
- Running, labeling and securing of required cables (Cat5e, IF, fiber, power)
- Termination of connectors at ODU and IDU ends, with assurance of connectivity, strain relief, taped/waterproofed/tie wrapped.
- Installation of grounding cable
- Installation of DC power cable from customer provided power source and breakers
- Validation of correct power and grounding of system
- Validation all of cables through cable testers
- Confirmation of installation quality through established punch-list
- Detailed photographs of installation
- Comprehensive MOP – outlining installation procedures and configuration details

Assumptions:

- Line of Sight, Site, construction and link configuration documentation provided
- Construction is complete prior to crew arrival, site ready for microwave installation
- Cable conduit (run) is open and easily accessible (closed conduits are not included)
- Site access is granted, available, provided by customer or their representative

PROCEDURE IN MICROWAVE INSTALLATION:

1- Confirm AMB allocation, spacing & azimuth.
2- Prepare the Antenna Assembly.
3- Check the polarity and change one guide pin to horizontal.
4- Verify which site is designated for low or high band frequency.
5- XPIC (Horizontal XIN to Vertical XOUT, Horizontal XOUT to Vertical XIN).
6- Install grounding cable and power cable connection.

Link Alignment and Testing:

After microwave link installation, Dragon Wave-X certified resources perform microwave link alignment and testing.

The link alignment and testing service includes:

- Precise alignment of antennae at both ends of the link
- Any final radio configurations as required
- Validation of traffic continuity of the link at the link designed throughput speeds
- Measurement of latency and throughput values using standard RFC tests
- 1 (one) hour Bit Error Rate test to confirm error-free traffic for the link between link demark endpoints (RJ45 connector terminating at local switch or BTS)
- Completion of Acceptance Test Plan

Assumptions:

- Site access is granted and available
- Connectivity of microwave link demarcation end points into, or configuration/management of customer owned site switch or BTS beyond scope of service.

Close Out Package

With the completion of each microwave link installation, Dragon Wave-X provides a complete Closeout Package (COP) which includes as a minimum:

- Marked up (customer supplied) construction documentation showing "as-built" for each site
- Microwave test results as output from link testing (RFC, BER)
- Radio configuration and diagnostic files, including RF actuals vs. RF design parameters
- Photos of complete installation – cabinet, lines, tower etc.
- Site coordinate information
- Serial numbers of each product deployed

Microwave Link Decommissioning

Microwave link decommissioning is performed by Dragon Wave-X qualified and certified crews. Crews with remove existing legacy equipment and dispose in accordance by customer or in an environmentally conscience manner.

Configuration for Microwave Links:

Microwave links are generally used for telecom carrier backhaul and government applications. Microwave link plays a crucial role in the communication system, which is used to transmit and receive the data. The classification of the antenna is based on the specifications like frequency, polarization, radiation, etc.,

The design goal is to maintain the link uptime to be as near to 100% as high as possible. In order to achieve such reliability, there are various redundancy method that have been implemented over the years.

Particular attention has been paid to protect against problems with radio chain. Much of the radio equipment is located outdoors, often mounted directly to the back of the antenna. Oudoor Unit (ODU) failures could take a long time, even days to repair/replace, as time climbs are needed to access the gear. To prevent this situation, one needs to implement a back-up scheme to keep the link up and running during the time of repair.

Microwave_ODUs can be deployed in various configurations.

1.Microwave ODU in 1+0 Configuration with Antenna.

The most common is 1+0 which has a single ODU, generally connected directly to the microwave antenna.

1+0 means “unprotected” in that there is no resilience or backup equipment or path.

2. Two Microwave ODUs in 1+1 HSB or 2+0 configuration with Coupler and Antenna.

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.

Other resilient configurations are 1+1 SD (Space Diversity, using separate antennas, one ODU on each) and 1+1 FD (Frequency Diversity)

3.The other non-resilient configuration is 2+0 which has two ODUs connected to a single antenna via a coupler.

The hardware configuration is identical to 1+1 FD, but the ODUs carry separate signals to increase the overall capacity.

1+1 Configuration:

One common way is to build the redundancy in the radio chain, namely 1+1 configuration. This configuration often involves two separate modems housed in a single IDU with each modem connected to an ODU of its own.

The ODUs are mounted on a “coupler” device which is directly mounted on the antenna much like the case of a 1+0 configuration. This way, there is no need to mount the coupler-ODU fixture separately. The figure below shows two ODUs mounted on the back of a 2FT antenna (left). The ODU coupler without the ODU mounted.

The ODU coupler, while providing a convenient way to implement a 1+1 configuration, does introduce coupling losses. Depending on the preference regarding the losses, the user can choose between two different types of couplers: symmetric and asymmetric. The symmetric version introduces equal losses in primary and redundant paths, about 3.5 dB. The asymmetric version favors the primary path (about 1 to 1.5 dB loss) over the redundancy path (about 6.5 to 7 dB loss). Some users prefer to lose as little as possible in the primary link and set up the redundant path at a lower modulation (lower speed) so as to compensate for 7dB loss. In that manner, the redundant link is just as robust as (if not more so) the primary link, albeit at a lower performance level. The user can at least maintain the link while working on the repair on the primary link.

The 1+1 configuration described above is often referred to as HSB (hot standby). In recent times, the concept is taken to the next level by monitoring the Tx power of the redundant ODU periodically. This is referred to as MHSB (Monitored Hot standby). This way, the user can make sure that the ODU transmitter is working properly while remaining not used for data transmission. The redundant ODU power is kept at a low level in order not to interfere with the primary transmitter.

In a typical 1+1 configuration, there is only one active transmitter (primary Tx) at a given time, as mentioned above but both receivers are active. The receiver chain in the Indoor Unit (IDU) then picks out the better of the two received signals, i.e. establish Receive diversity.

1+1 Space Diversity:

In some cases, the RF links conditions are very challenging due to link distances and/or presence of a body of water in the link path. Long link distances reduce available link budget. Water surface often can be a strong source of reflection which could introduce a multipath interference at the receiver. In the case of a large body of water, the water surface condition can be choppy at times and the RF conditions at the receiver accordingly can vary, which could lead to inconsistent performance.

In order to provide better link performance, a “space diversity (SD)” configuration can be used. In this case, a separate antenna is deployed for each ODU. The receiver can then pick out the better of the two received signals at two antennas, which could significantly improve link condition against multipath problems as well as in links with weak RF receive signals. The SD configuration also eliminates the coupler and the associated coupling losses. The drawbacks are the extra costs with the second sets of antennas and additional tower rental expenses due to more antenna space requirement.

1+1 configuration vs. 2+0 configuration:

Instead of using the 1+1 configuration, some users opt to implement a 2+0 implementation. 2+0 means there are 2 primary links simultaneously running from A to B without any redundancy. The main advantage is that the link capacity is now doubled from the 1+0 or 1+1 case. In a 2+0 configuration, either of the path will be functioning in the event that the other link malfunctions, which gives an inherent capability to protect against any one path failure. There are a few drawbacks with 2+0. The simplest way to achieve 2+0 is to attain spectrum licenses for two separate RF channels from the governing authorities in your country. In some cases, this may not be practical due to the dearth of RF channels or very high costs of spectrum licenses. In addition, antennas must support dual polarization with good cross polarization rejection (HP series from most manufacturers). These antennas come at significantly higher costs than single-polarization antennas and do not have provisions for direct mounts. Lack of slip-fit mount options forces the user to mount ODUs separately and run a short wave guide – cumbersome and costly. Compare the diagram below where the direct mount, shown in the left, makes the deployment very simple and introduces very little loss. The remote mount, needed for dual pol antennas, needs separate mounting of ODUs as well as running a short waveguide. Note that remote mounting needs to be done for both ODUs in the case of dual pol antennas.

<u>2+0 "Co-Channel" Deployment:</u>

In order to avoid additional spectrum licensing expenses, the user can deploy these two RF channels in a "co-channel" arrangement, e.g. one RF path into the vertical polarization and the other RF path into the horizontal polarization of a dual pol antenna. In this case, two additional steps are necessary.

• Ultra high performance antenna – operating two RF paths in the same channel leads to greater chances of cross-talk between them, even if they are launched in orthogonal dimensions. Typical cross pol rejection value is~ 30dB for HP antennas. With UHP antennas, these values can run up to 50 dB, significantly cutting down on cross-talk. However, UHP antennas add to the hard ware costs.

• Use XPIC in the IDU – this can be beneficial in all 2+0 situations, but is particularly useful in cochannel or adjacent-channel deployments. XPIC (cross polarization interference canceller). XPIC is a technology implemented at the modem level where interference between two data paths is mostly cancelled via use of signal processing. The cost is relatively minor in comparison to the cost increase with UHP antennas.

<u>Radio Mobile functions:</u>

For Microwave Link Planning, the software package can be configured with the characteristics of your required radio links.

- Transmit Power
- Frequency
- Antenna Gain
- Receiver Sensitivity
- Antenna heights
- System losses

Microwave ODU (Outdoor Unit):

The term ODU is used in Split-Mount Microwave systems where an Indoor Unit (IDU) is typically mounted in an indoor location (or weatherproof shelter) connected via a coaxial cable to the ODU which is mounted on a rooftop or tower top location.

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.

ODU functions:

The ODU converts data from the IDU into an RF signal for transmission. It also converts the RF signal from the far end to suitable data to transmit to the IDU. ODUs are weatherproofed units that are mounted on top of a tower either directly connected to a microwave antenna or connected to it through a wave guide.

Generally, Microwave ODUs designed for full duplex operation, with separate signals for transmit and receive. On the airside interface this corresponds to a "pair" of frequencies, one for transmit, the other for receive. This is known as "FDD" (Frequency Division Duplexing)

ODU Power and data signals:

The ODU receives its power and the data signals from the IDU through a single coaxial cable. ODU parameters are configured and monitored through the IDU. The DC power, transmit signal, receive signal and some command/control telemetry signals are all combined onto the single coaxial cable. This use of a single cable is designed to reduce cost and time of installation.

ODU 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.

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Grounding & Surge Protection:

Suitable ground wire should be connected to the ODU ground lug to an appropriate ground point on the antenna mounting or tower for lightning protection. This grounding is essential to avoid damage due to electrical storms.
In-line Surge Suppressors are used to protect the ODU and IDU from surges that could travel down the cable in the case of extreme surges caused by lightning.

Typical ODU Features and Specifications:

- 4-42GHz frequency bands available
- Fully synthesized design
- 3.5-56MHz RF channel bandwidths
- Supports QPSK and 16 to 1024 QAM. Some ODUs may support 2048QAM
- Standard and high power options
- High MTBF, greater than 92.000 hours
- Software controlled ODU functions
- Designed to meet FCC, ETSI and CE safety and emission standards
- Supports popular ITU-R standards and frequency recommendations
- Software configurable microcontroller for ODU monitor and control settings
- Low noise figure, low phase noise and high linearity
- Compact and lightweight design
- Very high frequency stability +/-2.5 ppm
- Wide operating temperature range: -40°C to +65°C