
Technical Note

Transmission Line Selection for Exalt Indoor Radio Systems

Applicable Products: EX-i Series

Abstract

This technical note describes the basics of transmission line design and selection for Exalt terrestrial microwave radio system deployments. Requirements and recommendations are discussed.

Introduction

Transmission line is the term used to describe the cable or waveguide that is connected between the antenna and a radio's RF antenna port. This term can also be applied to cables used between indoor units and outdoor units for two-piece (split-mount) radio systems. The selection of the proper transmission line is critical to the performance, availability and reliability of your microwave radio installation.

Critical Elements

There are several elements that need to be considered when selecting transmission line. These elements are briefly discussed here.



Coaxial Cable (HELIAX)



Waveguide

Photos courtesy of Andrew Corporation. HELIAX is a registered trademark of Andrew Corporation

Size

For waveguide, the frequency range is very specific. You must select waveguide that is specified over at least the entire frequency range of the radio system. For coax, a 'cutoff frequency' specification limits the maximum frequency for a given diameter. The larger the diameter of the coax cable, the lower the signal loss will be. It is thus recommended that the largest diameter coax cable that meets the frequency specifications be used, so as to minimize losses.

There may be practical limits to coax diameter based on the physical requirements for the installation. For example, larger diameter coax is less flexible and may make egress and cable installation more challenging. In some cases, a mixture of cable diameters may be the best approach for different segments of the transmission line run. For example, a large diameter cable can be used from the antenna to the egress point of the building or shelter (as there are likely no significant bending radius requirements along the outdoor run). From the egress point to the radio rack or cabinet, a medium diameter cable might be chosen to accommodate the egress bend and additional bends that may be required to route the cable through cable trays and conduit. Finally, a smaller diameter might be chosen for a jumper to the radio rack or cabinet to accommodate the tighter bend radius that may be needed at this location.

If multiple cables and/or cable types are planned, make sure that all cables and connectors are accounted for in the link budget calculation.

Termination (connectors)



Most Exalt radio systems require N-type male connections on both ends of the coax cable. For waveguide, flanges will need to be installed on the waveguide and adapters will be needed on one or both ends to convert to an N connector. The termination mechanics are critical when selecting particular vendors for the transmission line, connectors and tools required to perform termination.

Almost every brand and type of transmission line requires special training, special tools and significant practice to ensure high quality termination. Improper termination will result in significant radio system problems and these factors should not be ignored. Therefore an installer should seek proper training for the brand(s) that they intend to install and also must invest in the specific tools that will be needed for termination. It is important to match the proper transmission line to the proper termination tools and the proper connector style. If specialized adapters or connectors are required for the installation, such as a right-angle connector, the specifications for that connector must meet or exceed all the requirements of the radio system and the local environment.

Lightning Protection



Lightning damages telecommunications and data networking equipment all over the world every day. In addition to the obvious safety issues, a systems integrator should have as a goal the prevention of system down-time, as it causes lost revenue and even worse, potential loss of reputation in a competitive market. The proper installation of lightning protection on the RF cable system is crucial to protecting mission-critical microwave backhaul systems.

Additionally, most vendors' warranties do not cover damage induced by lightning strikes. A properly grounded coaxial surge suppressor installed at the cable's egress point of the building or shelter provides the needed protection in the event of a nearby lightning strike. Always ensure that the chosen surge arrester is rated over the operating frequency range of the radio system and that all losses incurred from the protection devices and additional connectors are accounted for in the link budget. Vendors offering appropriate surge suppressors for the EX-2.4i, EX-4.9i and EX-5i radio systems include Polyphaser, Andrew Corporation and Huber-Suhner.

Other Considerations

Outdoor connections need to be waterproof. The choice of transmission line and connector, along with the associated weatherproofing kit that may be provided, will need to be considered. Indoor cable runs may be required to be fire-retardant and/or constructed of particular materials to conform to building codes. Shielding style may also be critical, especially when radio systems are collocated with high-power RF equipment such as radars, radio/television, cellular base stations and paging transmitters. Some cables use solid copper shields that better isolate these signals from the radio system as compared to braided shields.

Guidance

As mentioned above, the use of the largest diameter (lowest loss) transmission line possible is recommended, especially in the 4.9 and 5 GHz bands.

Coax Cable Signal Loss (attenuation) in dB per 100'				
Frequency	3/8"	1/2"	5/8"	7/8"
2450 MHz	6.7	4.4	3	2.2
5300 MHz	10.3	6.9	4.6	N/A
5550 MHz	10.6	7.1	4.7	N/A
5800 MHz	10.8	7.3	4.9	N/A

Clearly, there may be physical restrictions to the transmission line diameter that can be installed. Also, the combined costs of the cable, connectors, shipping and installation will generally increase as the diameter increases. Following this rule of thumb for minimum loss and maximum diameter, the following are the diameters typically recommended for Exalt microwave radio systems:

- 2.4 GHz (2400-2483.5 MHz): 1/2-inch (larger diameters can be used, but will provide minimal additional benefit). 5/8-inch should be considered for commonality with 5 GHz systems for upgrade/re-use opportunity.
- 4.9 and 5 GHz (all bands): 5/8-inch (larger diameters cannot be used, as the cutoff frequency will be below the operating frequency).

The choice of transmission line is critical for long cable runs and/or long paths, as the losses associated with these two factors accumulate quickly. For any system, the transmission line lengths and associated losses should be kept to a minimum wherever possible or practical, especially for long paths.

The staff at Exalt has significant experience in the areas of engineering and implementation of microwave radio systems and has had opportunity to work with transmission line products from a number of vendors. While Exalt does not promote any particular vendor, there are several that have consistently demonstrated the exceptional product performance and customer support that are needed when designing and building carrier-class microwave networks.

Andrew Corporation - www.andrew.com
Times Microwave Systems - www.timesmicrowave.com
Eupen - www.eupencable.com
Commscope - www.commscope.com
Radio Frequency Systems - www.rfsworld.com
NK Cables - www.nkcablesusa.com

There are, of course, numerous other cable vendors, many of whom offer high quality transmission line products and strong customer support.