User Manual

WaveRider® *LPA_Tool™*

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Disclaimer

The WaveRider LPA_Tool program is provided as a system design and analysis guide for use by Authorized Partners. Before using this tool, it is highly recommended the intended user attend the WaveRider Communications Inc. training course. The LPA Tool is designed for use with only WaveRider Products. While every effort has been made to avoid errors or inaccuracies, in no event shall WaveRider Communications Inc. be responsible or liable for any damages arising from the use of the LPA_Tool program, whether such damages be direct, indirect, consequential or otherwise.

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WaveRider
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1. Overview

The WaveRider *Link Path Analysis Tool* was developed for use with the NCL family of products for Point-to-Point link analysis and design. These wireless products work in the 2.4 GHz ISM band. The LPA Tool is to be used with the WaveRider Communications Inc. System Planner. The System Planner series of documents include the definitions for all terms used in this document. It provides the user with all the essential tools for designing an NCL link. These include Link Budget, Path Length and Antenna Azimuth/Elevation calculation, First Fresnel Zone and required Antenna Height calculation, and Fade Margin estimation for a given path length. There are two versions, one to support FCC & Industry Canada Regulations (LPA v2-0.xls) and one for other regulatory bodies (LPA INT v2-0.xls).

On each worksheet there is a conversion calculator to convert metric to imperial and vice versa for the user's convenience.

2. System Requirements

- IBM PC or compatible with Windows 95 and Microsoft Excel installed
- Mouse or pointing device required.
- Printer recommended

3. Installation

Open either of the LPA_Tool.xls files in Microsoft ® Excel. The program was developed using Excel 97 and macros must be enabled to operate correctly.

4. Operation

The LPA_Tool program consists of a Microsoft Excel file with special-purpose worksheets labelled as follows:

1. General Data [main sheet for data entry]
2. Calc - General [determine Fresnel zone radius with or without obstructions]
3. Cable, ant, amp [reference only]
4. Coor & Elev [calculate distance and bearing based on deg. min. sec. & antenna elevation angle]
5. FCC [reference only]

The worksheets are inter-linked in one or more ways.

There are comments within cells to farther explain their use.

User entry cells are indicated by blue text, all other cells are locked.

Calculated cells are indicated with yellow fill, these cannot be altered.

The LPA_Tool program may be used either as a *design* tool or for the purpose of link *analysis*. For analysis, the existing known parameters are entered and the resulting performance limits quantified.

For design, *what-if* scenarios may be compared and the viability of any given proposed design quickly determined.

4.1 General Data

The General Data sheet is used for entering such parameters as model number, path length, transmission cable type and lengths, antenna type with gain, amplifiers, etc. The design criterion is based on full data throughput of the WaveRider product used. See figure 1.

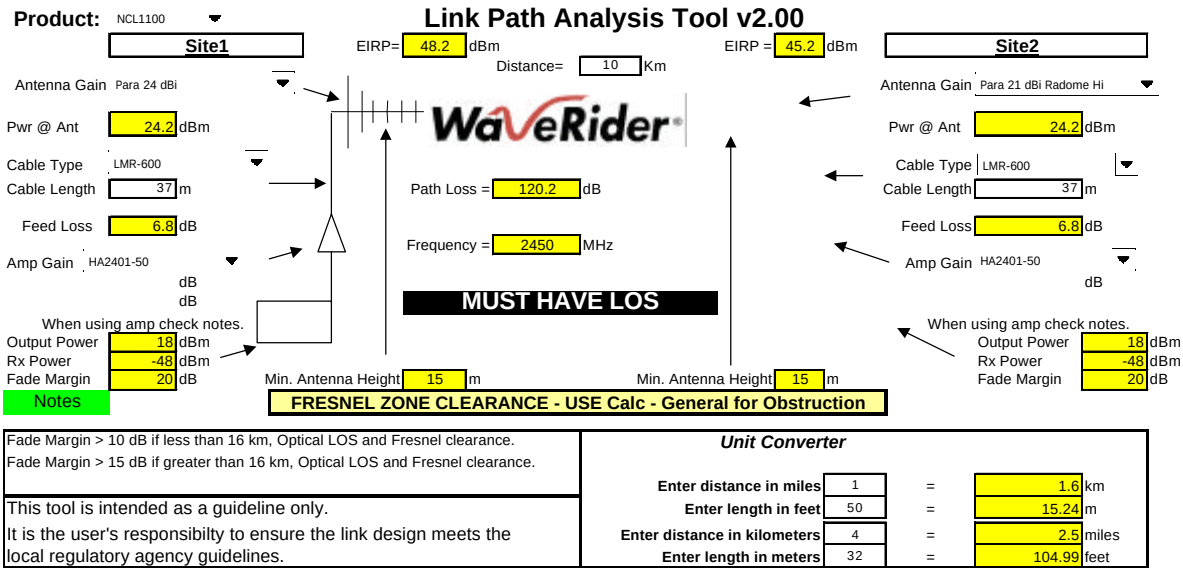


Figure 1. General Data Entry

Flat Fade margin is calculated based on the link budget parameters entered. The recommended fade margins are listed. The minimum Fade Margin recommended is 10 dB. This allows for component tolerances and installation degradation as well as Fresnel zone infractions.

The minimum antenna height is also displayed based on 60% of the first Fresnel zone radius plus 3 meters including obstruction clearance if entered.

Procedure:

1. Select NCL product - NCL1100 11Mbps, NCL200 2 Mbps, NCL135.
2. Type in the site names.
3. Enter the path distance - you may use the calculated value from the Coor & Elev worksheet. The maximum practical distance is 16 Km. Use the calculator to convert between Imperial and metric if required.
4. Enter the cable length that will be required to connect the antenna to the radio. Allow for drip loops and strain relief. There is a 1.5 dB factor added to the feed loss to allow for connectors and lightning arrestors. Use the calculator to convert between Imperial and metric units if required.
5. Choose the antenna from the pull-down menu. If not available, use the Other selection and enter the gain.
6. Choose the cable type from the pull-down menu. If not available, use the Other selection and enter the attenuation db per meter.

7. Choose the amplifier type from the pull-down menu. If not available, use the Other selection and enter the Tx (forward) and Rx (reverse) gain. Be sure to use the effective receive gain of the amplifier.
8. The goal is to achieve the desired fade margin by adjusting antenna gain, cable type and the use of an amplifier. When designing radio links, the following should be taken into consideration:
    - Design for the system requirement. Plan ahead for growth.
    - Do not over-power the design. More power is not always better. You may cause interference to your neighbors as well as other links that may be yours.
    - Ensure that the **E**ffective**I**sotropic**R**adiated**P**ower is in the stated limits of your local regulatory guideline.
    - If using amplifiers, be sure not to saturate the amplifier and end up putting it in to compression. Follow the guideline in the notes. The note displays which amplifier to use according to the feed loss. Amplifiers will not perform to specification when too much power is applied to them. This causes the amplifier to work in its non-linear range.
    - It is better to use higher gain antennas and larger diameter coaxial cable to achieve the fade margin rather than amplifiers. This will be based on the cost.
    - If area coverage is required, use sectoral antennas as opposed to omni-directional. The sectoral antennas allow for growth both in distance and user-capacity without disrupting the existing network.
9. To order the designed system components, refer to the SKU numbers listed in the worksheet Cable, ant, amps.

4.2 Calc - General

This sheet allows the user to see which values are used for the link budget. The user can also enter any obstruction information to determine the minimum antenna height for Fresnel zone clearance. See figure 2.

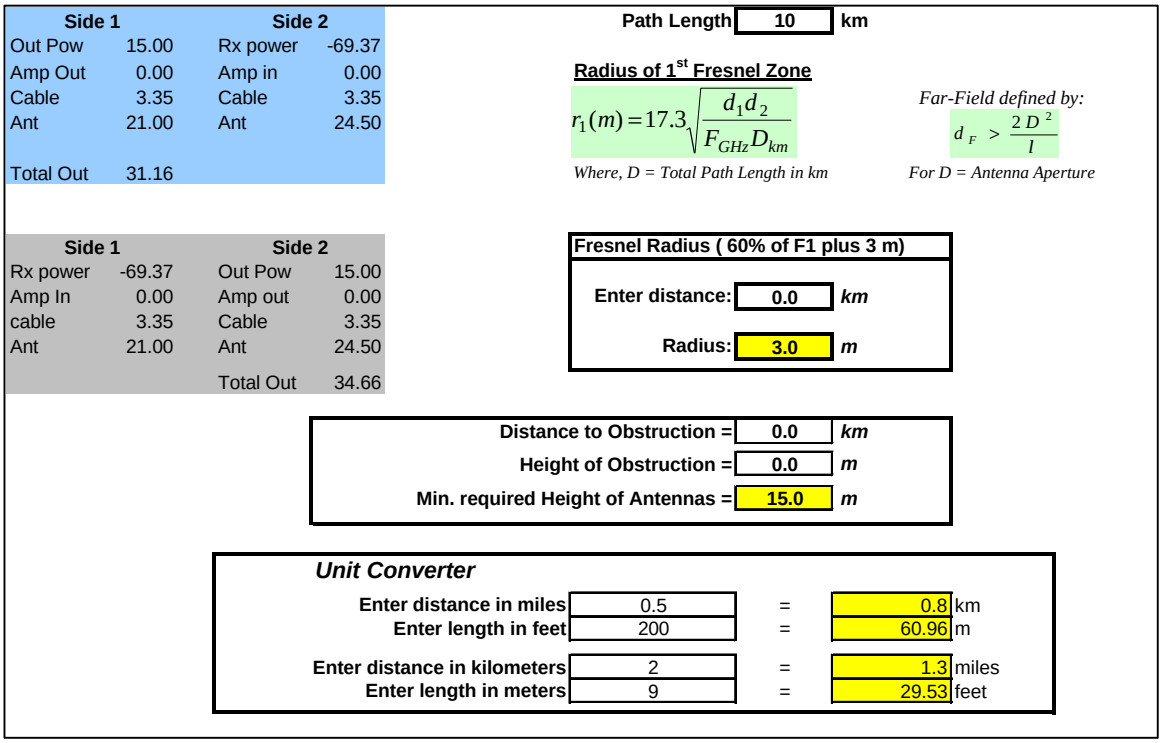


Figure 2. Calc - General entry.

Procedure:

1. Enter the distance of interest for Fresnel radius. Do not exceed the path length.
2. Enter the distance and height of the suspected (or confirmed) obstruction along path. Choose one most likely to obstruct the First Fresnel Zone if several exist. If this is difficult to determine, repeat the process for each suspected obstruction along the path.

Antenna height is determined by the following considerations:

- First Fresnel Zone evaluation
- Earth curvature between the sites
- Obstacles in the path between sites

4.3 Cable, ant, amps

This worksheet is for reference only. It lists the components used in designing the P2P link.

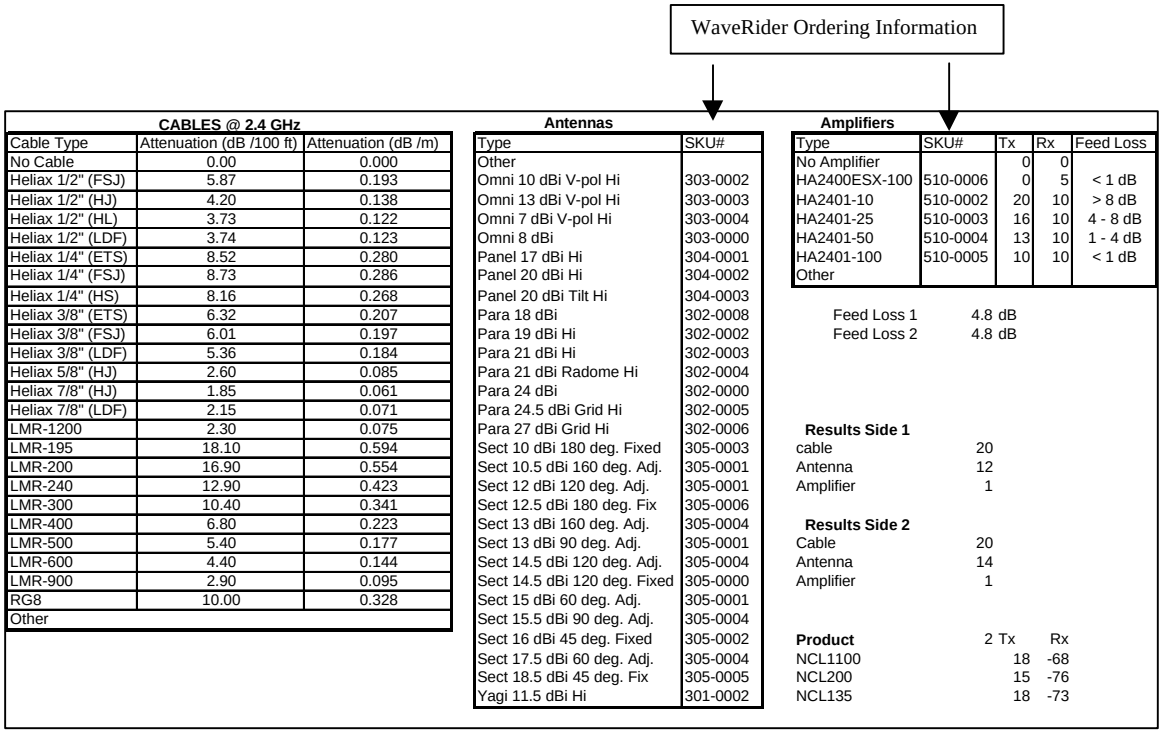
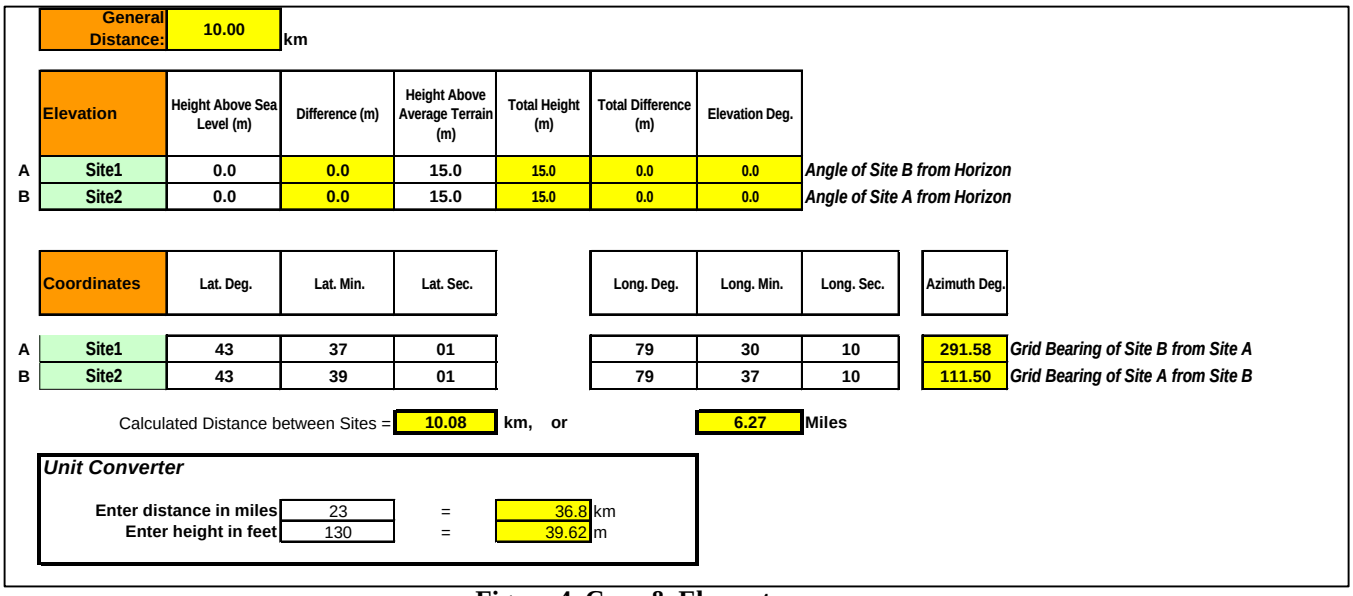


Figure 3. Cable, ant, amps Reference screen.

4.4 Coor & Elev

When the site coordinates are known, the path length and site azimuth (one from the other) may be calculated using the *Path Length Calc*. sheet. See figure 4.



	General Distance:	10.00	km							
	Elevation	Height Above Sea Level (m)	Difference (m)	Height Above Average Terrain (m)	Total Height (m)	Total Difference (m)	Elevation Deg.			
A	Site1	0.0	0.0	15.0	15.0	0.0	0.0	*Angle of Site B from Horizon*		
B	Site2	0.0	0.0	15.0	15.0	0.0	0.0	*Angle of Site A from Horizon*		
	Coordinates	Lat. Deg.	Lat. Min.	Lat. Sec.		Long. Deg.	Long. Min.	Long. Sec.	Azimuth Deg.	
A	Site1	43	37	01		79	30	10	291.58	*Grid Bearing of Site B from Site A*
B	Site2	43	39	01		79	37	10	111.50	*Grid Bearing of Site A from Site B*

Calculated Distance between Sites = 10.08 km, or 6.27 Miles

Unit Converter

Enter distance in miles	23	=	36.8 km
Enter height in feet	130	=	39.62 m

Figure 4. Coor & Elev entry.

Select the *Coor & Elev* sheet and enter the *Latitude* and *Longitude* for each site.

The distance between sites is automatically calculated and displayed in kilometres and miles. The azimuth bearing readings are also displayed. The path length must be entered in the General Data worksheet. The calculated distance is not linked to the General Data worksheet's Distance cell.

The elevation angle can also be calculated entering the height above mean sea level and the height above average terrain. The distance for this calculation is based on the General Data Distance.

4.5 FCC

This worksheet is for reference only. See figure 5.

2.400 - 2.4835 GHz

	Power (mW)	Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
FCC Start	1000.0	30.0	6.0	36.0
	794.3	29.0	9.0	38.0
	631.0	28.0	12.0	40.0
	501.2	27.0	15.0	42.0
	398.1	26.0	18.0	44.0
	316.2	25.0	21.0	46.0
	251.2	24.0	24.0	48.0
	199.5	23.0	27.0	50.0
	100.0	20.0	36.0	56.0
NCL135/1100	63.1	18.0	42.0	60.0
NCL200	31.6	15.0	51.0	66.0

From 15.249 Pgs. 690-692
Field strength of fundamental at 3 meters is 50 mV/m, of harmonics 500 uV/m.
In P2P, for every 3 dB increase in antenna gain, decrease the intentional radiator by 1 dB.

Figure 5. FCC Reference.