WaveRider®

NCL135 VAR Installation Guide

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VAR Installation Guide

1. Introduction

Overview

The WaveRider VAR program is designed to provide comprehensive Sales and Technical Training. The VAR Installation Guide is provided as part of the Technical Training program, and details all the necessary information and material identified by WaveRider to be required in completing a professional System installation.

The VAR Installation Guide is designed to be used in conjunction with the VAR Site Survey Guide and is part of the following set of documentation:

- **NCL135 System Planner** - *WaveRider document* #9902VAR001
- **WaveRider Site Survey Guide** - *WaveRider document* #9902VAR002
- **VAR Installation Guide** - *WaveRider document* #9902VAR003
- **WaveRider Systems Approach** - *WaveRider document* #9902VAR004

2. Recommended Equipment and Material

The following is a recommended list of equipment for use in the design and deployment of an NCL135-based system. It should be noted that all equipment is not absolutely necessary in all cases, but the list should be viewed as a comprehensive collection of the tools and material likely to prove most useful in system deployment.

1. Spectrum Analyser (3GHz)

   The Spectrum Analyser is arguably one of the most useful tools in the Installer's 'bag-of-tricks'. With this single tool, the Installer can measure Transmitter output and Receiver input signal levels, and evaluate the general RF environment (interference troubleshooting, etc.)

2. Strobe Light, Flashlight, Mirror

   Useful for evaluating Line-of-Sight conditions between potential sites

3. Digital Voltmeter (DVM)

   Used for general AC/DC Voltage, Current and Resistance measurements

4. Ground Resistance Meter

   Used for ground conductivity measurements.

5. Measuring Tape, minimum 10m or 25ft length.
6. Topographic map(s) 1:50,000 or better. Alternatively, computer based Path Profile analysis software, e.g., PathLoss® with appropriate database.
7. Hand-held GPS unit, or compass
8. Altimeter or Elevation Gauge (sextant type?)

9. RF Signal Level Meter (3GHz)
10. Notebook PC for configuration and commissioning of NCL135's

    Must have an available Serial Port (RS-232, DB-9)
11. Software: NCL135 configuration utilities
12. Transmission Cable: LMR400, LMR600, etc.

    This cable connects Transceiver to antenna. Note: Special attention must be paid to the +36dBm EIRP limit imposed by FCC and Industry Canada regulations.
13. Connectors

    N-Type and Reverse-Polarity TNC connectors are required to complete the link between Transceiver and antenna. Also useful is an adaptor (reverse TNC terminations required), allowing the insertion of a fixed-value attenuator for the evaluation of Fade Margin..
14. Miscellaneous installation hardware

    Clamps, weatherproofing tape, grounding cable, etc.

3. Site Survey

The Site Survey is a critical step in the successful deployment of an NCL135-based system. It is important in that it will yield a quick assessment of the feasibility of any given proposed site antenna and equipment location. For further details, refer to the **WaveRider Site Survey Guide**, WaveRider document # 9902VAR002.

4. Line-of-Sight (LOS)

In general, Line-of-Sight is necessary for communication in the 2.4GHz frequency region. Strictly speaking, this is *not* true. The fact of the matter is that at any frequency, it is possible for communication to occur without LOS conditions. Why? Diffraction loss is a phenomenon that may be predicted and observed for all electromagnetic waves. While this causes some hindrance to system design and operation at lower frequencies, it is extremely destructive (i.e., signal attenuation is extreme) at higher frequencies, to the point that relative to normal system design goals, communications coverage in such 'shadowed' areas may be disregarded for signals above approximately 1GHz. Actually, for relatively short distances, providing the transmitter EIRP is sufficiently high, communication is possible through walls and around corners.

Thus, for all practical purposes, and certainly for *point-to-point* or *point-to-multipoint* links, we must assume that LOS is a mandatory requirement.

4.1 Optical LOS

How do we determine whether LOS exists?

The first step in establishing that Optical LOS exists is to determine whether one site (proposed antenna location) is visible from the other. This can be easily confirmed using a high-power Flashlight, or if the weather conditions permit (bright sun), a Mirror. If conditions are foggy or hazy, a Strobe light may suffice.

4.2 Radio LOS

With optical LOS established, the next step is to qualify the path in terms of *Fresnel Zone* clearance. In other words, does Radio LOS exist?

The Fresnel Zones are successive regions where secondary waves (waves other than the *direct* or straight-line wave) have a path length from transmitter to receiver which are $n l/2$[1] greater than the total path length of a line-of-sight path. Successive Fresnel zones have the effect of alternately providing *constructive* and *destructive* interference to the total received signal.

Thus, the Fresnel Zones exist as co-axial *ellipsoids* connecting the two antennae. The maximum diameter of each ellipsoid is located at the centre point of the ellipsoid's axis, and increases as the distance between the antennae increases.

Typically, for optimally designed microwave paths, *at least 60%* of the first Fresnel Zone must be free of obstructions. Any further clearance will yield negligible improvement in the received signal level. For maximum link reliability, the entire first Fresnel zone should be free of obstructions.

A hand-held GPS unit is very useful in determining the distance to potential obstructions. When the distance is determined. Use the WaveRider Link Path Analysis Tool to calculate the first Fresnel Zone radius at a given distance from either antenna.

Radio LOS = Optical LOS + First Fresnel Zone Clearance

[1] *l is the wavelength of the signal. At 2.4GHz, the signal wavelength is approximately 12cm.*

5. Installation, Set-up and Operation of the NCL135

For details of the NCL135 Set-up and Operation, refer to the NCL135 Operators Manual.

The following sections provide information on the Installation of the NCL135.

5.1 Physical Considerations

The NCL135 is a compact unit measuring approximately 22cm x 24cm x 4cm (8¾ in. x 1¾ in. x 9½ in). The units are provided with rubber feet and may be stacked vertically.

Pay special attention to the transmission cable bend-radius limitations. A transmission cable under such stress may exhibit poor VSWR / Return Loss characteristics and may even be permanently damaged at areas exceeding specified bend-radius limits.

5.2 Antenna Installation

The antenna should be installed with a view to optimising Line-of-Sight conditions, while minimising transmission line length. Among the most critical factors in the installation are:

- Proper aiming of the antenna to obtain the required link budget, or system coverage target(s).

  Note that with Omni-directional antennas, it is <u>*absolutely critical*</u> to ensure that the unit is vertical. *If this is not achieved, alignment errors can easily translate into severe signal loss*. The use of a surveyor's transit (Theodolite) or similar equipment to ensure accurate alignment is highly recommended.

- Mechanical robustness of the installation to ensure longevity of the above. Changes in antenna *azimuth* (horizontal plane) and *elevation* (vertical plane) may effect variations in coverage sufficient to cause system performance degradation.
- Electrical integrity of the transmission line connection, including grounding as may be required.
- Protection from environmental influences – snow, ice build-up, wind-load.

5.3 Transmission Line Installation

The transmission line must be installed with a view to optimising both electrical and mechanical integrity. Special attention must be paid to the following issues:

- Line lengths must be sufficient to allow all bends to be made within the manufacturers' bend-radius restrictions.
- Connectors used must be matched to cable dimensions. This will ensure minimal mechanical stress and optimum electrical contact, especially of the outer shield.
- Drip-loops should be used to reduce the possibility of water ingress into cable entry ports.
- Protect all connector junctions by wrapping in weatherproofing (mastic type) tape. This tape is designed to be non-hardening over time. However, do not assume that a given connector junction will not ever be exposed to moisture, even when indoors. If any environment is questionable, sealing the connector junction is advisable.

<u>Note</u>: In general, it is better to use a longer ethernet cable in order to minimise transmission line length.

5.4 Heating, Ventilation and Air Conditioning (HVAC)

The HVAC considerations for the NCL135 are relatively trivial in comparison with typical installed equipment, but it is nevertheless worthwhile documenting the prevailing environmental conditions, especially in the event that the equipment is installed in an equipment room, for example, not normally occupied by people.

The requirements for the NCL135 are as follows:

Operating Temperature range: min. 0º, max. +65ºC

Humidity: 10% to 90%, non-condensing

In the absence of specific environmental data, a good indication of its suitability is when the intended area is comfortable enough for normal occupancy.

Beware of installing the NCL135 where temperature swings are likely to be extreme, e.g.:

- Directly in front of cooling and/or heating ducts
- In Direct sunlight, especially while installed in confined space (greenhouse effect)

5.5 Grounding and Lightning Protection

Grounding is an extremely important topic and as such merits special consideration. A properly grounded system will typically exhibit lower noise, as well as lower risk of damage due to transients. While no lightning protection scheme is absolutely foolproof, when proper grounding is combined with judiciously applied lightning arrestor(s), the system is optimally protected against damage due to lightning strikes.

The lightning arrestor ground should be attached within two (2) feet of the first entry point into the building or structure housing the NCL135 system. Typically, the ground used may be the building structural steel or existing lightning arrestor ground conductors. *Do not use water pipes, gas lines, or electrical system conduit*.

Be sure to check the local electrical code for governing regulations!

In cases where the ground conditions are in question, a ground resistance measurement must be done. This requires specialised equipment and is best performed by the appropriate qualified contractor. If necessary, a separate ground must be specially installed.

Attached is a collection of relevant literature produced by PolyPhaser® Corporation. Further information may be obtained from their web site at www.polyphaser.com.

5.6 System Tests – *Optimization and Commissioning*

Optimization

After the installation has been completed, the next step is to confirm and optimize performance. By way of objective measurement of the appropriate parameter(s) – parameters such as link receive signal levels, and data throughput, for each link in the system.

FTP Test

The FTP test is commonly used to quantify link performance. While not a true 'benchmark' type test, it will without the necessity of specialised equipment readily facilitate the quick evaluation of system throughput performance.

The most reliable application of this test involves the use of the same known source of data as well as the same equipment (test computers, software, etc.) so that as far as possible the sources of error in the measurement are constant.

RSSI Data Logging

The NCL135 is equipped with an on-board signal level measurement tool. This may be invoked by using the console (RS232, DB-9 serial port) input and the necessary commands. Refer to the NCL135 Set-Up Guide for further details.

RSSI data logging is used to obtain a long-term record of link performance. It may be obtained either on-site (connecting a computer directly to the serial Console port), or remotely using a dial-up modem attached to the console port, or via Telnet to the NCL135.

Commissioning

System Commissioning refers to the collecting of performance data over time. WaveRider recommends the collection of data for a minimum of 7 days. This will reveal any problems of a cyclic nature; e.g., interference which appears periodically and predictably. Performance under extreme weather conditions is also of critical importance as it may affect System *Availability*. For further information on this topic, refer to the **WaveRider System Planner**.

APPENDIX A: Regulatory Issues

FCC

The NCL135 is approved under FCC Part 15, as a Class B device. This means that the NCL135 is approved for use in residential as well as commercial environments.

Industry Canada

In Canada the NCL135 is approved under RSS139 (for licensed operation) and RSS210 (unlicensed operation).

Licensing

Operation in the unlicensed ISM 2.4GHz band requires no special authorisation from the FCC or Industry Canada. It should be noted, however, that in Canada the 2400 – 2483.5 MHz band is divided into *licensed* and *unlicensed* portions.

Operation in the lower sub-band, or 2400 to 2450MHz requires approval from Industry Canada. Operation in the upper sub-band or 2450 to 2483.5MHz is licence-free.

- **RSS139** approval is required for operation either in the licensed sub-band 2400 to 2450 MHz, or over the entire range 2400 to 2483.5 MHz.
- **RSS210** approval is required for operation in the unlicensed sub-band

***IMPORTANT*: The local licensing requirements should be verified in the intended area of operation before deploying an NCL135 system.**

Municipal By-Laws

Municipal by-laws are potentially the source of significant impediments to system deployment. Most notably are the by-laws that restrict the type and/or appearance of antenna and external structures in general. Fortunately, the frequency of operation and nature of system design allow the use of smaller and more inconspicuous antennas.

Notwithstanding the above, the VAR should be sure to confirm local regulations *before* system deployment.

The Electrical Code

The local Electrical Code typically governs ground installations among many other things. The VAR must be familiar with the specific areas of the code that might potentially affect the proper installation of ground connections, most importantly at the lightning arrestor installation point(s).

APPENDIX B: Fresnel Zones

The radius of the first Fresnel zone at any point ‘X’ along a path connecting two sites, distance d_1, d_2 km from the respective sites, is given by:

$$r_1(m) = 17.3\sqrt{\frac{d_1 d_2}{F_{GHz} D_{km}}}$$

where,

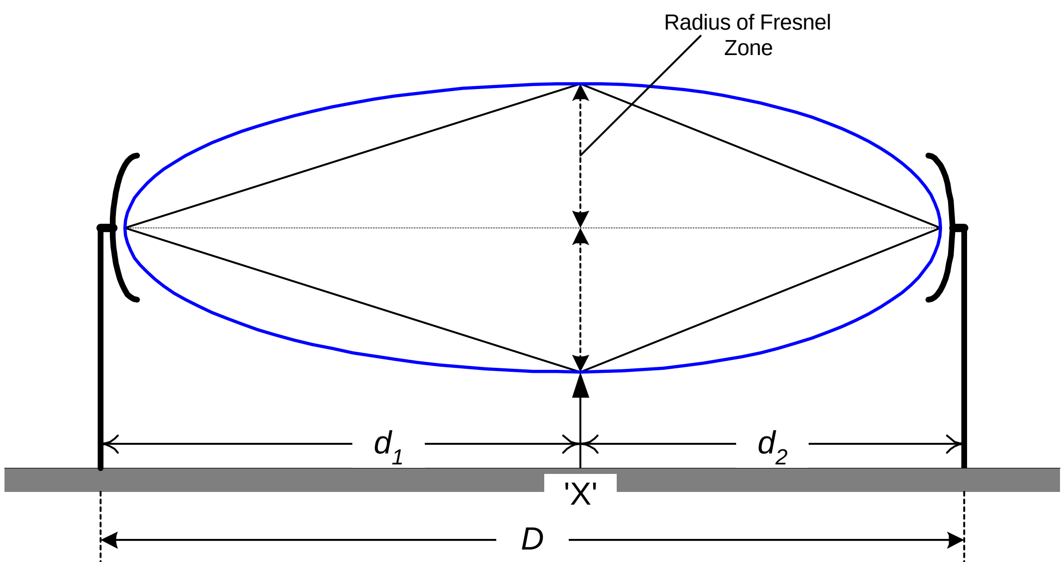
D = Total Path Length in km,

F = Frequency in GHz,

d = distance to point ‘X’ in km

Further, the radius r_n of the n^{th} Fresnel Zone is given by,

$$r_n(m) = r_1\sqrt{n}$$



APPENDIX C: