RIZAL TECHNOLOGICAL UNIVERSITY
COLLEGE OF ENGINEERING AND ARCHITECTURAL TECHNOLOGY
DEPARTMENT OF ELECTRONICS ENGINEERING

Microwave Communication Systems Design Linking from Jasmin, Paranaque to Manuyo Dos, Las Pinas

In Partial Fulfillment of the Requirements for the Subject
Technical Electives 2: Telecommunications

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I. Company Profile

Kaizen Optilink Inc.

Kaizen Optilink Inc. is a distinguished organization, steadfastly dedicated to innovation and excellence. Concentrating on providing reliable connections and seamless communication experiences, the company is firmly grounded in the principles of continuous improvement and the optimization of network infrastructure to ensure peak performance, reliability, and security**.**

Mission

To consistently provide reliable, and secure telecommunication network services, while continuously improving and optimizing our network architecture to meet the evolving needs of our clients.

Vision

As we journey into the future, our vision is clear: “to be the driving force behind a connected world, where communication knows no bounds and our company stands as a symbol of reliability, innovation, and transformative impact.".

II. Objective

Main Objective:

To create a system and design that connects two locations, specifically Jasmin, Paranaque to Manuyo Dos, Las Pinas, using a microwave communication system. This system will offer a streaming video service with a frequency band of 13GHz, and a capacity of 34Mbit/s or higher capacity up to 140 Mbit/s. The configuration will utilize a non-protected configuration (1+0).

Specific Objectives:

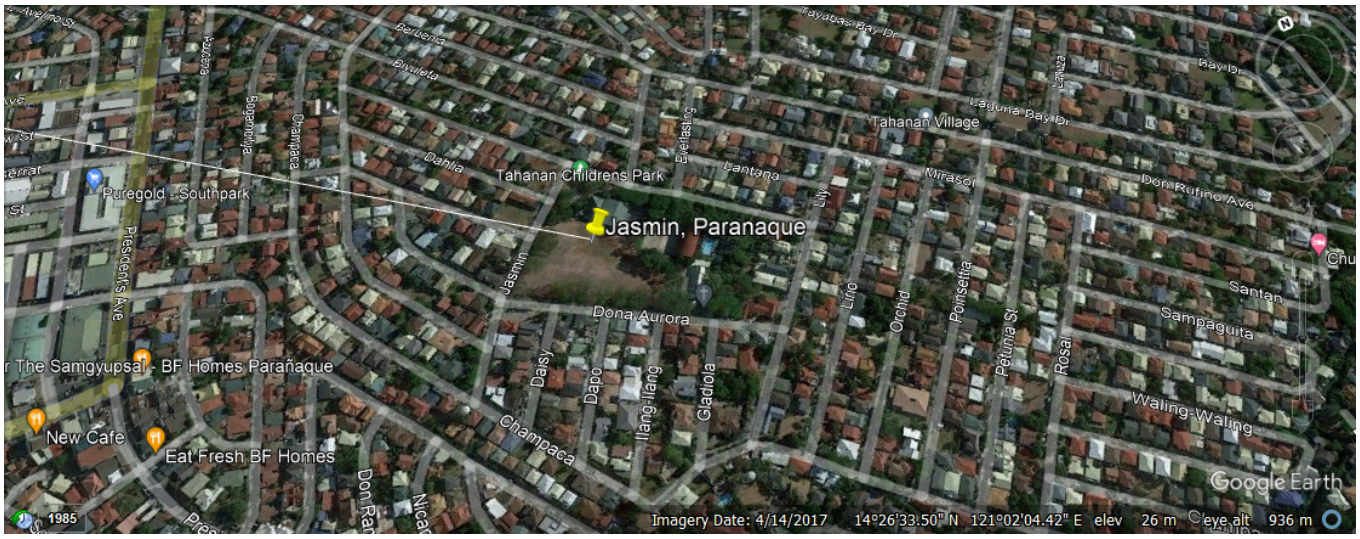
- To determine the geographic region and weather conditions of the site where the microwave system and tower will be constructed.
- To develop a microwave communication system design that ensures an exceptional level of reliability (99.99%) and optimal system performance.
- To identify key parameters that will optimize the performance of the streaming service using microwave communication links.
- To determine the specifications of communication system equipment that will successfully meet the project's objectives and other desired outcomes.
- To address the current limitations by utilizing cutting-edge technology for microwave communication networks, ensuring significant improvements in the near future.
- To determine the cost of achieving a transmission reliability rate of 99.99% and assess its effectiveness.

III. Site Overview

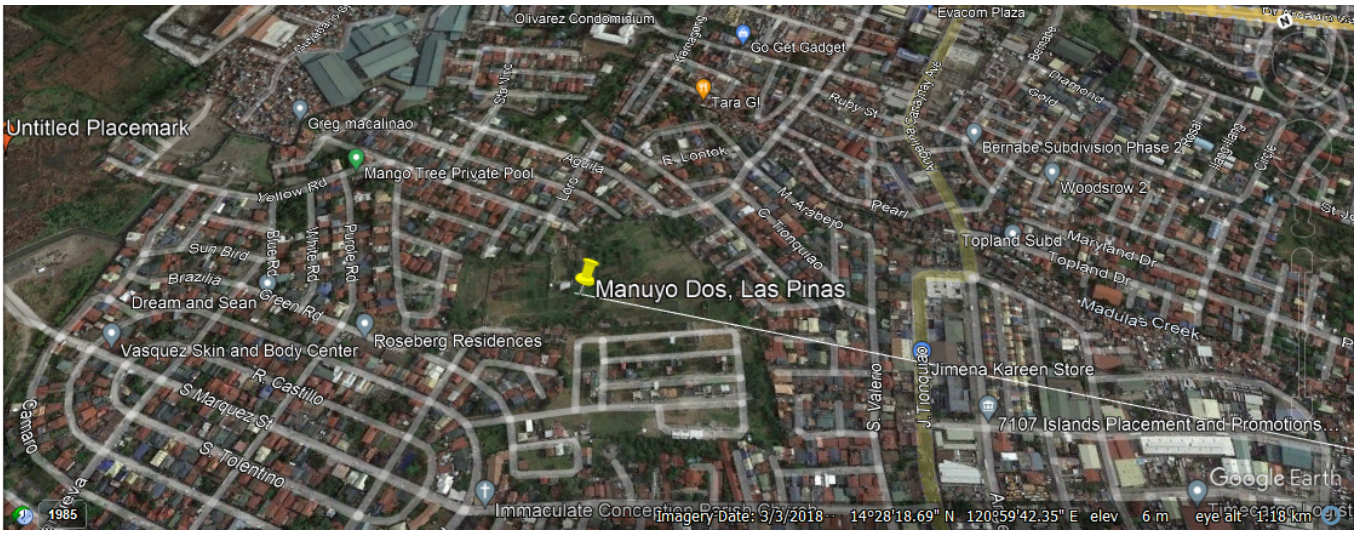
Location and Path Length

Path Length: 5.17 km

Site A: 14.444779, 121.032799

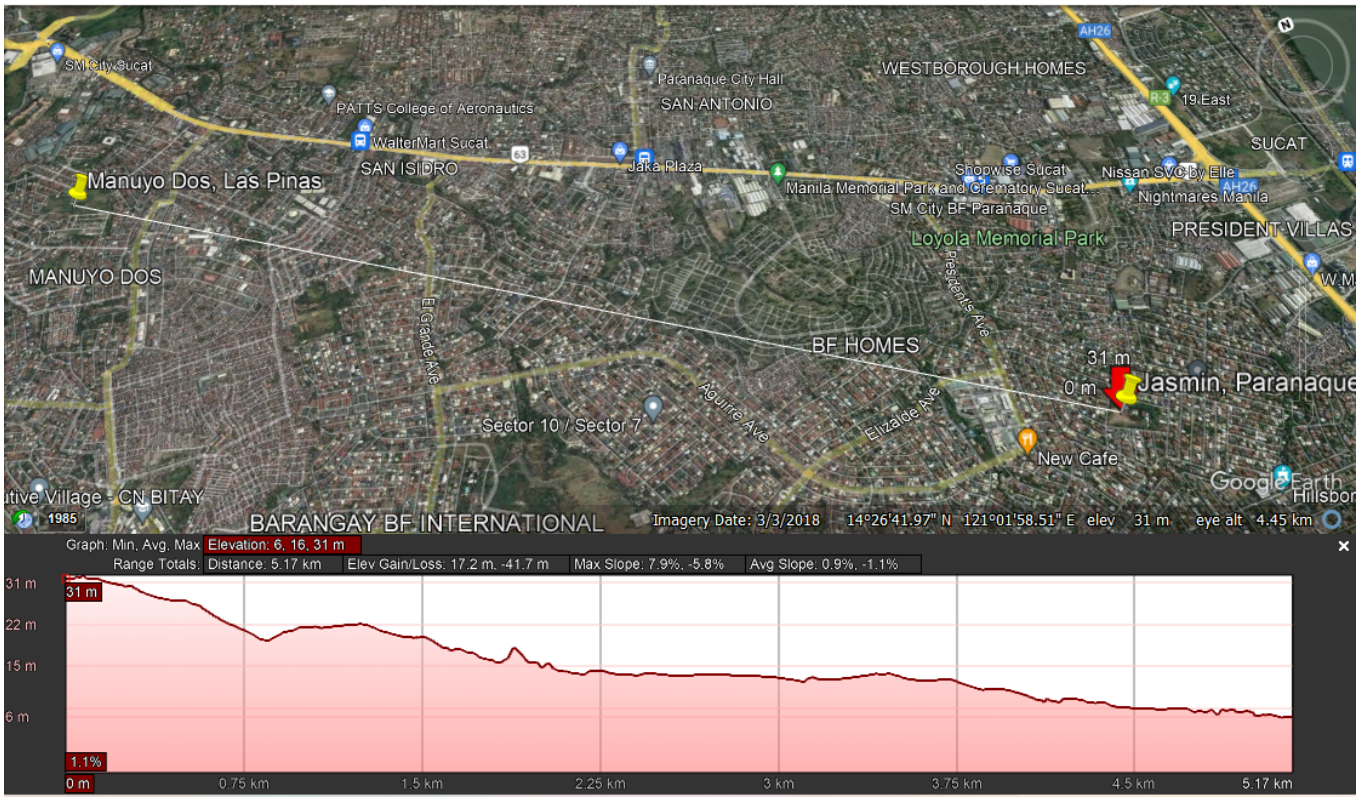


Site B: 14.472122, 120.994685



Site A: Jasmin, Paranaque

Elevation: 31m. (101.71 ft)



Province: National Capital Region

Area: 46 sq. km.

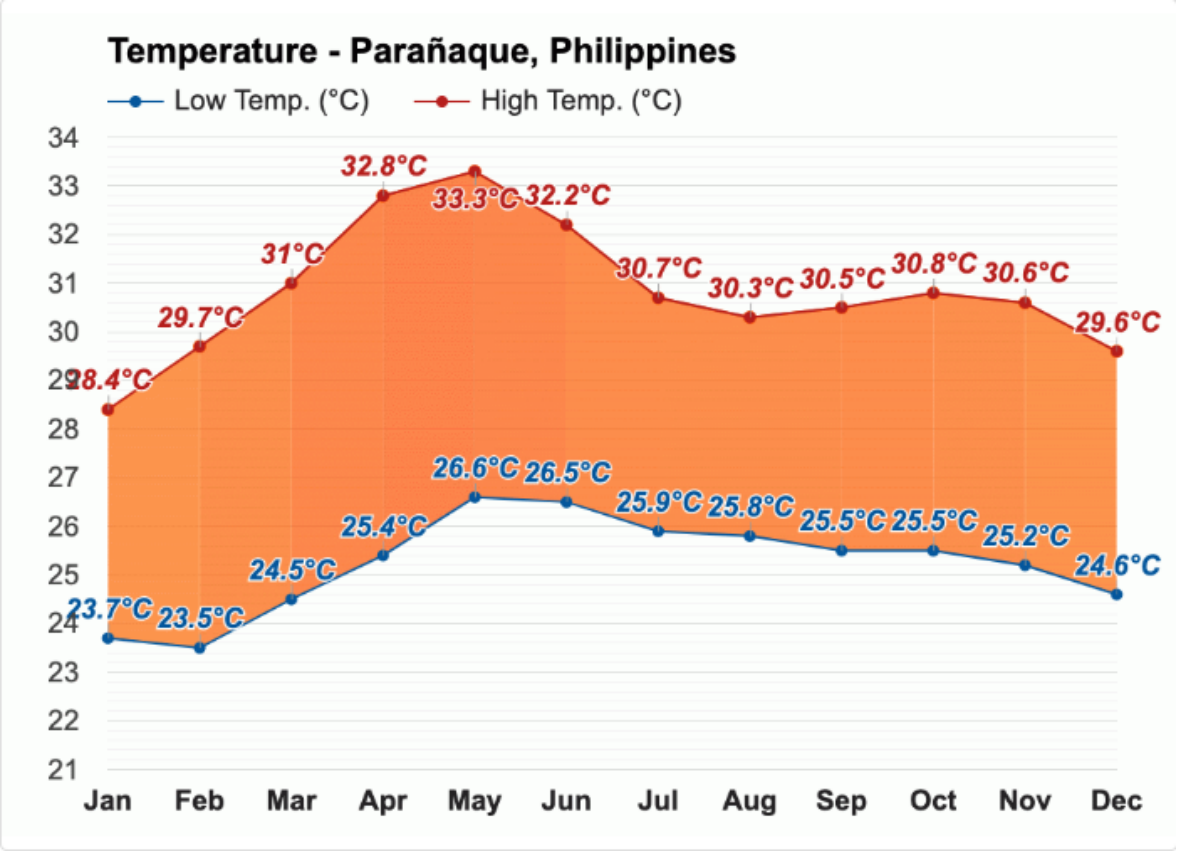
Population: 689, 992

Population Density: 14,816 per sq. km

Climate:

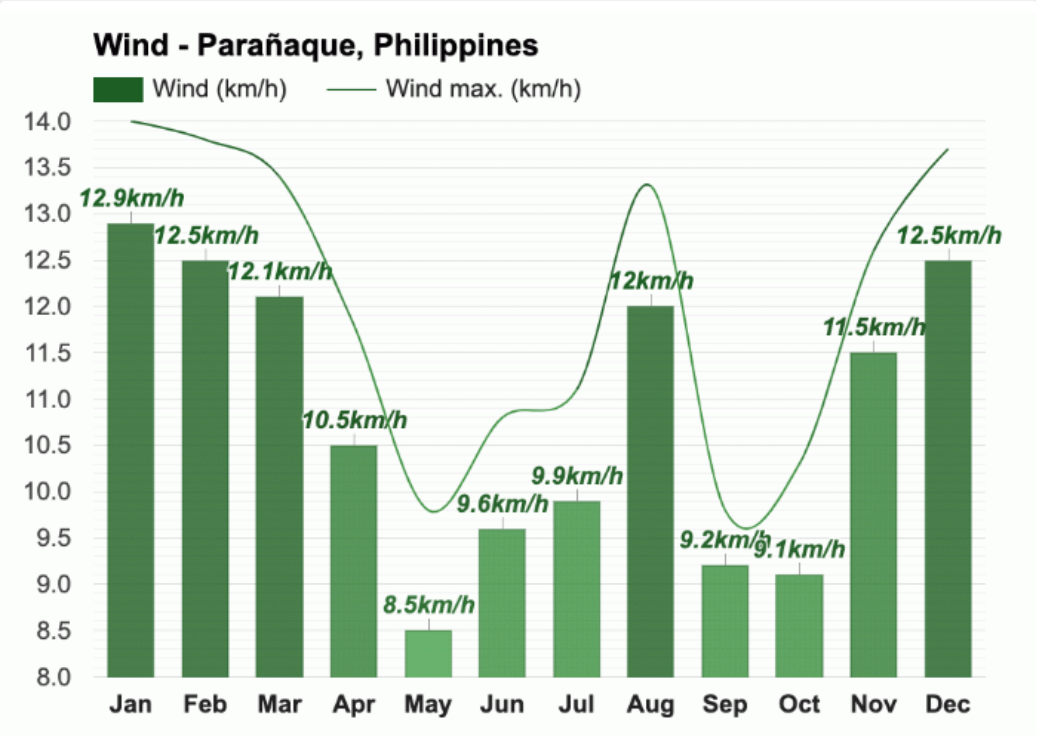
A typical year in Parañaque observes temperatures fluctuating between the minimum values of 23.5°C to a maximum reach of 33.3°C based on weather atlas. Contrastingly, relative humidity remains comparatively consistent, generally ranging between 70% and 79%. One might recognize rainfall in the city as a frequent occurrence, bearing an average of 2.3 days dry spell compared to wet days every month. The peak rainfall can be noted from 131mm to 191mm per month, predominantly occurring between the months of May and August.

Average Temperature:



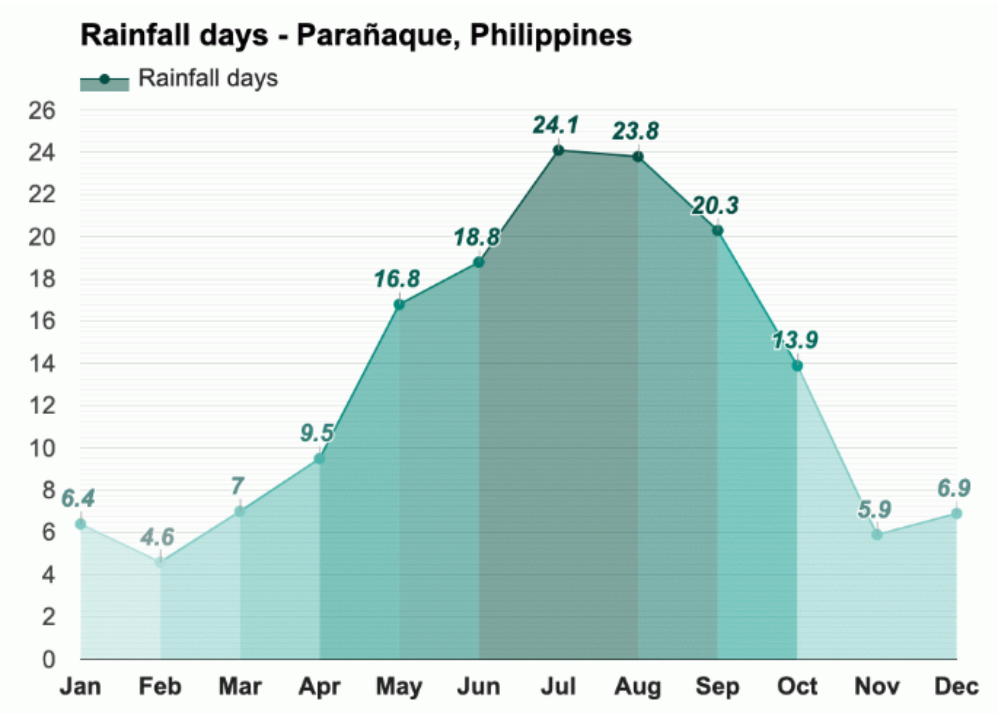
The warmest month (with the highest average high temperature) is **May** (33.3°C). The month with the lowest average high temperature is **January** (28.4°C). The month with the highest average low temperature is **May** (26.6°C). The coldest month (with the lowest average low temperature) is **February** (23.5°C).

Average wind speed:



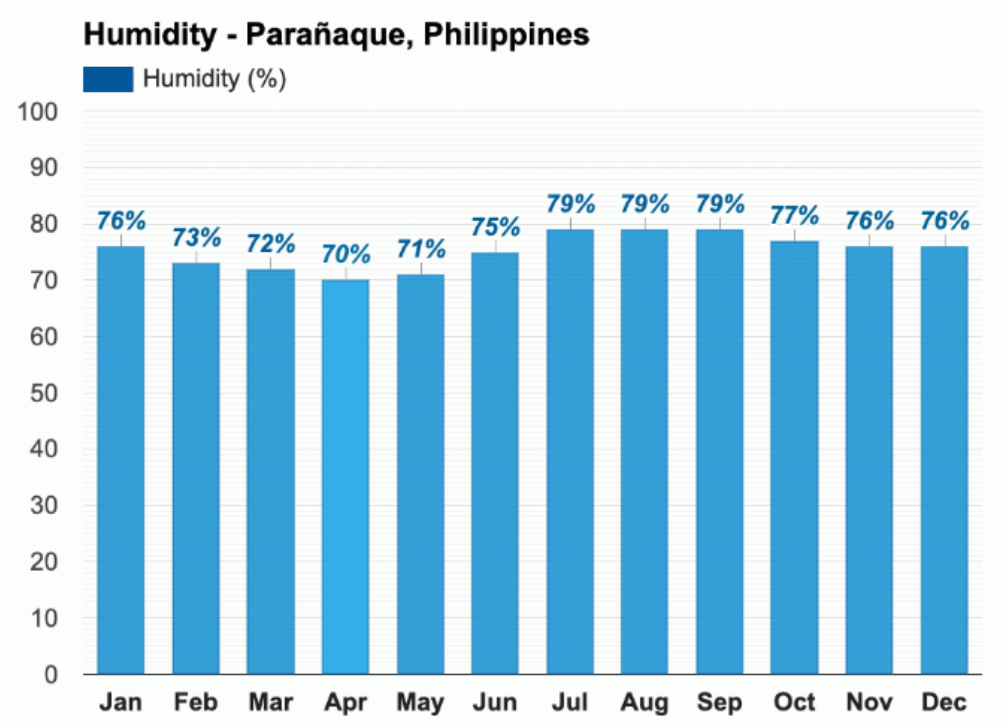
The windiest month (with the highest average wind speed) is **January** (12.9km/h). The calmest month (with the lowest average wind speed) is **May** (8.5km/h).

Average Rainfall:



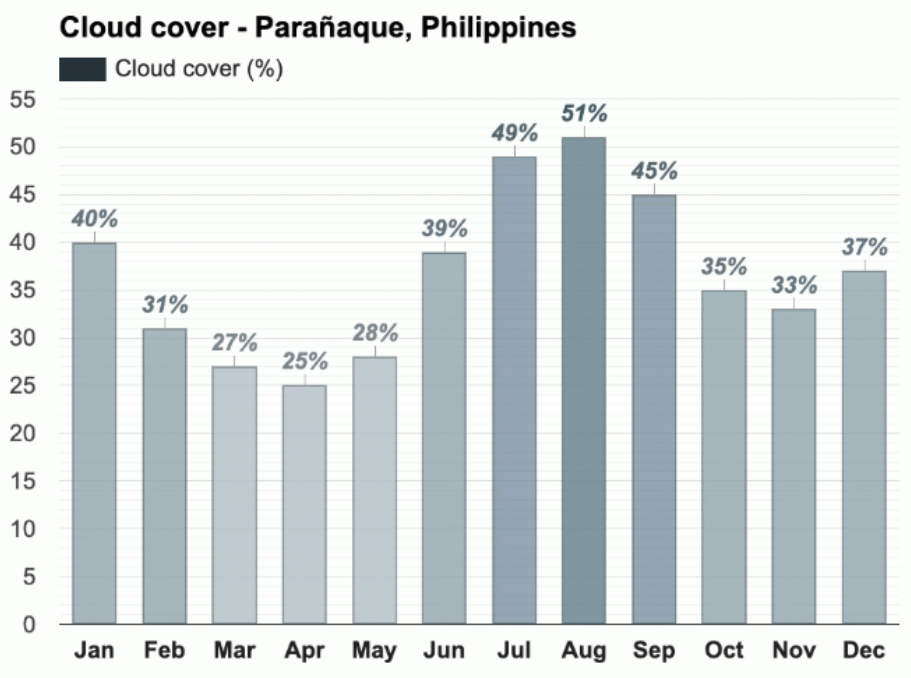
The month with the highest number of rainy days is July (24.1 days). The month with the least rainy days is February (4.6 days).

Average Humidity:



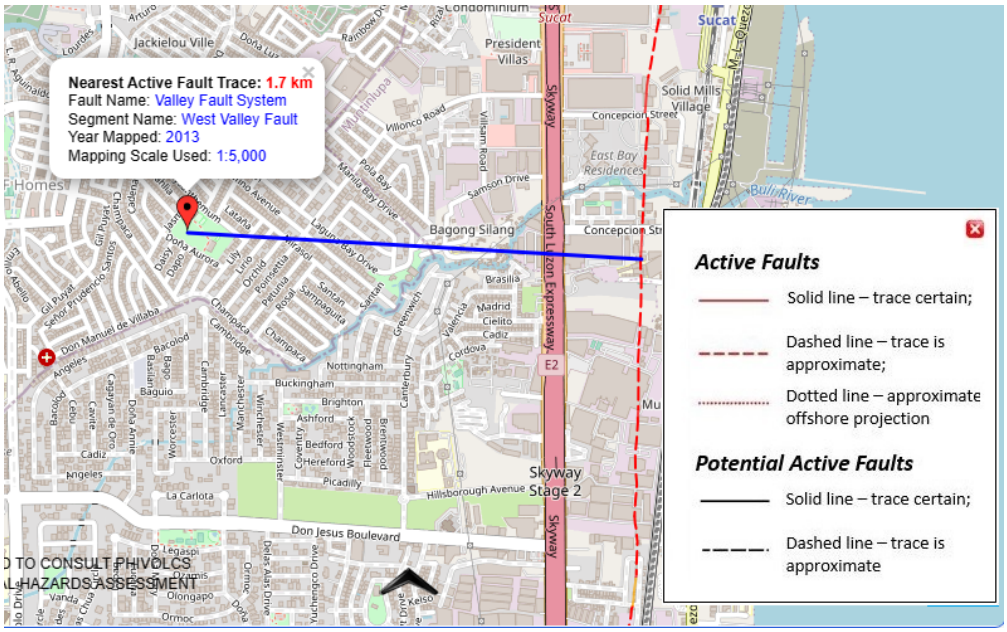
The months with the highest relative humidity are **July**, **August** and **September** (79%). The 1month with the lowest relative humidity is **April** (70%).

Average Cloud cover:



The month with the most cloud cover is **August** (Cloud cover 51). The month with the least cloud cover is **April** (Cloud cover 25).

Distance from near fault line: 1.7 km away from the near fault line (Marikina Fault Line).



Site B: Manuyo Dos, Las Pinas

Elevation: 6 m (19.69 ft)

Province: National Capital Region

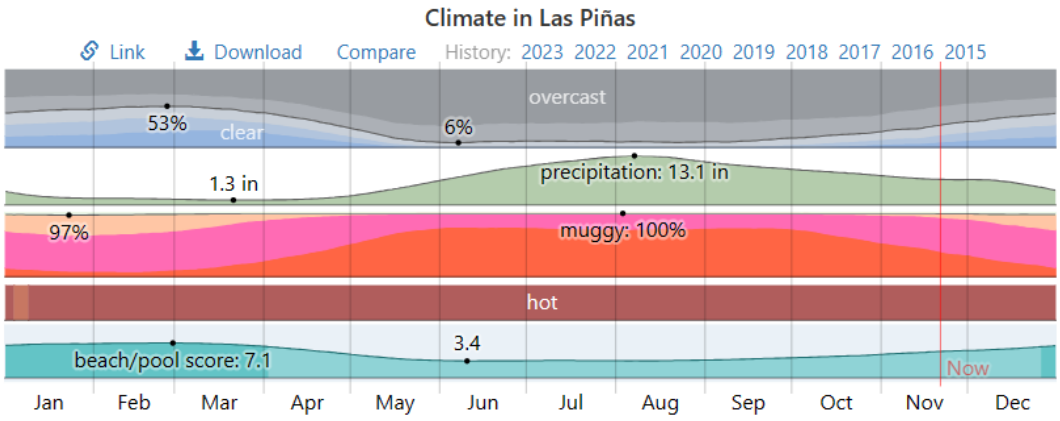
Area: 41.54 sq. km.

Population: 606, 293

Population Density: 14, 435 per sq. km.

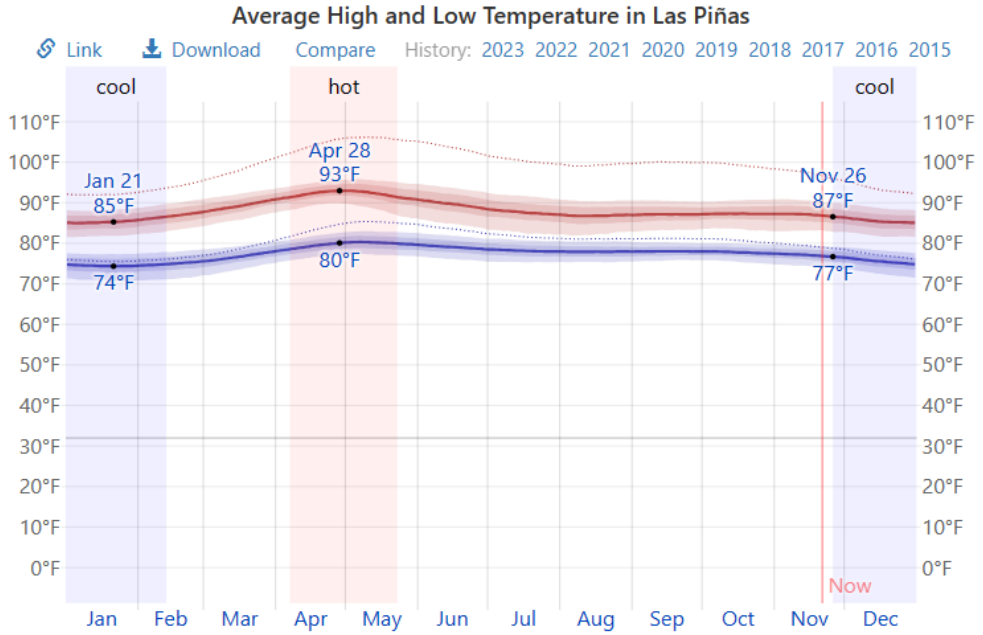
Climate:

In Las Piñas, the wet season is overcast, the dry season is partly cloudy, and it is hot and oppressive year round. Over the course of the year, the temperature typically varies from 74°F to 93°F and is rarely below 71°F or above 96°F. Based on the beach/pool score, the best time of year to visit Las Piñas for hot-weather activities is from late December to early April.



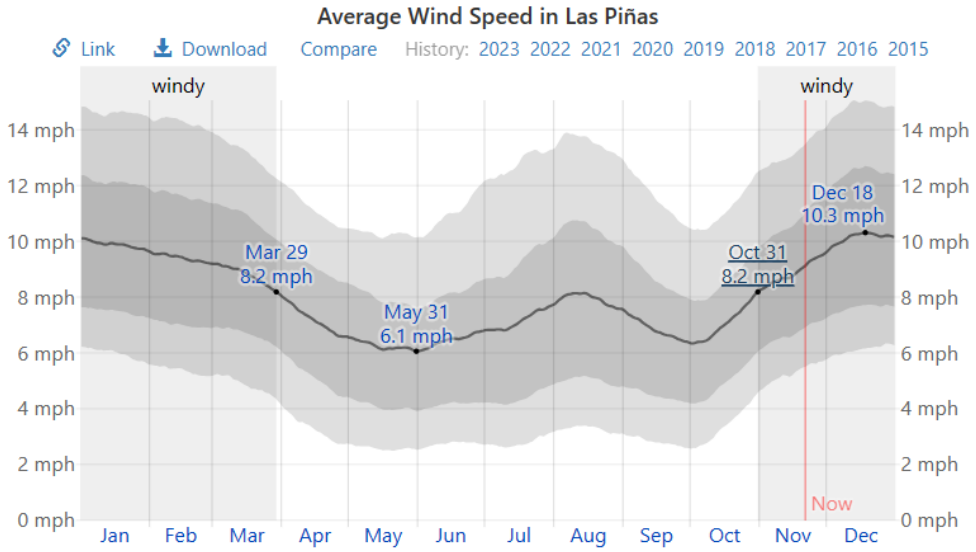
Average Min/Max Temperature:

The hot season lasts for 1.5 months, from April 7 to May 23, with an average daily high temperature above 91°F. The hottest month of the year in Las Piñas is May, with an average high of 92°F and low of 80°F. The cool season lasts for 2.6 months, from November 26 to February 13, with an average daily high temperature below 87°F. The coldest month of the year in Las Piñas is January, with an average low of 74°F and high of 85°F



Average Min/Max Wind Speed and Gust:

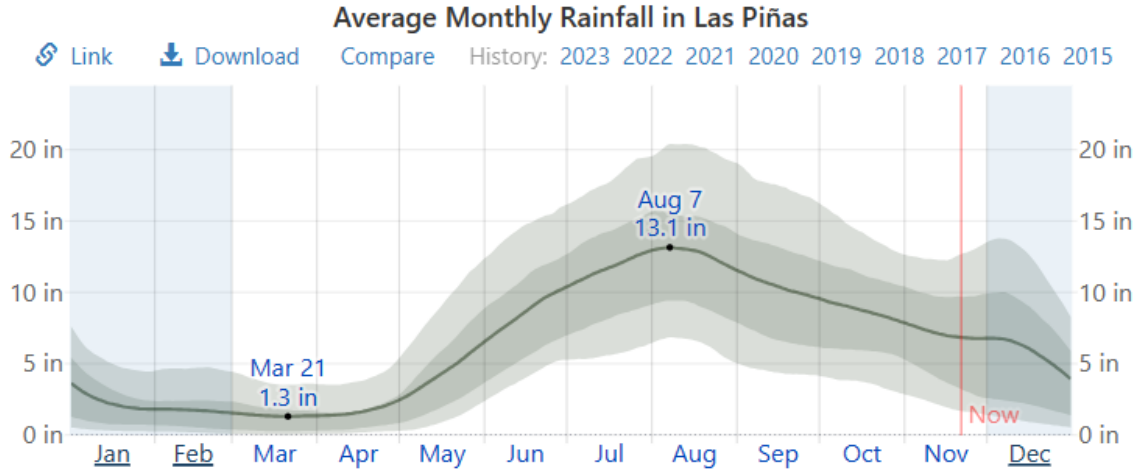
The average hourly wind speed in Las Piñas experiences significant seasonal variation over the course of the year. The windier part of the year lasts for 5.0 months, from October 31 to March 29, with average wind speeds of more than 8.2 miles per hour. The windiest month of the year in Las Piñas is December, with an average hourly wind speed of 10.1 miles per hour. The calmer time of year lasts for 7.0 months, from March 29 to October 31. The calmest month of the year in Las Piñas is May, with an average hourly wind speed of 6.2 miles per hour.



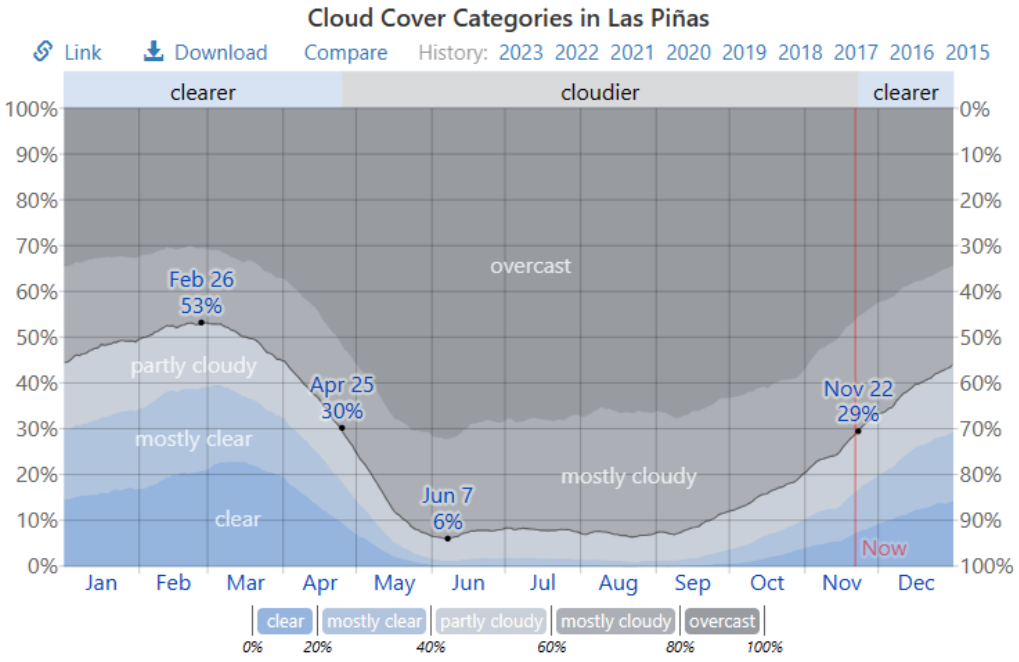
The average of mean hourly wind speeds (dark gray line), with 25th to 75th and 10th to 90th percentile bands.

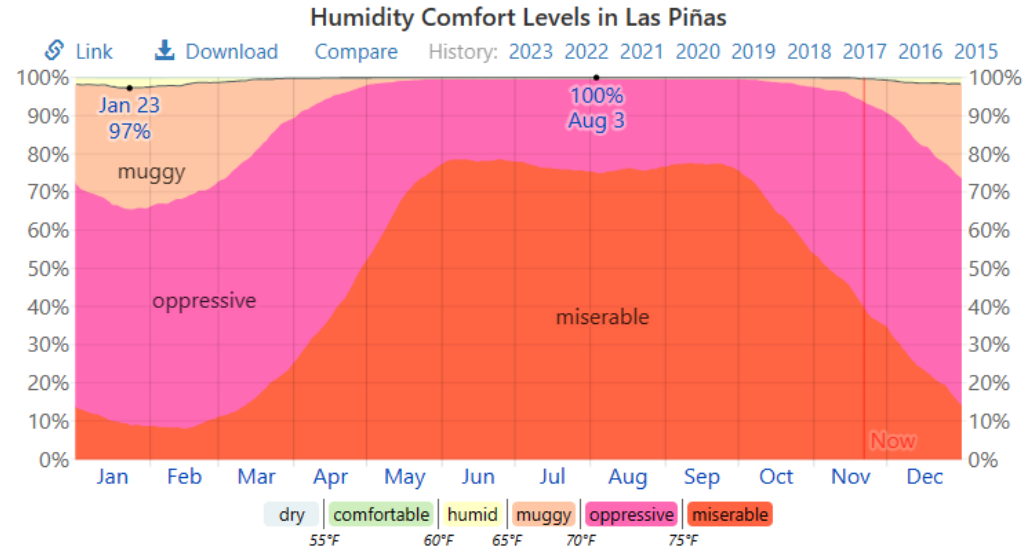
Average Rainfall Amount:

Rain falls throughout the year in Las Piñas. The month with the most rain in Las Piñas is August, with an average rainfall of 12.9 inches. The month with the least rain in Las Piñas is March, with an average rainfall of 1.3 inches.



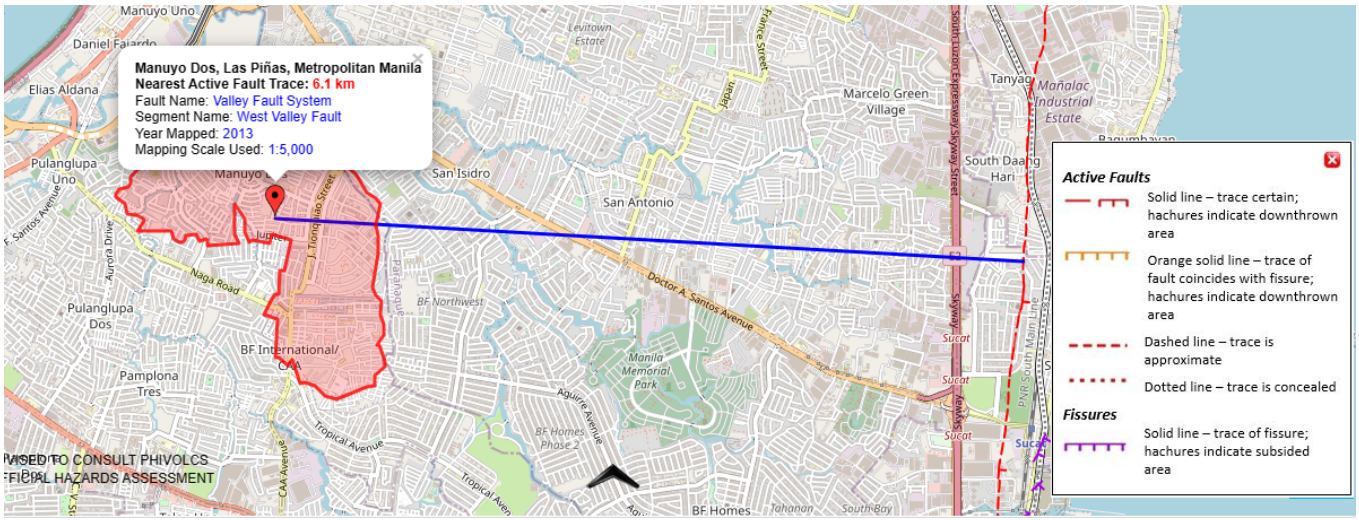
Average Cloudy and Humidity:





The clearer part of the year in Las Piñas begins around November 22 and lasts for 5.1 months, ending around April 25. The clearest month of the year in Las Piñas is February, during which on average the sky is clear, mostly clear, or partly cloudy 52% of the time. The cloudier part of the year begins around April 25 and lasts for 6.9 months, ending around November 22. The cloudiest month of the year in Las Piñas is August, during which on average the sky is overcast or mostly cloudy 93% of the time. The perceived humidity level in Las Piñas, as measured by the percentage of time in which the humidity comfort level is muggy, oppressive, or miserable, does not vary significantly over the course of the year, staying within 1% of 99% throughout.

Distance from Near Fault Line: 6.1 km away from the near fault line (Marikina Fault Line)



IV. Design Considerations

Basis of the Designs

Several aspects must be considered in order to attain the given aims and solve the challenges using technical methods. Several microwave communication projects have used these considerations. Path profile, site selection, lightning protection system, radio equipment used, tower consideration are the most prevalent considerations. Certain standards may also support a variety of concerns.

Site Selection Consideration

- Line of sight between two antennas
- Accessible roads near the location of the sight.
- Geographical coordinates of the proposed sites.
- Site elevation and terrain type of the links.
- Existing and future obstructions between two locations.
- Power and water availability.
- Climate in the area
- Distance from Near Fault Line

Frequency Considerations

- The frequency ranges used in the microwave systems design is 12.75 GHz to 13.25GHz.
- The frequency planning is based on the microwave channel chart given by the National Telecommunications Commission.
- The standard used in frequency consideration is ITU-R F.497-7.

Radio Systems Considerations

- The radio system used is a directly mounted unit with a coupler (Optx RTN 980A), manufactured by Huawei.
- The radio system must be based on the operating frequency range of 12.75 GHz to 13.25GHz.

Antenna Considerations

- The diameter of the parabolic microwave dish antenna is one of the top considerations in the design.
- The antenna must be compatible with an operating frequency range of 12.75 GHz to 13.25 GHz.
- The horizontal and vertical panning of the antenna must also be considered.
- The antenna is manufactured by Jirous.
- The strength of the antenna at a certain wind speed that can withstand the wind is also considered.

Lighting Considerations

- Towers should be positioned at different angles to provide light sources from various directions.

- To avoid aviation accidents, high intensity flashing white obstacle lights should be lit at all times of the day and night.

Tower Considerations

- The tower should not be counted as a physical hazard and must pass the construction permit application.
- It must first obtain permission to build a tower so that it will not endanger aviation.
- The land where the tower will be built should not be suitable for the tower's weight and size.
- Tower must be painted or illuminated accordingly as it represents a danger to air navigation.

Power Considerations

- For BTS located in residential locations, a quiet generator set is required. This can be achieved by housing the generator set in a sound- attenuation enclosure. Specifying a critical mufler is not a complete solution, because there are other sources of noise besides the exhaust, e.g., the radiator fan.
- For rural and remote locations, the generator should have at least eight input/output dry contacts and relays for remote monitoring devices, as well as an oversized fuel tank and fuel pressure sensors.
- For wet and humid environments, specify aluminum enclosures and anti-condensation heaters to prevent insulation failures and short circuits between the windings in the alternator stator.

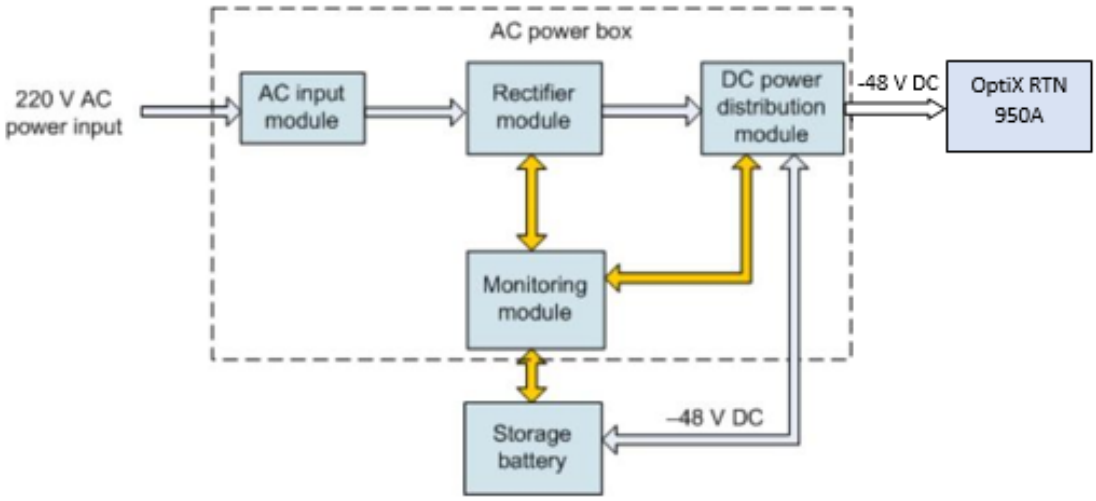
Lightning Considerations

- The lightning rod must always be located at least two meters above any other object within its protection radius and therefore must be above any antenna.
- The antenna poles must be attached to the lightning protection system, which is usually achieved via the metal structure.

Grounding Considerations

- Ground rods are also required to be buried to the depth of 30” or lower, along with the grounding wire (typically a #2 solid copper, tinned wire).
- As the Motorola R56 specification states, ground plates shall have a minimum surface area of two square feet. A 12” x 12” grounding plate has one square foot surface area on either side and meets the minimum requirement, if ground rods are prohibited.
- For poor soil conditions at telecom sites, an 18” x 18” plate is a better option as this affords 4.5 square feet, 2¼ times the surface area.

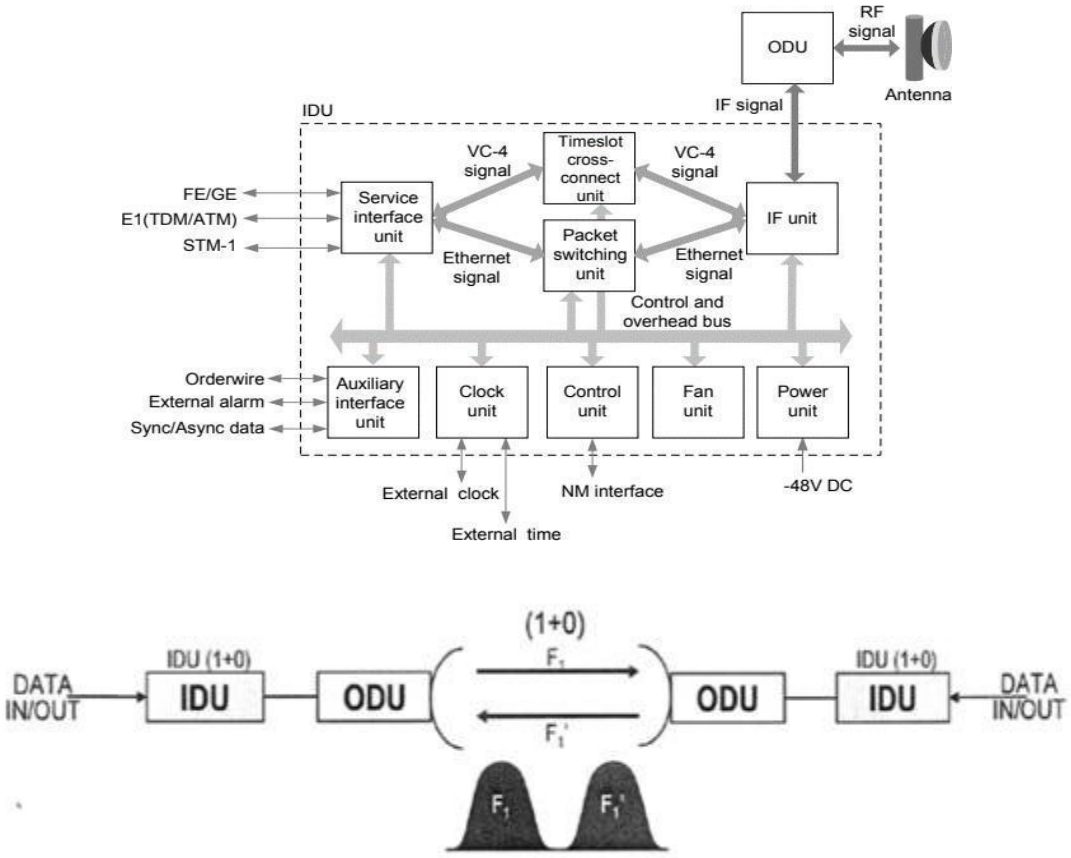
V. System Architecture



AC Power Box

Functions:

- The AC power box consists of an AC input module, a rectifier module, a DC distribution module, and a monitoring module. The storage battery provides the backup power supply.
- When receiving a 220 V AC power input, the rectifier module converts the 220 V AC power into a -48 V DC and provides two -48 V DC power outputs into the OptiX RTN 950A and one -48 V DC power output into the storage battery.
- When the 220 V AC power input is interrupted, the storage battery discharges to ensure the two -48 V DC power outputs to the OptiX RTN 950A.
- The monitoring module detects alarms about AC power input interruption.
- When the storage battery voltage decreases to 45 V, the monitoring module reports the DC under voltage alarms.
- When the storage battery voltage decreases to 43 V, the power supplied by the storage battery is cut off to protect the storage battery.
- When the 220 V AC power supply is restored, the power system resumes to normal operation.



Block Diagram of System Design

Functions:

- Service Interface Unit
  - Receives/Transmits TDM E1 signals.
  - Receives/Transmits ATM/IMA E1 signals, and demultiplexes ATM services from ATM/IMA E1 signals.
  - Receives/Transmits STM-1 signals.
  - Receives/Transmits FE/GE signals.
  - Uses the EoSDH/EoPDH function to encapsulate Ethernet services into SDH or E1 signals.
  - Performs E1/ATM/Ethernet service emulation based on PWE3.

- Timeslot Cross-Connect Unit
  - Provides the cross-connect function and grooms TDM services.

- Packet Switching Unit
    - Process Ethernet services and forward packets.
    - Processes MPLS labels and forward packets.
    - Processes PW labels and forward packets.

- IF Unit
    - Maps service signals to microwave frame signals and demaps microwave frame signals to service signals.
    - Performs conversion between microwave frame signals and IF analog signals.
    - Provides the O&M channel between the IDU and the ODU.

- Control Unit
    - Provides the system communications and control.
    - Provides the system configuration and management.
    - Collects alarms and monitors performance.
    - Processes overheads.

- Clock Unit
    - Traces the clock source signal and provides various clock signals for the system.
    - Supports input and output of external clock and external time signals.
    - Provides the time synchronization function.

- Auxiliary Interface Unit
    - Provides the orderwire interface.
    - Provides the synchronous/asynchronous data interface.
    - Provides the external alarm input/output interface.

- Power Unit
    - Accesses -48 V DC power.
    - Provides DC power for the IDU.
    - Provides -48 V DC power for the ODU.

- Fan Unit
    - Provides air cooling and flow for the IDU.

- ODU
    - Converts IF signals into RF signals.
    - Amplifies RF signals.

VI. Design Calculations

- Frequency Allocations

    FIXED – 140Mbit/s data

    Frequency Band: 13GHz

    Frequency Range: 12.75 – 13.25 GHz

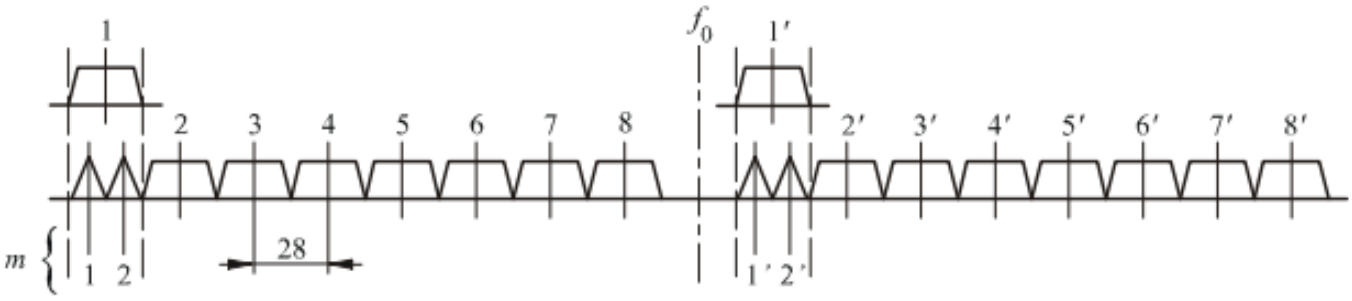
    Duplex Spacing: 266 MHz

    Channel Spacing: 28 MHz

    Channel Bandwidth: 14 MHz

    No. of Duplex Channels: 8

13GHz BAND (12.75-13.75)
RF CHANNEL ARRANGEMENTS



Low Band Range (GHz)		High Band Range (GHz)	
Ch. 1	12.775	Ch. 1'	13.041
Ch. 2	12.803	Ch. 2'	13.069
Ch. 3	12.831	Ch. 3'	13.097
Ch. 4	12.859	Ch. 4'	13.125
Ch. 5	12.887	Ch. 5'	13.153
Ch. 6	12.915	Ch. 6'	13.181
Ch. 7	12.943	Ch. 7'	13.209
Ch. 8	12.971	Ch. 8'	13.237

∴ 14 MHz option under Rec. ITU-R F.497-7

Lower half of the band $f_{m(MHz)}$

$$f_{m(MHz)} = f_0 - 280 + 28n + 14m$$

Upper half of the band $f'_{m(MHz)}$

$$f'_{m(MHz)} = f_0 - 14 + 28n + 14m$$

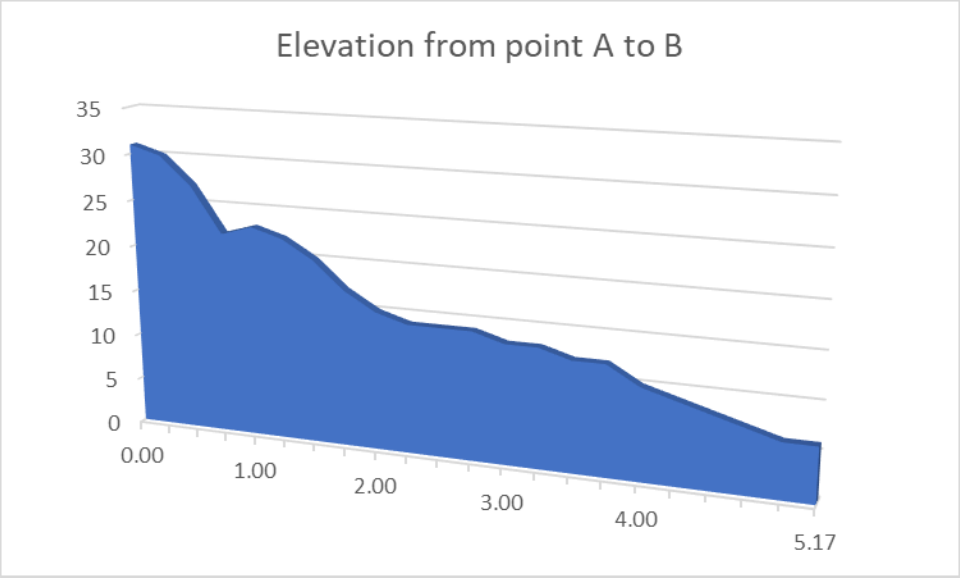
Where:
m = 1
n = number of the basic channel arrangement = 8

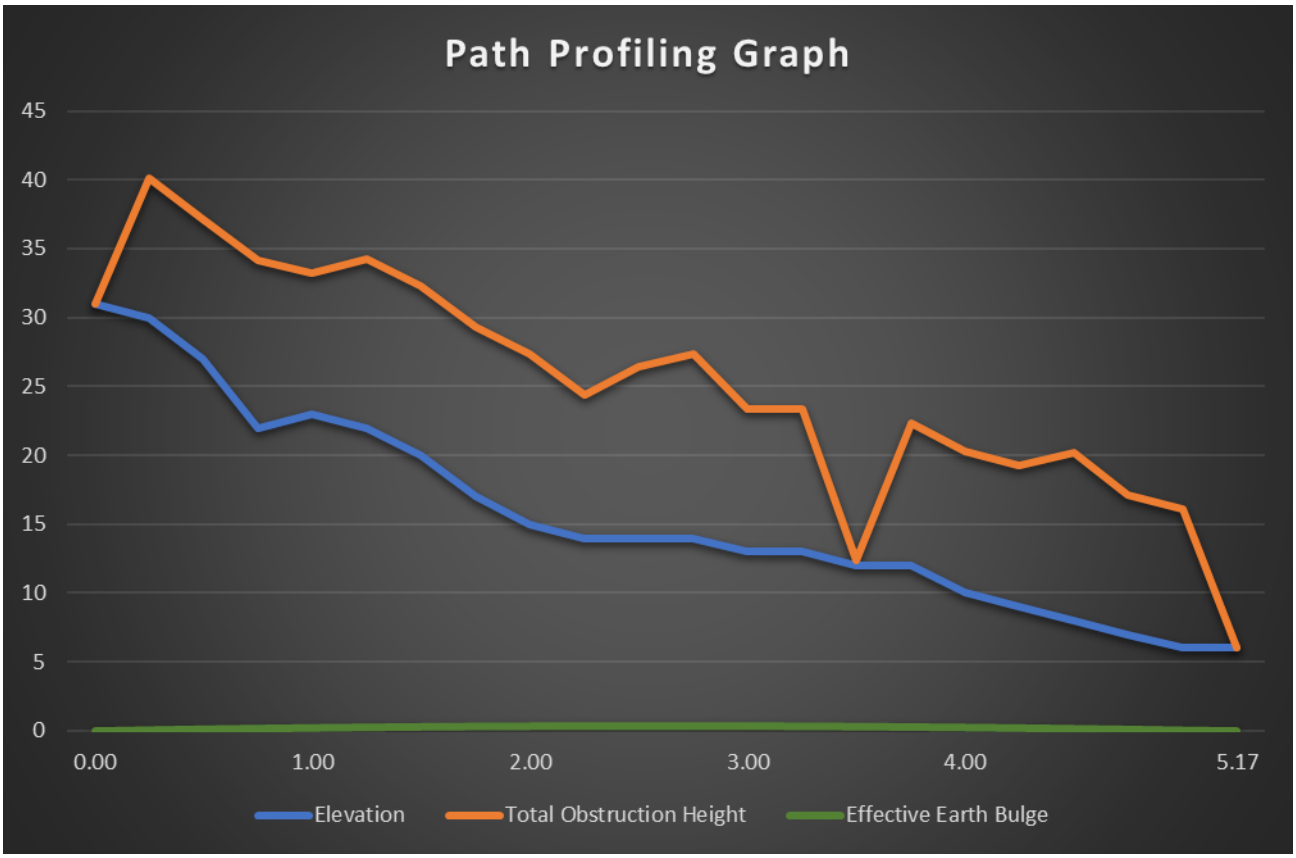
∴ Channel Capacity

$$C = 2B(M)$$
$$C = 2(14MHz)(32)$$
140Mbit/s data

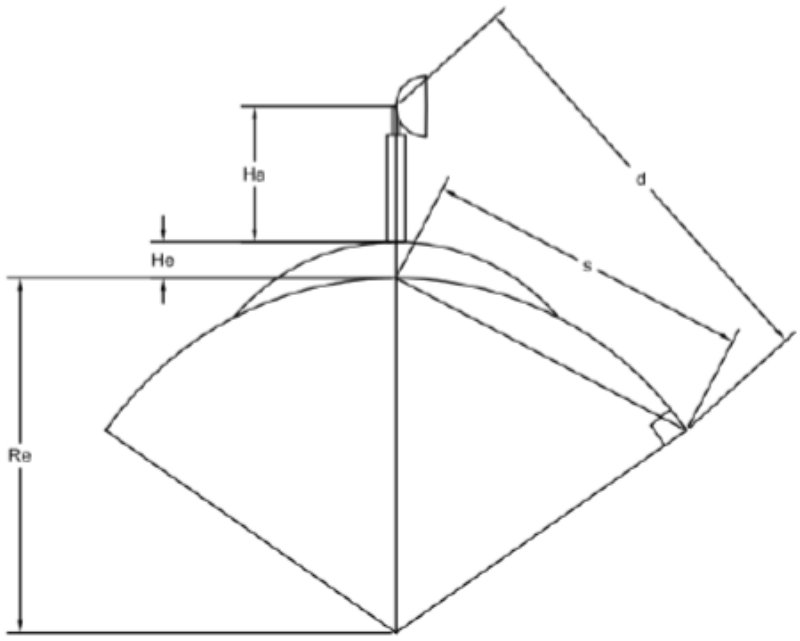
- **Path Profile**

Distance from A (km)	Distance from B (km)	Effective Earth Bulge (m)	Elevation (m)	Terrain Type	Obstruction Allowance (m)	Obstruction Height (m)	1st Fresnel	60% 1st Fresnel
0.00	5.17	0.0000000000	31	Empty Slot	0	31.00	0.00	0.00
0.25	4.92	0.0723529412	30	Residential	10	40.07	2.34	1.40
0.50	4.67	0.1373529412	27	Commercial Building	10	37.14	3.22	1.93
0.75	4.42	0.1950000000	22	Tree	12	34.20	3.84	2.31
1.00	4.17	0.2452941176	23	Residential	10	33.25	4.31	2.59
1.25	3.92	0.2882352941	22	Tree	12	34.29	4.67	2.80
1.50	3.67	0.3238235294	20	Tree	12	32.32	4.95	2.97
1.75	3.42	0.3520588235	17	Tree	12	29.35	5.16	3.10
2.00	3.17	0.3729411765	15	Tree	12	27.37	5.31	3.19
2.25	2.92	0.3864705882	14	Residential	10	24.39	5.41	3.25
2.50	2.67	0.3926470588	14	Tree	12	26.39	5.45	3.27
2.75	2.42	0.3914705882	14	Church	13	27.39	5.44	3.27
3.00	2.17	0.3829411765	13	Residential	10	23.38	5.38	3.23
3.25	1.92	0.3670588235	13	Residential	10	23.37	5.27	3.16
3.50	1.67	0.3438235294	12	Grove	0	12.34	5.10	3.06
3.75	1.42	0.3132352941	12	Commercial Building	10	22.31	4.87	2.92
4.00	1.17	0.2752941176	10	Residential	10	20.28	4.57	2.74
4.25	0.92	0.2300000000	9	Residential	10	19.23	4.17	2.50
4.50	0.67	0.1773529412	8	Tree	12	20.18	3.66	2.20
4.75	0.42	0.1173529412	7	Commercial Building	10	17.12	2.98	1.79
5.00	0.17	0.0500000000	6	Residential	10	16.05	1.95	1.17
5.17	0.00	0.0000000000	6	Empty Slot	0	6.00	0.00	0.00





- **Antenna Height Calculations**



HEIGHT OF THE FIRST ANTENNA

$$H_{A(1)} = \left| \frac{(D_{total})^2}{8R_E} - H_e \right|$$

HEIGHT OF THE SECOND ANTENNA

$$H_{A(2)} = \frac{H_{A(1)}}{2}$$

Where:
R_E = Radius of the Earth
H_E = Obstacle Height
H_A = Antenna Height
D_{Total} = Path Length

$$H_{A(1)} = \left| \frac{(5.1km)^2}{8(6370km)} - 40.07 \right| = 39.55m$$

$$H_{A(2)} = \frac{39.55}{2} = 19.78m$$

- **Atmospheric Loss Calculations**

∴ Oxygen Absorption Loss

$$A_o = \left[\left(7.19x10^{-3}\right) + \frac{6.09}{F_c^{\,2}+0.227} + \frac{4.81}{\left(F_c-57\right)^2+1.5} \right] \left(F_c\right)^2 \left(10^{-3}\right) \left(D_{Total}\right)$$

Where:
F_c = Center Frequency (GHz)
D_{Total} = Total Distance
A_o = Oxygen Absorption Loss (dB)

$$A_o = \left[\left(7.19x10^{-3}\right) + \frac{6.09}{13^2+0.227} + \frac{4.81}{(13-57)^2+1.5} \right] (13)^2 \left(10^{-3}\right) (5.1)$$
$$= 0.03935413492$$

∴ Water Vapor Loss

$$A_{H_2 0} = \left[0.067 + \frac{3}{\left(F_c - 22.23\right)^2} + \frac{9}{\left(F_c - 183.3\right)^2 + 6} + \frac{4.81}{\left(F_c - 323.8\right)^2 + 10}\right](F_c^{\,2})(12x10^{-4})(D_{Total})$$

Where:

F_c = Center Frequency (GHz)

D_{Total} = Total Distance

A_{H20} = Water Vapor Loss (dB)

$$A_{H_2 0} = \left[0.067 + \frac{3}{(13 - 22.23)^2} + \frac{9}{(13 - 183.3)^2 + 6} + \frac{4.81}{(13 - 323.8)^2 + 10}\right](13^2)(12x10^{-4})(5.1)$$

$$= \mathbf{0.1060904952}$$

- **Rainfall Attenuation**

$$\psi = \frac{D_T}{1 + \frac{D_T}{35e^{-0.015R_r}}}$$

$$M = \frac{\log[f_{lower}] - \log[f_C]}{\log[f_{lower}] - \log[f_{higher}]}$$

$$k = 10^{[\log(0.0355) - M(\log(0.0355) - \log(0.0168))]}$$

$$\alpha = 1.154 + 0.063M$$

$$A_r = \psi k R_r^{\alpha}$$

Where:

F_c = Center Frequency

D_{Total} = Total Distance

R_r = Rainfall Rate(mm/hr) = 0.4636193022

A_r = Rainfall Attenuation (dB) **= 0.043495992007**

$$\therefore \text{Total Atmospheric Loss}$$

$$A_{AL} = A_r + A_{H_2O} + A_O$$

$$A_{AL} = 0.03935413492 + 0.03935413492 + 0.043495992007$$

$$\mathbf{= 0.1222042618dB}$$

- **Transmission Calculations**

Transmission Calculations	
Frequency (GHz)	13
Path Length (km)	5.1
Power Transmitted (dBm)	24
Antenna Diameter (m)	0.9
Wavelength (m)	0.02307692308
Antenna Gain (dB)	39.16791649
Atmospheric Loss (Total Loss)(dB)	0.1222042618
TLL (dB)	10.88
Improvement Threshold (dBm)	-77.5 = -107.5dB
Free Space Loss (FSL) (dB)	128.87
Received Signal Loss (RSL) (dBm)	-37.53

Transmission Line Loss (TLL)	
Waveguide Loss @ T_1 & T_2 (dB)	6.72 & 3.36
Connector Loss @ T_1 & T_2 (dB)	0.2 & 0.2
Adapter Loss @ T_1 & T_2 (dB)	0.2 & 0.2
TLL (Total)	10.88

∴ FSL

$$FSL_{dB} = 10 \log log \left[\left(\frac{4\pi D_{Total}}{\lambda} \right)^2 \right]$$

$$FSL_{dB} = 10 \log log \left[\left(\frac{4\pi(5100)}{\frac{3x10^8}{13x10^9}} \right)^2 \right]$$

= 128.87dB

Where:

λ = Wavelength

D_{Total} = Total Distance

∴ Antenna Gain

$$G_{ant(dB)} = 10 \log log \left[n \left(\frac{\pi d}{\lambda} \right)^2 \right]$$

$$G_{ant(dB)} = 10 \log log \left[0.55 \left(\frac{\pi(900mm)}{\frac{3x10^8}{13x10^9}} \right)^2 \right]$$

= 39.16791649

Where:

n = Antenna efficiency = 0.55

d = Diameter of antenna

λ = Wavelength

∴ Waveguide Loss

0.168dB/m

@ Tower 1

$$Waveguide\ Loss_{T1} = \frac{0.168dB}{m}(40m)$$

= 6.72dB

@ Tower 2

$$Waveguide\ Loss_{T2} = \frac{0.168dB}{m}(20m)$$

= 3.36dB

∴ Received Signal Level

$$RSL_{dBm} = Gains + Losses$$

$$RSL_{dBm} = 24 + 39.16791649 + 39.16791649 - 0.12 - 10.88 - 128.87$$

= -37.53dBm

- **Fade Margin and Reliability**

Received Signal Level (dBm)	-37.53
Fade Margin (dB)	39.97
Reliability (%)	99.991773

∴ Fade Margin

$$FM = RSL - Improvement\ Threshold$$

$$FM = FM = (-37.53) - (-77.5)$$

= 39.97dB

Rayleigh Fade Margin

FADE MARGIN (dB)	RELIABILITY (%)
8	90
18	99
28	99.9
38	99.99
39.97	x
48	99.999
58	99.9999
68	99.99999
78	99.999999

$$\frac{39.97-48}{48-38} = \frac{x-99.999}{99.999-99.99}$$

$$= \mathbf{99.991773\%}$$

- **Unavailability**

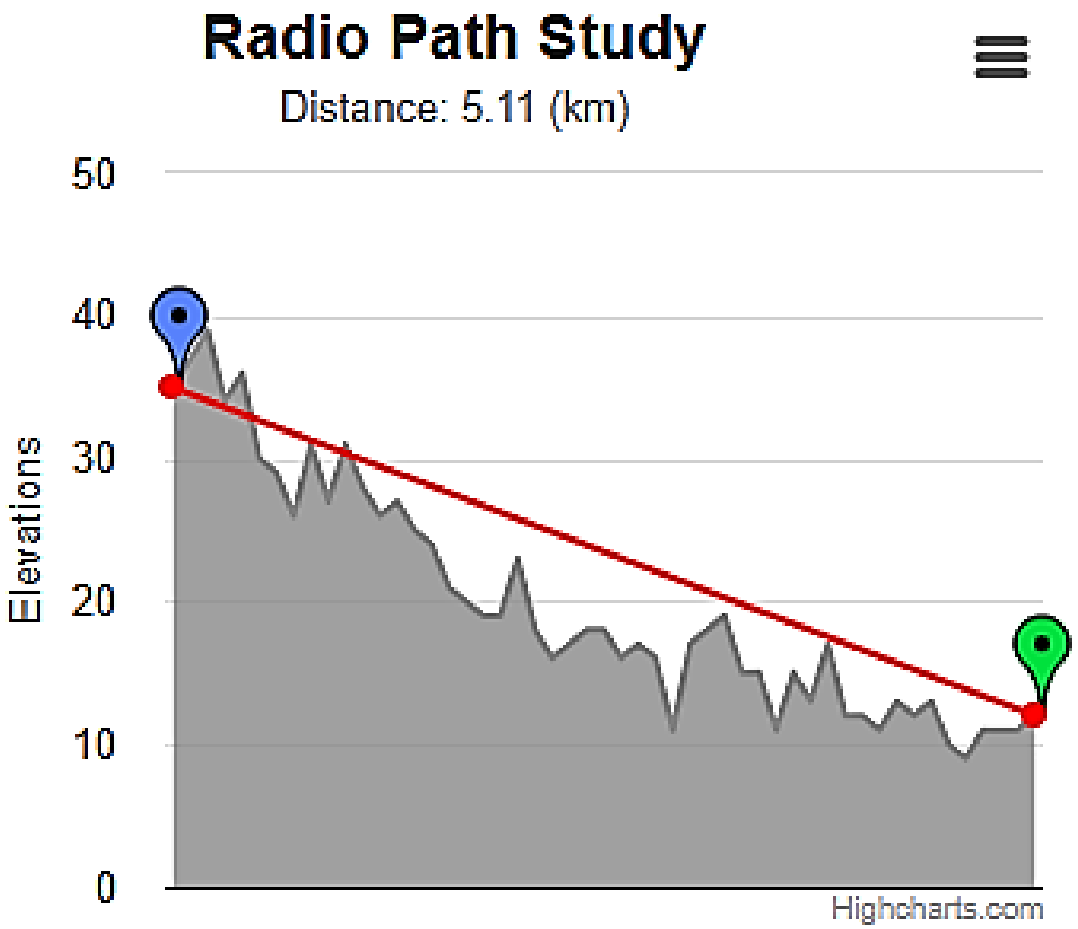
Fade Margin(dB)	39.97
Unavailability(seconds/yr)	2594.46672

$$U_d = 365 - [0.99991773(365)] = 0.03002855\ day$$

$$U_h = 0.03002855\ day\left(\frac{24hr}{1day}\right) = 0.7206852hr$$

$$U_m = 0.7206852hr\left(\frac{60mins}{1hr}\right) = 43.241112min$$

$$U_s = 43.241112\left(\frac{60secs}{1min}\right) = 2594.46672secs$$


Radio Path Study
Distance: 5.11 (km)
Elevations
50
40
30
20
10
0
Highcharts.com

VII. Bill of Materials

Bill of Materials					
No.	**Equipment**	**Brand, Model**	**Unit Price (Php)**	**Quantity**	**Total Price**
1	ODU and IDU	OptiX RTN 950A -XMC-2 Huwawei	333,709.2	1	667,418.4
2	Antenna	Parabolic antenna JRMC – 900 –13	48957.66	1	48957.66
3	Adapters	7G/8G Compatible Adapter Huwawei	44,074.8	2	88,149.6
4	Tower 1	ROHN SSV TOWER KIT, 90 MPH, 3/4" ICE, 80'	462,499.2	1	462,499.2
	Tower 2	ROHN SSV TOWER KIT, 90 MPH, 3/4" ICE, 120'	583,332.84	1	583,332.84
5	IF Cable	FSJ4-50B, HELIAX® Superflexible Foam Coaxial Cable, corrugated copper, 1/2 in, black PE jacket (Halogen free jacketing non-fire-retardant)	223.8084	1000	223,808.4
6	A.C.U	In-room Air Cooled Cooling Product - NetCol8000-A	442,019.59	1	442,019.59
7	Generator	PWH-DSG-40KVA Powerhouse Diesel Power Generator (Super Silent Type)	450,000	2	900,000
8	Rectifier	BST-4850H-G2 3.0KW 48V RECTIFIER MODULE BST	7,899.12	4	31,596.48
9	Obstruction Lights	DWS702S DoubleWise	5,666.76	4	22,667.04
10	Battery	WT12100-01 Woteampower	11,333.52	4	45,334.08
11	Lighting Arrester	High Voltage Line Type ZnO Lightning Arrestors Yh10W-15	57,240	1	57,240
12	Grounding Kit	STG Towers Tower Base Grounding Kit, SOI	7,006.176	1	7,006.176
13	Telco. Shelter	Prefabricated Portable Modular Outdoor Telecom Equipment Shelters	45792	1	45792
14	Rack	19 Inch 42u OEM Telecom Steel Cabinet Deep 45u 48u Premium Server Rack	17,172	4	68,688
				GRAND TOTAL:	**3,694,509.466**

Appendices

A.1. Standards

B.1 ITU-R Standards

The OptiX RTN 950A complies with the ITU-R standards designed for microwave equipment.

B.2 ETSI Standards

The OptiX RTN 950A complies with the ETSI standards designed for microwave equipment.

B.3 IEC Standards

The OptiX RTN 950A is compliant with the IEC standards related to the waveguide.

B.4 ITU-T Standards

The OptiX RTN 950A complies with the ITU-T standards designed for SDH/PDH equipment.

B.5 IETF Standards

The OptiX RTN 950A complies with IETF standards.

B.6 IEEE Standards

The OptiX RTN 950A complies with the IEEE standards designed for Ethernet networks.

B.7 MEF Standards

The OptiX RTN 950A complies with MEF standards.

B.8 AF Standards

The OptiX RTN 950A complies with AF standards.

B.9 Environmental Standards

The OptiX RTN 950A complies with the environmental standards designed for split-mount microwave equipment.

Table B-1 ITU-R standard

Standard	Description
ITU-R F.383-8	Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band
ITU-R F.384-10	Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the upper 6 GHz band
ITU-R F.385-9	Radio-frequency channel arrangements for fixed wireless systems operating in the 7 GHz band
ITU-R F.386-8	Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the 8 GHz band
ITU-R F.387-10	Radio-frequency channel arrangements for radio-relay systems operating in the 11 GHz band
ITU-R F.497-7	Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band

Table B-2 ETSI standard

Standard	Description
ETSI EN 302 217-1 V1.3.1	Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 1: Overview and system-independent common characteristics
ETSI EN 302 217-2-1 V1.3.1	Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2-1: System-dependent requirements for digital systems operating in frequency bands where frequency co-ordination is applied
ETSI EN 302 217-2-2 V1.3.1	Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2-2: Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for digital systems operating in frequency bands where frequency co-ordination is applied
ETSI EN 302 217-3 V1.2.1	Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 3: Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for equipment operating in frequency bands where no frequency co-ordination is applied
ETSI EN 302 217-4-1 V1.4.1	Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4-1: System-dependent requirements for antennas
ETSI EN 302 217-4-2 V1.5.1	Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 4-2: Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for antennas

ETSI EN 301 126-1 V1.1.2	Fixed Radio Systems; Conformance testing; Part 1: Point-to-Point equipment - Definitions, general requirements and test procedures
ETSI EN 301 126-3-1 V1.1.2	Fixed Radio Systems; Conformance testing; Part 3-1: Point-to-Point antennas; Definitions, general requirements and test procedures
ETSI EN 301 390 V1.2.1	Fixed Radio Systems; Point-to-point and Multipoint Systems; Spurious emissions and receiver immunity limits at equipment/ antenna port of Digital Fixed Radio Systems

Table B-3 Relevant IEC standards

Standard	Description
IEC 60154-1	Flanges for waveguides. Part 1: General requirements
IEC 60154-2	Flanges for waveguides. Part 2: Relevant specifications for flanges for ordinary rectangular waveguides
IEC 60154-3	Flanges for waveguides. Part 3: Relevant specifications for flanges for flat rectangular waveguides
IEC 60154-4	Flanges for waveguides. Part 4: Relevant specifications for flanges for circular waveguides
IEC 60154-6	Flanges for waveguides. Part 6: Relevant specifications for flanges for medium flat rectangular waveguides
IEC 60154-7	Flanges for waveguides - Part 7: Relevant specifications for flanges for square waveguides

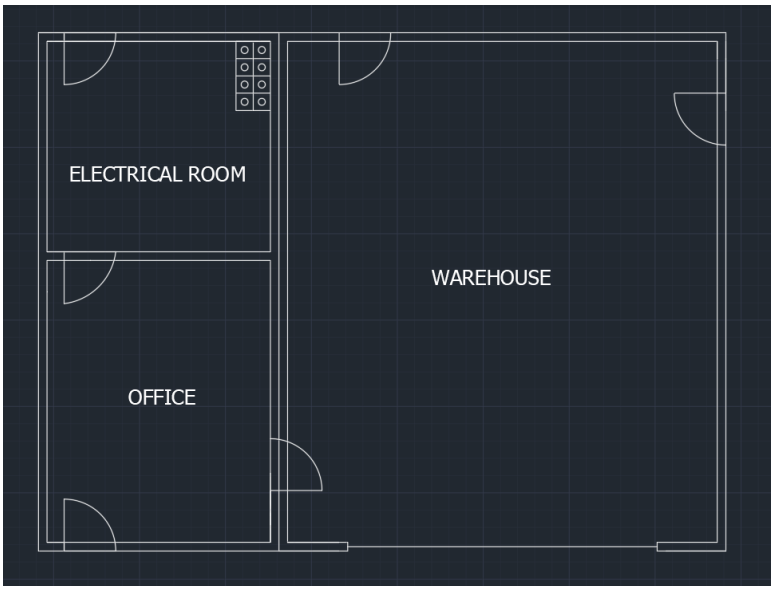
Table B-9 environmental standard

Standard	Description
EN 55022	Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 22	Limits and methods of measurement of radio disturbance characteristics of information
ETSI EN 301 489-1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
ETSI EN 301 489-4	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services
EN 60950-1	Information technology equipment-Safety-Part 1: General requirements
UL 60950-1	Information technology equipment-Safety-Part 1: General requirements
IEC 60825-1	Safety of laser products-Part 1: Equipment classification, requirements and user's guide

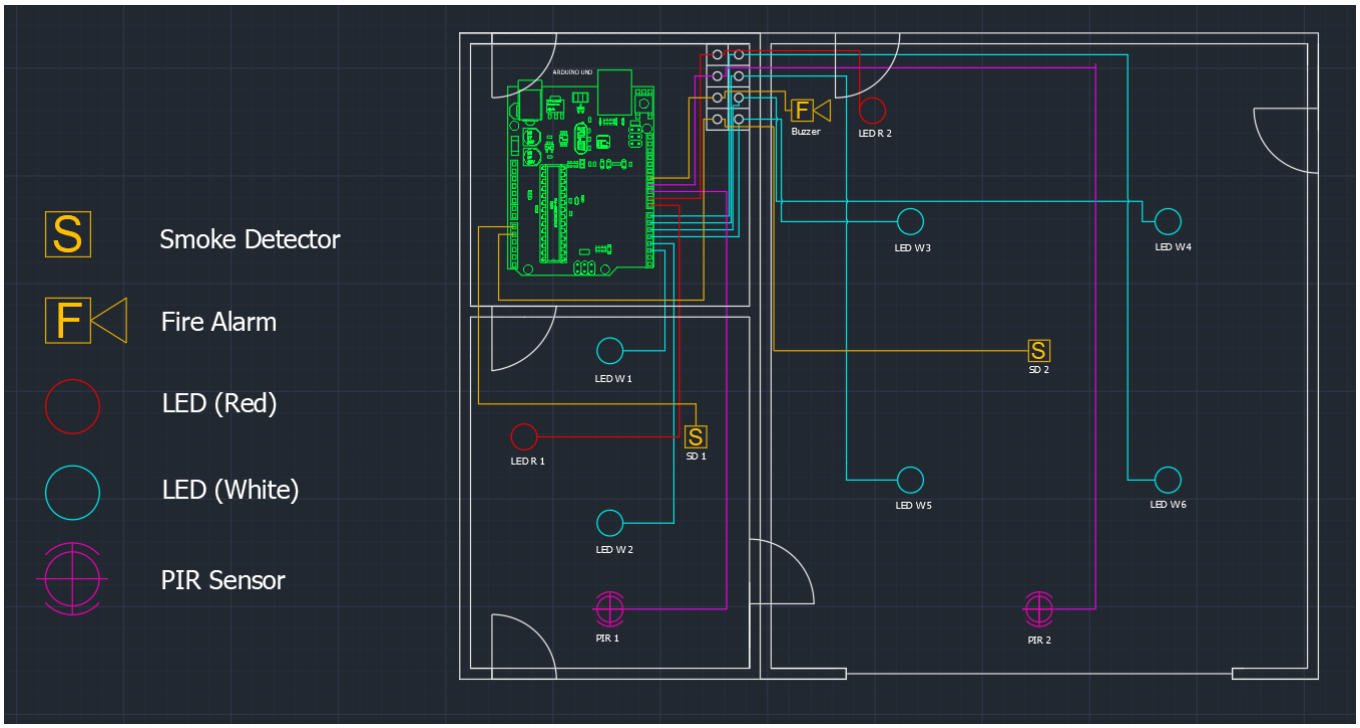
IEC 721-3-1 Classes 1K4/1Z2/1Z3/1Z5/1B2/1C2/1S3/1M2	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 1: Storage Classes 1K4/1Z2/1Z3/1Z5/1B2/1C2/1S3/1M2
IEC 721-3-2 Classes 2K4/2B2/2C2/2S2/2M2	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transportation Classes 2K4/2B2/2C2/2S2/2M2
IEC 721-3-3 Classes 3K5/3Z2/3Z4/3B2/3C2(3C1)/3S2/3M2 (Indoor Unit)	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weather protected locations Classes 3K5/3Z2/3Z4/3B2/3C2(3C1)/3S2/3M2
IEC 721-3-4 Classes 4K2/4Z5/4Z7/4B1/4C2(4C3)/4S2/4M5 (Outdoor Unit)	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 4: Stationary use at non-weather protected locations. Classes 4K2/4Z5/4Z7/4B1/4C2(4C3)/4S2/4M5

A.2. Layouts

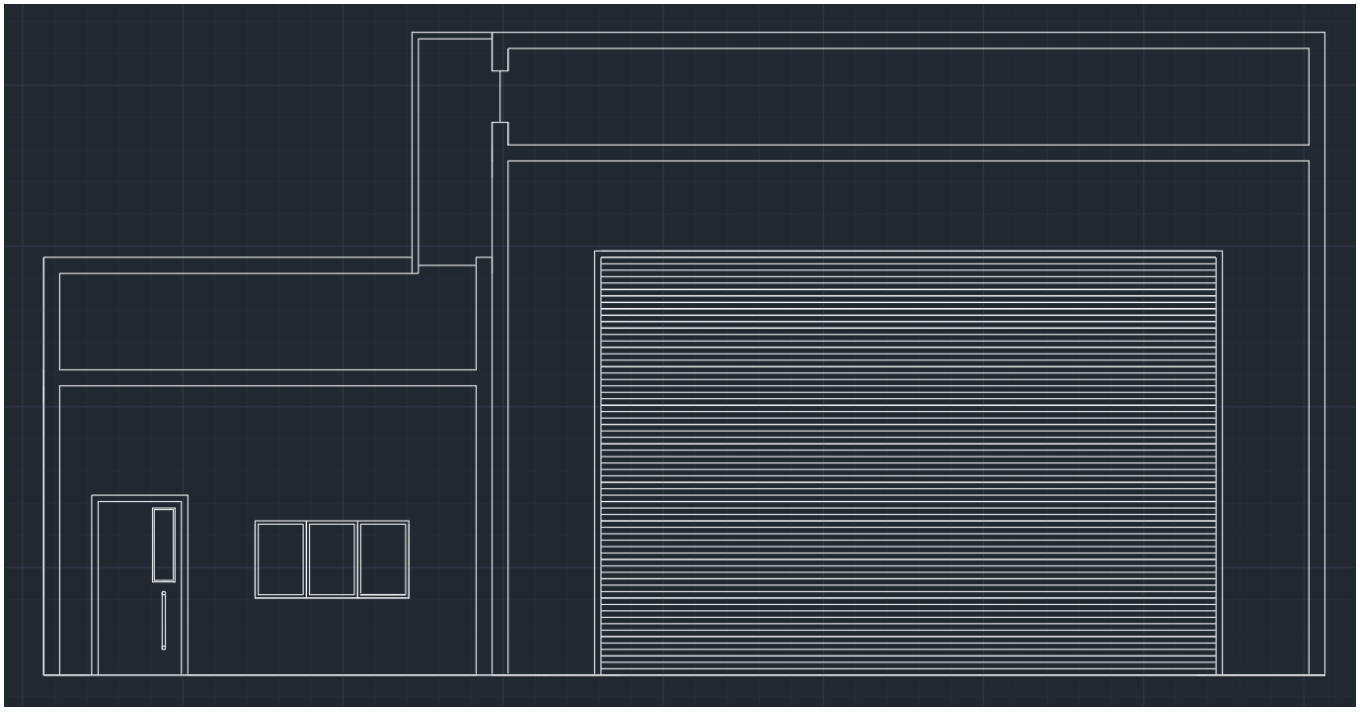
Warehouse Layout

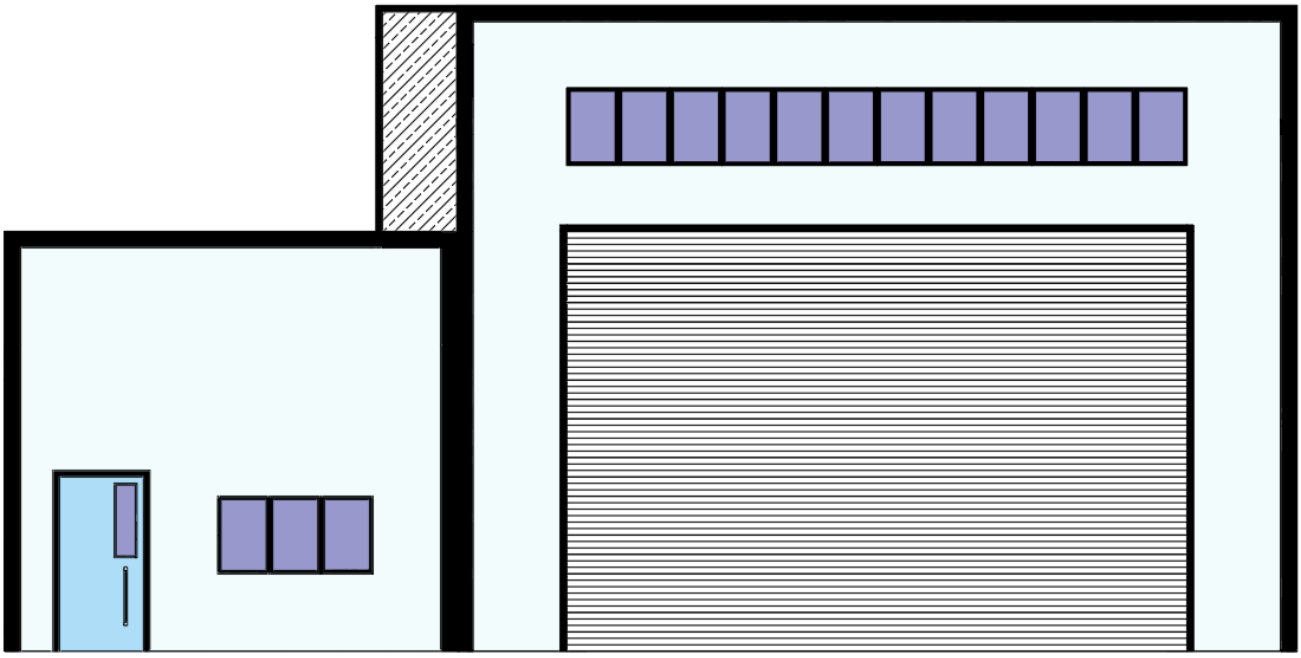


Floor - Plan



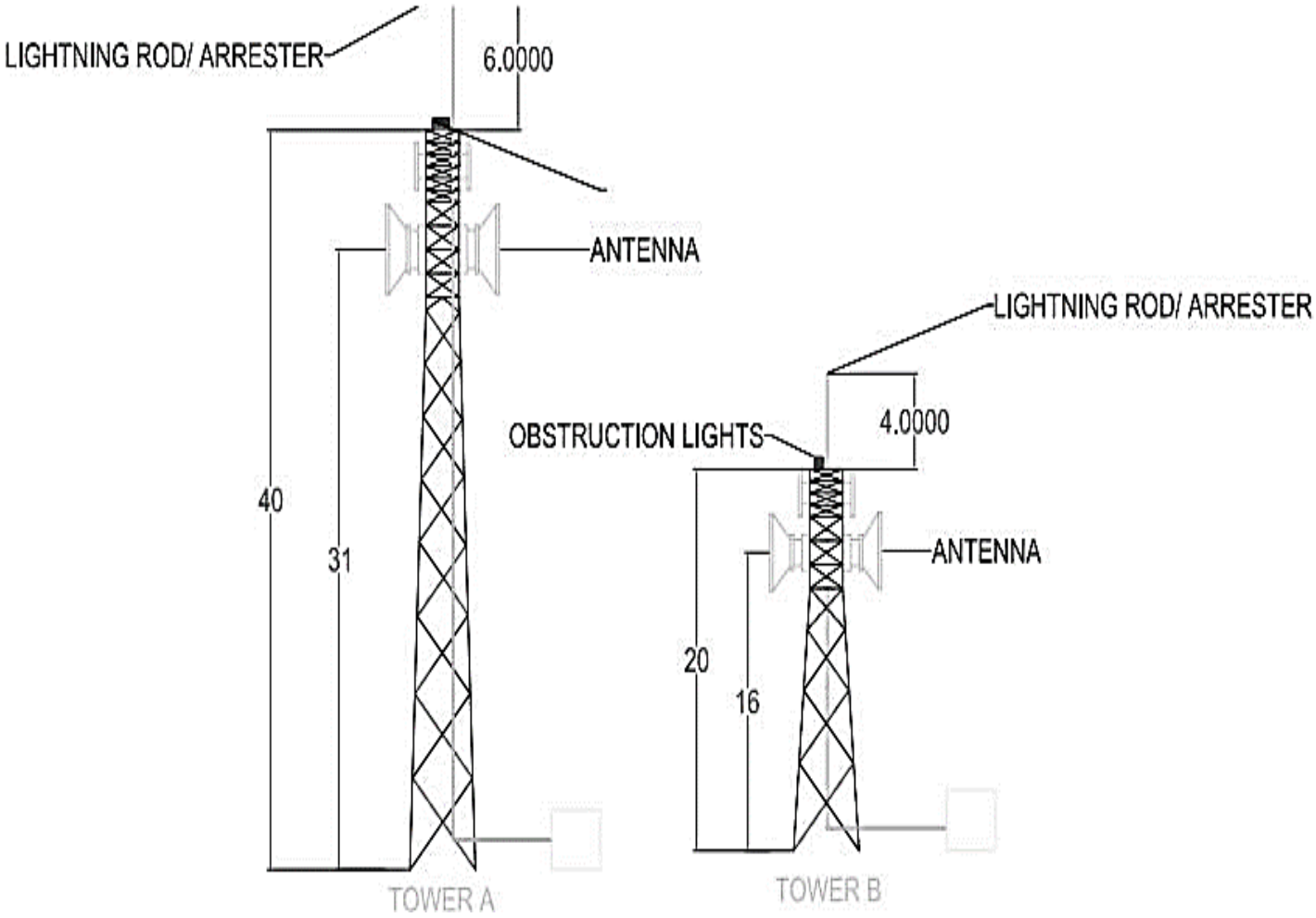
Floor - Plan (Electrical Layout Plan)





Floor - Plan (Front View)

A.3. Telco Tower



A.4. Equipment with Specifications

Radio Equipment IDU

OptiX RTN 950A

Specifications	RTN905e	RTN950A	RTN980	RTN980L
Frequency	6/7/8/10/10.5/11/13/15/18/23/26/28/32/38/42 GHz			56/7/8/11GHz
Channel Spacing	3.5/7/14/28/40/50/56 MHz			3.5/7/14/28/40/50/56/112 MHz
RF Directions	1U/2 RF	2U/10 RF	5U/20 RF	5U/16 RF
Switching Capacity	8 Gbit/s	10 Gbit/s	22 Gbit/s	120Gbit/s
Cross-Connect Capacity	8 x 8 VC-4	32 x 32 VC-4	128 x 128 VC-4	128 x 128 VC-4
IDU Dimension (W x D x H)	442 mm x 220 mm x 44 mm	442 mm x 220 mm x 88 mm	442 mm x 220 mm x 225 mm	442 mm x 220 mm x 225 mm
IDU Weight	3.1 kg	6.2 kg	15.4 kg	20.1 kg
Power Supply	–38.4V to –57.6V	-38.4V to -57.6V	-38.4V to -72V	-38.4V to -72V
Typical Power Consumption	92W	125W	470W	746W
Environment	Temperature Ranges: IDU –5°C to +60°C, ODU –35°C to +55°C Humidity Ranges: IDU 5% to 95%, ODU 5% to 100%			

Table 6-18 IF running modes and microwave working modes

IF Running Mode	Application Scenario
IS6	• The IS6 mode provides high bandwidth and large capacity. • The IS6 mode supports 12 types of modulation modes, including QPSK Strong, QPSK, 16QAM Strong, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, 1024QAM, 2048QAM, and 4096QAM, among which 4096QAM is used only when AM is enabled. • The XMC-3 ODU supports the IS6 mode. • For information about the highest-order modulation scheme supported by each frequency band, see **Table 6-19** to **Table 6-20**. • For information about the supported radio working modes, see **Table 6-21** to **Table 6-25**.

IF Running Mode	Application Scenario
IS3	• The IS3 mode provides large capacity. When working in this mode, ISM6 boards can interconnect with ISV3 boards or with OptiX RTN 905. • The IS3 mode supports 13 types of modulation modes, including QPSK Strong, QPSK, 16QAM Strong, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, 512QAM Light, 1024QAM, 1024QAM Light, and 2048QAM, among which 2048QAM is used only when AM is enabled. • ISM6 boards in IS3 mode can work with the XMC-2, XMC-2H, and XMC-3 ODU. • ISM6 boards working in IS3 mode support the same radio working modes as ISV3 boards. For details, see **6.1.1.4 Microwave Work Modes (ISV3 board)**.
IS2	• The IS2 mode provides standard capacity. When working in this mode, ISM6 boards can interconnect with ISU2/ISX2 boards. • The IS2 mode supports six types of modulation modes: QPSK, 16QAM, 32QAM, 64QAM, 128QAM, and 256QAM. • ISM6 boards in IS2 mode can work with the XMC-2, XMC-2H, and XMC-3 ODU. • ISM6 boards working in IS2 mode and with XPIC disabled support the same radio working modes as ISU2 boards. For information about the supported radio working modes, see **Table 6-2**, **Table 6-3**, and **Table 6-4** in **6.1.1.2 Microwave Work Modes (ISU2 board)**. • ISM6 boards working in IS2 mode and with XPIC enabled support the same radio working modes as ISX2 boards. For information about the supported radio working modes, see **Table 6-5**, **Table 6-7**, and **Table 6-8** in **6.1.1.3 Microwave Work Modes (ISX2 board)**.

Table 3-248 Typical receiver sensitivity in the Integrated IP microwave mode XVI (IS6 mode, XPIC enabled)

Item	Specifications (Channel Spacing: 28 MHz)					
	QPSK Strong	QPSK	16QAM Strong	16QAM	32QAM	64QAM
RSL@ BER = 10^{-6} (dBm)						
@7 GHz	-90.5	-89	-83.5	-82	-79	-75.5
@8 GHz	-90.5	-89	-83.5	-82	-79	-75.5
@7&8 GHz(XMC-3 W)	-89.5	-88	-82.5	-81	-78	-74.5
@11 GHz	-90	-88.5	-83	-81.5	-78.5	-75

Item	Specifications (Channel Spacing: 28 MHz)					
	QPSK Strong	QPSK	16QAM Strong	16QAM	32QAM	64QAM
@13 GHz(XMC-3 W)	-89	-87.5	-82	-80.5	-77.5	-74
@13 GHz	-90	-88.5	-83	-81.5	-78.5	-75
@15 GHz	-90	-88.5	-83	-81.5	-78.5	-75
@15 GHz(XMC-3 W)	-89	-87.5	-82	-80.5	-77.5	-74
@18 GHz(XMC-3 W)	-88.5	-87	-81.5	-80	-77	-73.5

s

Item	Performance									
	QPSK	16QAM	32QAM	64QAM	128QAM	256QAM	512QAM	1024QAM	2048QAM	4096QAM
Nominal maximum transmit power (dBm)										
13GHz	25	24	24	23	23	21	20	18	18	17
15GHz	25	24	24	23	23	21	21	19	19	18
18GHz	24	23	23	22	22	20	19	17	17	16
23GHz	24	23	23	22	22	19.5	19.5	18	18	17
26GHz	22	21	21	19	19	17	17	15	15	14
28GHz	22	20	20	19	19	17	16	15	15	-
32GHz	22	20	20	19	19	17	16	15	15	-

Radio Equipment ODU

RTN-XMC-2 ODU

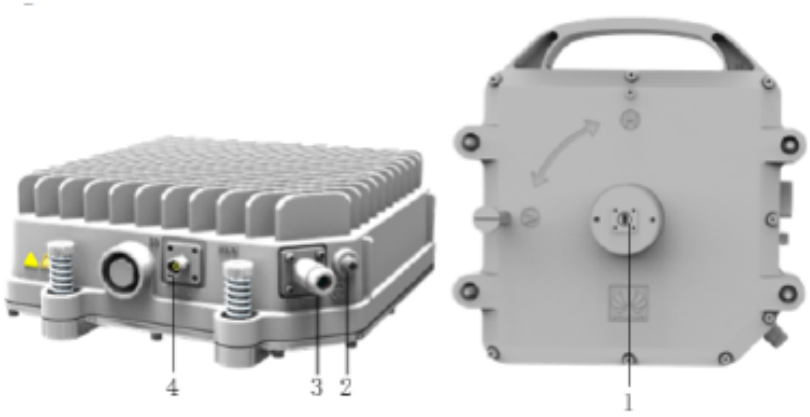


Table 1-13 Working frequency bands of the ODU (XMC-2 ODU)

Frequency Band	Frequency Range (GHz)	Interval Between Center RX and TX Frequencies in a Channel (MHz)
6 GHz	From 5.925 to 7.125	252.04, 160/170, and 340/350
7 GHz	From 7.093 to 7.897	154, 161, 168, 196, and 245
8 GHz	From 7.731 to 8.497	119/126, 151.614, 208, 266,303, 310 and 311.32 **NOTE** 310 is a sub-frequency band of the 8 GHz-2E frequency band .
10 GHz	From 10.130 to 10.650	350
	From 10.500 to 10.678	91
11 GHz	From 10.675 to 11.745	500/490, 530/520
13 GHz	From 12.751 to 13.248	266
15 GHz	From 14.400 to 15.358	315/322, 420, 490, 644, and 728

Antenna Equipment

Parabolic antenna JRMC – 900 –13

Antenna JRMC – 900 – 13 is designed for microwave links at the frequency band 13 GHz. Precise performance with deep reflector dish complies with standard ETSI class 3 and FCC.

Electrical parameters:

Frequency range	12.7 – 13.3 GHz
Gain – Low frequency	38.2 ± 1 dBi
Gain – High frequency	38.6 ± 1 dBi
Front to back ratio	≥ 63 dB
Beamwidth$_{3\ dB}$	1.7°
Return loss (VSWR)	≥ 18 dB
Polarization	Linear, vertical/horizontal
Electrical Compliance	US **FCC Part 101B** **Class 3** ETSI EN 302-217-4-2 v1.5.1

Mechanical parameters:

Parabola	Ø 900 mm , aluminium alloy
Radome	UV steady plastic ABS
Input / output	Circle waveguide Ø 16 mm
Installation for mast	Ø 40 – 120 mm
Operating wind load	140 km/h (87 mph)
Survival wind load	210 km/h (130 mph)
Weight of antenna **of holder**	8.2 kg (18.1 lbs.) 3.2 kg (7.1 lbs.)
Shipping dimensions	1000 x 990 x 430 mm / 18 kg (39.7 lbs.)

Table 10-1 Specifications for the feed boom interface of an antenna

Frequency Band	Interface Type			
	Direct-Mount Single-Polarized Antenna	Direct-Mount Dual-Polarized Antenna	Separate-mount Single-Polarized Antenna	Separate-mount Dual-Polarized Antenna
6 GHz	153IEC-R70, can be interconnected with the PDR70	153IEC-R70	154IEC-PDR70	154IEC-PDR70
7/8 GHz	153IEC-R84, can be interconnected with the PBR84	153IEC-R84	154IEC-UBR84	154IEC-UBR84
10/11 GHz	153IEC-R100, can be interconnected with the PBR100	153IEC-R100	154IEC-UBR100	154IEC-UBR100
13 GHz	153IEC-R120, can be interconnected with the PBR120	153IEC-R120	154IEC-UBR120	154IEC-UBR120
15 GHz	153IEC-R140, can be interconnected with the PBR140	153IEC-R140	NA	154IEC-UBR140
18/23/26 GHz	153IEC-R220, can be interconnected with the PBR220	153IEC-R220	NA	154IEC-UBR220
28/32/38 GHz	154IEC-R320, can be interconnected with the PBR320	153IEC-R320	NA	154IEC-UBR320
42 GHz	UG 383/U-R400, can be interconnected with the UG 383/U-R400	UG383	NA	UG383

Table 10-3 Diameter of the separate-mount dual-polarized antenna

Frequency Band	Antenna Diameter								
	0.3 m	0.6 m	0.9 m	1.0 m	1.2 m	1.8 m	2.4 m	3.0 m	3.7 m
6 GHz	NA	NA	NA	Y	Y	Y	Y	Y	Y
7/8 GHz	NA	Y	Y	Y	Y	Y	Y	Y	Y
10 GHz	NA	Y	Y	Y	Y	Y	NA	NA	NA
11 GHz	NA	Y	Y	Y	Y	Y	Y	Y	Y
13 GHz	NA	Y	Y	Y	Y	Y	Y	Y	Y

Adapter

7G/8G Compatible Adapters

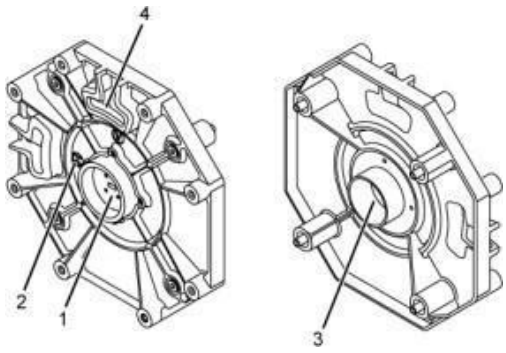


Table 11-1 Technical specifications of the antenna adapter

Item	Specification
Loss	≤ 0.2 dB (7/8/10/11/13/15/18/23/26/28/32/38 GHz frequency band)

Item		Specification
Voltage Standing Wave Ratio (VSWR)		≤ 1.3 (7/8/10/11/13/15/18/23/26/28/32/38 GHz frequency band)
Interfaces	Antenna side	1.025 inch dia circular (7/8 GHz frequency band) 153IEC-R100 (10/11 GHz frequency band) 153IEC-R120 (13 GHz frequency band) 153IEC-R140 (15 GHz frequency band) 153IEC-R220 (18/23/26 GHz frequency band) 153IEC-R320 (28/32 GHz frequency band) 0.219 inch dia Circular (38 GHz frequency band)
	ODU/hybrid coupler side	153IEC-R84, can be interconnected with the PBR84 (7/8 GHz frequency band) 153IEC-R100, can be interconnected with the PBR100 (10/11 GHz frequency band) 153IEC-R120, can be interconnected with the PBR120 (13 GHz frequency band) 153IEC-R140, can be interconnected with the PBR140 (15 GHz frequency band) 153IEC-R220, can be interconnected with the PBR220 (18/23/26 GHz frequency band) 153IEC-R320, can be interconnected with the PBR320 (28/32/38 GHz frequency band)
Weight		≤ 2.5 kg

Waveguide

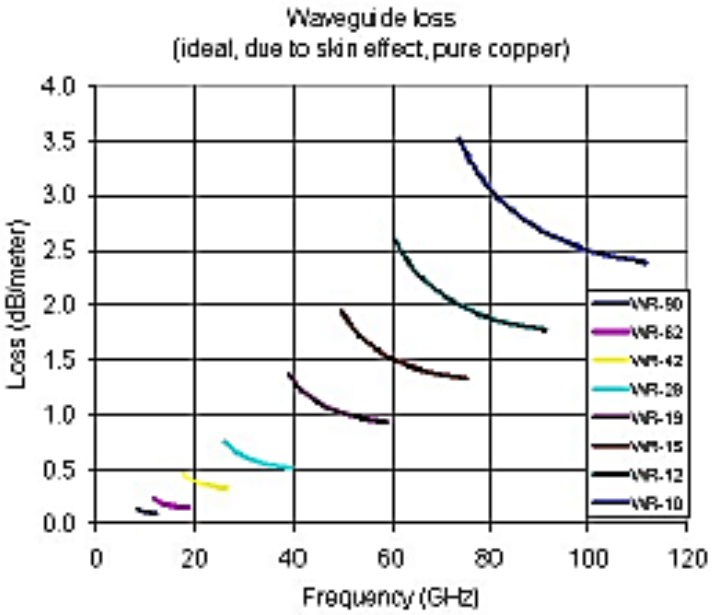
Waveguide Size

EIA Standard:	WR62
RSCS Standard (British Military):	WG18
IEC Standard:	R140

WR62 Specifications

Recommended Frequency Band:	12.40 to 18 GHz
Cutoff Frequency of Lowest Order Mode:	9.488 GHz
Cutoff Frequency of Upper Mode:	18.976 GHz
Dimension:	0.622 Inches [15.7988 mm] x 0.311 Inches [7.8994 mm]

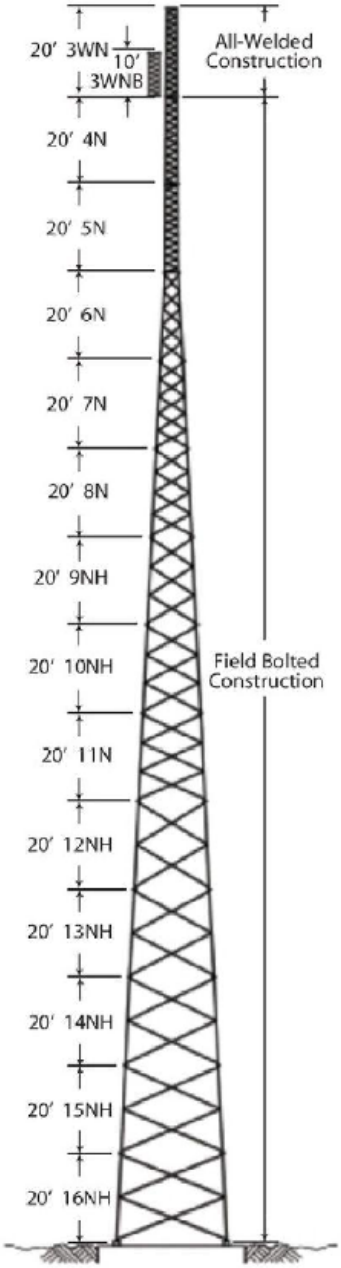
WR-90: 0.108 dB/m (10 GHz),
WR-62: 0.168 dB/m (15 GHz)
WF-42: 0.370 dB/m (21 GHz)
WR-28: 0.576 dB/m (32 GHz)
WR-19: 1.04 dB/m (48 GHz)
WR-15: 1.51 dB/m (60 GHz)
WR-12: 1.97 dB/m (75 GHz)
WR-10 2.69 dB/m (90 GHz)



Tower Specification

SS SELF-SUPPORTING TOWERS

SSV HD SELF-SUPPORTING TOWERS



SSV
HEAVY DUTY

GENERAL USE

The ROHN SSV HD tower has the same features and utility as the SSV tower, but with Heavy Duty legs and braces. The heavy duty tower allows for the structure to support more loading and higher wind and ice loading. This tower serves the same applications as the SSV including: PCS, broadband, security, sports lighting and many others. The SSV HD also has standard "pre-engineered" towers created from standard sections. All ROHN SSV towers are hot-dip galvanized, inside and out for corrosion protection.

Section Number	Nominal Spread Dimension	
	Upper	Lower
3WN	1' - 6"	1' - 10"
3WNB	1' - 10"	1' - 10"
4N	1' - 10"	2' - 2"
5N	2' - 2"	2' - 6"
6N	2' - 6"	4' - 6 1/4"
7N	4' - 6 1/4"	6' - 6 3/4"
8N	6' - 6 3/4"	8' - 6 3/4"
9NH	8' - 6 3/4"	10' - 6 3/4"
10NH	10' - 6 3/4"	12' - 7 1/4"
11N	12' - 7 1/4"	14' - 7 7/8"
12NH	14' - 7 7/8"	16' - 8 3/8"
13NH	16' - 8 3/8"	18' - 8 3/8"
14NH	18' - 8 3/8"	20' - 9 3/8"
15NH	20' - 9 3/8"	22' - 9 3/8"
16NH	22' - 9 3/8"	24' - 9 3/8"

Do not use for construction. See tower assembley drawings.

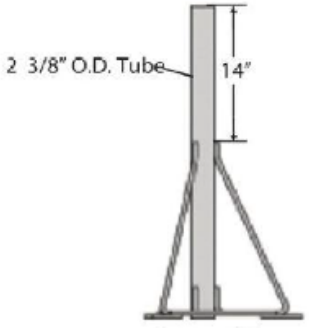
Per Rev G requirements, any structure greater than 10' requires a climber safety device. Please contact ROHN for ordering information.

SELF-SUPPORTING HEAVY DUTY STANDARD TOWERS

REV G, 90 MPH 3-SEC, 3/4" ICE							
TOWER HEIGHT (FT.)	TOWER ASSEMBLY NUMBER	SECTIONS		EFFECTIVE PROJECTED AREA (SQ. FT.)			
				TOP		30' BELOW TOP	
		TOP	BASE	EXP B	EXP C	EXP B	EXP C
40	SS040HD90	3WN	4N	41	29	60	40
50	SS050HD90	3WNB	5N	36	27	60	40
60	SS060HD90	3WN	5N	35	26	60	40
70	SS070HD90	3WNB	6N62	32	23	54	38
80	SS080HD90	3WN	6N62	22	15	37	25
90	SS090HD90	3WNB	7N165	27	18	46	30
100	SS100HD90	3WN	7N165	20	13	34	21
110	SS110HD90	3WNB	8N106	24	10	41	17
120	SS120HD90	3WN	8N106	18	11	31	18
130	SS130HD90	3WNB	9N82	21	9	36	15
140	SS140HD90	3WN	9N82	16	10	27	17
150	SS150HD90	3WNB	10N183	19	11	33	18
160	SS160HD90	3WN	10N183	15	8	25	14
170	SS170HD90	3WNB	11N332	18	9	31	15
180	SS180HD90	3WN	11N332	13	6	21	10

General Notes:

1. Standard tower designs are in accordance with approved national standard ANSI/TIA-222-G, Structure Class II, Topographic Category 1, 3/4" design ice thickness, seismic coefficient $S_s \leq 1.0$.
2. Tower designs assume allowable projected areas are symmetrically placed on the tower.
3. Designs assume one 7/8 line to top and two 7/8 lines to 30 feet below top, one line on each face.
4. All towers are provided with step bolts and a tapered top.
5. Grounding kit must be ordered seperately.
6. Assembly drawings and standard foundation details are supplied with the tower.
7. Custom designs for site-specific applications are available upon request.



Tapered Top

Assy. P/N	Tower Section No.
1TT	1W, 1WB, 2W
3TT	2WST, 2WB, 3WN
4TTN	3WNST, 3WNB, 4N
5TTN	4NST, 4NA, 4WB, 4NC, 5N
6TT	5NST, 5NA, 5NB, 5NC, 6C

IF Cable Specification

IF Cable Specification

FSJ4-50B, HELIAX® Superflexible Foam Coaxial Cable, corrugated copper, 1/2 in, black PE jacket (Halogen free jacketing non-fire-retardant)

Product Classification

Product Type	Coaxial wireless cable
Product Brand	HELIAX® | SureFlex®
Product Series	FSJ4-50B
Ordering Note	CommScope® standard product (Global)

General Specifications

Flexibility	Superflexible
Jacket Color	Black
Performance Note	Attenuation values typical, guaranteed within 5%

Dimensions

Diameter Over Dielectric	8.89 mm | 0.35 in
Diameter Over Jacket	13.462 mm | 0.53 in
Inner Conductor OD	3.556 mm | 0.14 in
Outer Conductor OD	12.192 mm | 0.48 in
Nominal Size	1/2 in

Electrical Specifications

Cable Impedance	50 ohm ±1 ohm
Capacitance	82.7 pF/m | 25.207 pF/ft
dc Resistance, Inner Conductor	2.69 ohms/km | 0.82 ohms/kft
dc Resistance, Outer Conductor	5.12 ohms/km | 1.561 ohms/kft
dc Test Voltage	2500 V
Inductance	0.207 µH/m | 0.063 µH/ft

Air Conditioning Unit Specifications

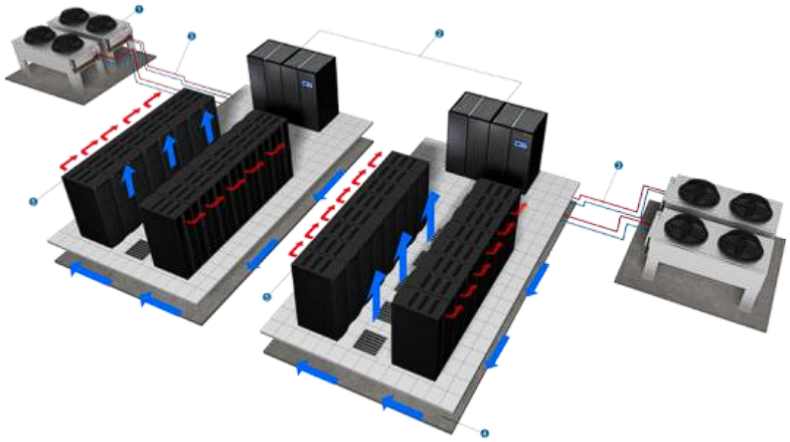
In-room Air Cooled Cooling Product - NetCol8000-A

NetCol8000-A

NetCol8000-A is in-room air cooled smart cooling product, composed of indoor and outdoor unit, it adopts all-variable frequency design, supports up flow and downflow to meets the cooling requirements for different computer rooms. It is usually deployed around the computer room, and supply the efficient, reliable and simple cooling solution for middle small sized low power density computer room, helps to build next generation green data center.

Application Scenarios

- Medium and large exchange room and data room
- Computer room and data center
- High-tech environment and lab
- UPS and battery room



Typical Application

Value & Features

- All-variable-frequency design: Inverter compressor, EC fan and electronic expansion valve, saving 30% energy compared with fixed-frequency system
- iCooling algorithm: intelligently optimize operation, AEER can be increased by 8%+
- Wet-film humidifier: Without heating water, “0” power consumption for humidification

Reliable

- Refrigerant detection: AI algorithm detects the refrigerant content, generating charging prompt when the refrigerant is insufficient
- Stable operation: Reliable the dehumidification at minimum 10% load, eliminate condensation risk

Simple

- Intelligent display: Display key parameters real-time, promptly knows the unit running status
- Fault self-diagnosis: Intelligently locate the malfunction, guiding O&M engineer maintain quickly
- Fast installation for fan: No need for auxiliary tools, saving fan installation time 70%

Technical Specification

Indoor Unit Technical Specification

Unit Model	Unit	NetCol8000-A045D/U	NetCol8000-A060D/U	NetCol8000-A090D	NetCol8000-A120D
Air Discharge Direction	-	D: Downflow; U: Upflow			
Total Cooling Capacity	kW	45	60	90	120
Sensible Cooling Capacity	kW	45	60	90	120
Air Volume	m^3/h	11250	14500	22500	29000
Power Supply	V/Ph/Hz	380/400/415Vac, 50/60Hz, 3Ph+N+PE			
Heating Capacity	kW	6	6	12	12
Humidifier Capacity	kg/h	4.5	6	10	10
Full Load Current	A	36(40)	41(45)	72(80)	82(90)
Dimension: W×D×H	mm	900*900*2000	1100*1000*2000	1800*1000*2000	2200*1000*2000
Net Weight	kg	355	480	643	850

1. Nominal condition: indoor return air 35°C/26%RH, outdoor 35°C.
2. The current data in brackets are applicable to the indoor unit with electric heater & humidifier (Optional).
3. NetCol8000-A045 and NetCol8000-A060 is a single-system unit. NetCol8000-A090 and NetCol8000-A120 is a dual-system unit.

Outdoor Condenser Technical Specification

Unit Model	Unit	NetCol500-A060	NetCol500-A080	NetCol500-A110	NetCol500-A120
Power Supply	V/Ph/Hz	Power supply from indoor unit			
Liquid Pipe OD	in	5/8	5/8	5/8	5/8
Gas Pipe OD	in	7/8	7/8	7/8	7/8
Full Load Current	A	2.5	4.5	7.0	5.0
W×D×H	mm	1356×1094×1107	2186×1094×1107	2250×1100×1770	2189×1356×1107
Net Weight	kg	130	240	366	250

1. NetCol500-A060, NetCol500-A080 and NetCol500-A110 are single-system units. NetCol500-A120 is a dual-system unit.
2. A single-system indoor unit is used with a single-system outdoor unit; two single-system indoor units are used together with a dual-system outdoor unit; a dual-system indoor unit is used with two single system outdoor units; a dual-system indoor unit is used with a dual-system outdoor unit.

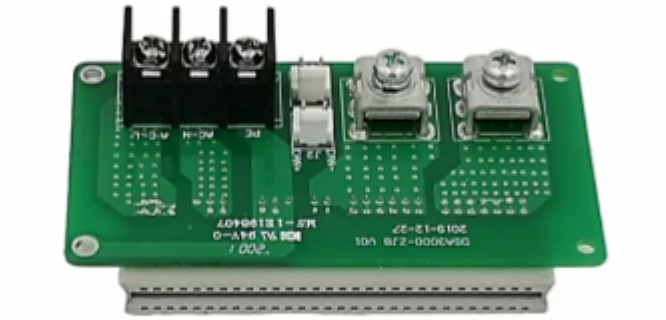
Generator

Powerhouse Diesel Power Generator (Super Silent Type)

Model	PWH-DSG-40KVA
Votalge/ Frequency	220V / 60 Hz
Prime/Surge Power	36 kVa / 40 kVa
Engine Speed	1800 rpm
Fuel Consumption	13 L/h
Coolant Capacity	4.8 L
Lubrication Capacity	12.5 L
Fuel Tank Capacity	101 L
Size	2200 x 900 x 1200mm
Weight (kg)	940 kg

Rectifier

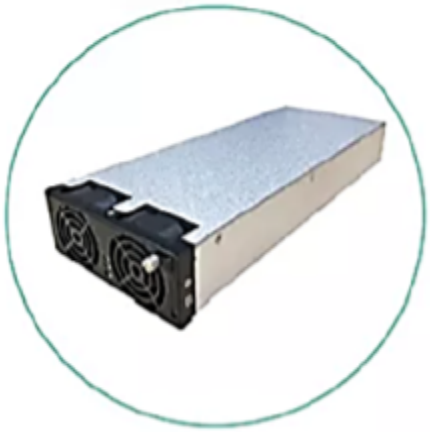
R4850 Rectifier



Specification

Output power	3000W
Rated input voltage	230V
AC Input voltage	80~300VAC
DC Input voltage range	120~425VAC
Operating frequency	47~63Hz
Output voltage range	42~58v
Typical output voltage	53.5v
Efficiency	96%

Product information



BST-R4850H-G2 Electronic Characteristics_48VDC/3000W					
Input	PARAMETER	VALUE	Output	Output voltage range	42~58V
	Rated input voltage	230		Typical output voltage	53.5
	AC input voltage range	80~300		Max output current	62.5
	Operating frequency	47~63		Output power	3000
	DC input voltage range	120~425		Efficiency	≥96% (half load)
	PF	≥0.99		Ripple voltage & noise	≤200
Function	Under voltage protection	80±5V	Environment	Operating temperature	-40 — +75
	Under (recover) voltage	100±5V		Storage temperature	-40 — +85
	Over voltage protection	305±5V		Humidity(Storage)	≤95%
	Under (recover) voltage	290±5V		Altitude	≤2000
	Output over voltage	≥58.5		Cooling	Forced air

Product details

Terminal Pin

Back panel

01 DC Fan

02

03 Aluminim case

04

Obstruction Lights Equipment

Tower Aircraft Warning Supplier Solar Power LED Aviation Obstruction Light

Essential details

Warranty(Year):	1-Year	Color Rendering Index(Ra):	85
Type:	Aviation Obstruction Lights	Support Dimmer:	NO
Lifespan (hours):	50000	Product Weight (kg) :	3.5
Input Voltage(V):	DC 7.2V	Lamp Luminous Flux(lm):	1400
Lamp Luminous Efficiency(lm/w):	120	CRI (Ra):	85
		Color Temperature(CCT):	2000 to 6000
Beam Angle(°):	15	IP Rating:	IP67
Emitting Color:	white,red,amber	Lamp Body Material:	PC
Base Type:	Polycarbonate	Light Source:	LED
Place of Origin:	Shaanxi, China	Brand Name:	DOUBLEWISE
Lighting solutions service:	Solar Obstruction Lighting	LED intensity:	Medium Intensity Aviation Obstruction Light
		Application:	tower, Chimney and high buildings

Features and Benefits

ICAO/FAA flashing patterns and medium-intensity
Solar panel 7.2Wp, replaceable Lithium battery 16Ah/7.2V.
Light Output : 360 ° or Any Sector.
Turns on at dusk and off at dawn automatically or by switch.
Completely self-contained and waterproof IP67.
To Charge under nearly all weather conditions and up to 200 hrs of operating capacity from a full charge.
Lens is poly-carbonate with anti-UV which is produced by Bayer.
Manufactured to ISO9001:2015 QAS .

	Main Specifications
Model / Name	DWS702 / Medium-intensity Solar Obstruction Light
Peak Intensity	2000 cd ±25%
Source	Ultra-intensity LED
Vertical Divergence	±7.5° at 50% intensity
Horizontal Output	360°
Minimum Autonomy	200 Hours
Solar Panel	Mono-crystalline , Maximum Power : 7.2 watts , Efficiency:16%
Battery	Lithium , 16Ah/7.2V,Replaceable
Lens Material / Weight	Polycarbonate / 3.4kg
Waterproof	as per IP67
Patents	Chinese patents: 201320285.73.0 Other patents pending
Optional	GPS Synchronization

Battery Specifications

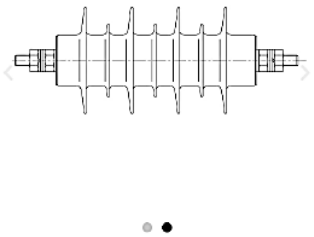
Essential details

Place of Origin:	Guangdong, China	Brand Name:	Woteampower
Model Number:	WT12100-01	Battery Type:	LiFePO4
Product name:	LifePO4 Lithium Battery Pack	Application:	Energy Storage
Type:	Life4po Battery	Voltage:	12V 12.8V
Capacity:	100 Ah	Cycle life:	6000 Times
Protection:	BMS Protection	BMS:	100A or custom
Battery cell:	3.2V 100Ah LifePO4 Prismatic Cell	OEM/ODM:	Accepatable

Specification

item	value
Place of Origin	China
	Guangdong
Brand Name	Woteampower
Model Number	WT12100-01
Battery Type	LiFePO4
Product name	LifePO4 Lithium Battery Pack
Application	Energy Storage
Type	Life4po Battery
Voltage	12V 12.8V
Capacity	100 Ah
Cycle life	6000 Times
Protection	BMS Protection
BMS	100A or custom
Battery cell	3.2V 100Ah LifePO4 Prismatic Cell
OEM/ODM	Accepatable

Lightning Arrester



Technical details

Type	Rated voltage UR (kV)	Continuous operating voltage Uc (kV)	Steep current impulse residual voltage (kV)	Lightning impulse residual voltage (kV)	Switching impulse residual voltage (kV)	Square wave impulse withstand Current (A)	High Current impulse withstand Current (kA)
	kV (r.m.s)		kV ≤			A	kA
HYSW-3	3	2.55	11.3	9	8.9	150	65
HYSW-6	6	5.1	22.6	18	16.8	150	65
HYSW-9	9	7.65	33.7	27	23.8	150	65
HYSW-10	10	8.4	36	30	26.4	150	65
HYSW-11	11	9.4	40	33	30	150	65
HYSW-12	12	10.2	42.2	36	31.7	150	65
HYSW-15	15	12.7	51	45	38.5	150	65
HYSW-18	18	15.3	61.5	54	46.2	150	65
HYSW-21	21	17.0	71.8	63	54.2	150	65
HYSW-24	24	19.5	82	72	62	150	65
HYSW-27	27	22.0	92	81	69.8	150	65
HYSW-30	30	24.4	102	90	79	150	65
HYSW-33	33	27.5	112	99	86.7	150	65
HYSW-36	36	29.0	123	108	92.4	250	65
HY10W-3	3	2.55	11.3	9	8.9	250	100
HY10W-6	6	5.1	22.6	18	16.8	250	100
HY10W-9	9	7.65	33.7	27	23.8	250	100
HY10W-10	10	8.4	36	30	26.4	250	100
HY10W-11	11	9.4	40	33	30	250	100
HY10W-12	12	10.2	42.2	36	31.7	250	100
HY10W-15	15	12.7	51	45	38.5	300	100
HY10W-18	18	15.3	61.5	54	46.2	300	100
HY10W-21	21	17.0	71.8	63	54.2	300	100
HY10W-24	24	19.5	82	72	62	300	100
HY10W-27	27	22.0	92	81	69.8	300	100
HY10W-30	30	24.4	102	90	79	300	100
HY10W-33	33	27.5	112	99	86.7	300	100
HY10W-36	36	29.0	123	108	92.4	300	100

Grounding Kit

Standard Grounding Kit for elliptical waveguide 43

Product Classification

Product Type	Grounding kit

General Specifications

Bonding Conductor Jacketing Material	PVC
Bonding Conductor Material	Copper
Bonding Conductor Wire Size	6 gauge
Cable Type	Elliptical waveguide
Color	Black
Grounding Kit Type	Standard Grounding Kits
Grounding Strap Material	Copper
Lug Attachment	Factory attached
Lug Type	Two-hole lug
Thread Size	3/8 in

Dimensions

Bonding Conductor Length	914.4 mm | 36 in
Cable Jacketing Removal Length, maximum	58.42 mm | 2.3 in
Cable Jacketing Removal Length, minimum	55.88 mm | 2.2 in
Compatible Diameter, maximum	76.454 mm | 3.01 in
Compatible Diameter, minimum	58.674 mm | 2.31 in

Waveguide Size	WR187 | WG12 | R48

Electrical Specifications

Current Handling	Tested to withstand 100,000 amps peak current surge
Current Handling Test Method	MIL-STD-1757
Grounding, Bonding and Shielding Test Method	MIL-STD-188-124A
Lightning Protection Test Method	IEC 1024-1

Material Specifications

Rivet Material	Copper

Environmental Specifications

Operating Temperature	-40 °C to +85 °C (-40 °F to +185 °F)
Storage Temperature	-40 °C to +80 °C (-40 °F to +176 °F)
Blowing Rain Test Method	MIL-STD-810, Method 506
Corrosion Test Method	MIL-STD-1344, Method 1001
Freezing Rain/Icing Test Method	MIL-STD-810, Method 521
Humidity Test Method	MIL-STD-1344, Method 1002
Immersion Test Method	IEC 60529:2001, IP68
UV Resistance Test Method	MIL-STD-810, Method 505
Vibration Test Method	MIL-STD-202, Method 214
Weatherproofing Method	Butyl and electric tape

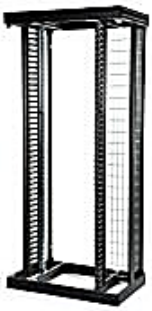
Packaging and Weights

Height, packed	266.7 mm | 10.5 in
Width, packed	266.7 mm | 10.5 in
Length, packed	58.42 mm | 2.3 in
Included	Grounding kit | Hardware | Lug | One roll of 2 in PVC tape | One roll of 24 in butyl rubber tape
Packaging quantity	1
Weight, gross	0.81 kg | 1.786 lb

Shelter Specifications

Performance:	
Air cooling system for two pieces	Follow clients requirements(ex:Constant +25 C in the cabinet /to work 220V/ position in the picture
Sensors with NC contact of output relay (Normal close)	Follow clients requirements(ex:smoke detector, door sensor, water sensor,temperature sensor e.g...
Working temperature	Follow clients requirements (ex:(-50C+65C) - no thermal loss
Storage temperature	Follow clients requirements (ex:Give us the requirement
Wind resistance	Follow clients requirements(ex:Must be wind resistant. Please give more information on this requirement, as how the offered shelter will fulfill this requirement
Fire resistance	Follow clients requirements(ex:Must be fire resistant.
Earth-quake resistance	Follow clients requirements(ex:Not less than level 8 resistant.
Water proof	Follow clients requirements(ex:Must be water resistant.
Sunlight resistance	Follow clients requirements(ex:Must be protected from sunlight.

Rack Specifications



NETpodium™ Rack, 2200 mm x 1000 mm x 600 mm, black

Product Classification

Regional Availability	Australia/New Zealand | EMEA
Portfolio	NETCONNECT®
Product Type	Rack
Product Brand	NETpodium™
Product Series	NETpodium

General Specifications

Color	Black
Rack Units	45

Dimensions

Height	2200 mm | 86.614 in
Width	1000 mm | 39.37 in
Depth	600 mm | 23.622 in

Packaging and Weights

Packaging quantity	1
Packaging Type	Kit

Regulatory Compliance/Certifications

Agency	Classification
CHINA-ROHS	Below maximum concentration value
REACH-SVHC	Compliant as per SVHC revision on www.commscope.com/ProductCompliance
ROHS	Compliant

LSA-PLUS® Distribution Rack, for holding standard and PROFIL modules series 2, black

Product Classification

Regional Availability	EMEA
Product Type	Rack
Product Brand	LSA-PLUS®
Product Series	LSA-PLUS

General Specifications

Application	For use with LSA-PLUS modules
Color	Black
Mounting	Wall
Orientation	Vertical

Dimensions

Height	2004 mm | 78.898 in
Width	560 mm | 22.047 in
Depth	150 mm | 5.906 in

Material Specifications

Material Type	Steel