MOTOROLA

Network Solutions Sector

iDEN® Update: EBTS

Title: Recommended Coax and Connectors for iDEN EBTS

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Update Overview

There has been some uncertainty concerning the performance requirements for coaxial cable and connectors with regards to the EBTS. The following explains some of the issues to consider in making the selection.

There are many factors to consider when selecting coaxial cable and connectors to be used within an iDEN EBTS site. Some of the factors involved are cost, ease of installation, degradation due to time and weathering, and RF performance. The two types of coaxial cable that will be discussed have a single inner conductor and outer conductor, and those with multiple layer or braided metallic outer conductors.

A. Intermodulation

Most of the sites utilized in the wireless industry involve several transmitters. When these multiple signals are present at differing but close spaced frequencies, any non-linearity will cause the potential for intermodulation products to develop that can be potentially destructive to receivers either on or close to the site. Serious contributors in a radio system are usually the active elements in the transmitters and receivers. After appropriate techniques have been applied to deal with these, there will still be passive elements that must have minimal potential for generating these intermodulation signals. In passive components such as coaxial cables and connectors, intermodulation generation is usually caused by either ferromagnetic materials (e.g., nickel plating), or by thin surface oxide layers at junctions between conductors. Where currents have to cross a junction between one conducting element and another, i.e. cable connector interface, the oxide layer that is always present provides some rectifying action. Significant intermodulation generation can follow unless the problem is overcome at the component design stage. Junctions between elements require high metal to metal contact pressure be established. Coaxial cables using single inner and single outer conductors eliminate the conductor junctions for current and thereby minimize the potential for intermodulation. Performance testing and specifications of the two types of coax confirm that the single inner and outer conductor type will perform better by up to 30 dB. These measurement differences may increase as weathering causes greater oxidation between the dissimilar metal shields for the multi-layer coax. At a typical EBTS site, assuming 50 dB isolation between antennas could produce a third order IM level of approximately -75 dBm. A tolerable level for an iDEN or Cellular receiver would be -80 dBm. Higher order mixes are not a problem since they would be far below this level.

B. Transmitters Using Separate Antennas From Receivers

There has been a past philosophy that using separate transmitter and receive antennas can prevent IM. The following compares two iDEN systems using three antennas:
1) Tx Antenna with eight transmitters and two Rx antennas,
2) Two antennas with four Tx each duplexed with Rx and the 3^{rd} antenna with Rx only, yet capable of duplexing four more transmitters.

1. A system having eight transmitters on one antenna requires cavity combining in order to minimize insertion loss and achieve path balance. It also increases the potential number of intermodulation (IM) products that can occur in the antenna system by a multiple of more than 9. For example, 8 transmitters can produce a total of 224 3rd order products on one antenna, whereas four transmitters can produce 24 3rd order products each for a total of 48 on two antennas. This large disparity in number of IM products is important since IM mixes are typically additive. If the purpose of separating the Tx from the receive antennas in an iDEN system is to remove internal IM potential, this configuration will help by virtue of the antenna isolation. However, the products that would be generated within the iDEN band are generally high order (7th or greater) products, which are typically low level.

2. In addition to the internal iDEN IM potential mentioned above, there are more serious IM products to consider. The IM, if generated in the antenna system, can produce 3^{rd} order products which can be potentially harmful to nearby cellular channels or other adjacent frequency bands. This situation must be corrected since the products are strong enough that even normal antenna separation on the same site may not help. In addition to increasing IM potential, connecting eight transmitters to one antenna can cause parts to fail in the antenna system; due to exceeding peak power and peak voltage limits.

3 Basically any IM generated as harmful to the iDEN EBTS would have to come from failed elements within the antenna system, since the RFDS is designed to provide protection against IM from occurring within the EBTS. The IM source must be corrected to prevent potentially harmful interference; whether four transmitters are duplexed or eight transmitters use their own antenna. Therefore the prime reason of using separate transmit and receive antennas is negated.

4. There are two benefits in using three duplexed antennas. One benefit would be that there would be transmit redundancy in case of antenna failure since there are now two transmit antennas. The second will be the benefit of three branch receive diversity as opposed to two branch diversity, which yields a 1.7 dB uplink gain improvement.

C. Recommendations

Rather than trying to minimize IM by using separate antennas, it is recommended that preventative measures be taken to prevent IM. One of the best ways to reduce the passive IM potential is through use of high performance coax and connectors, as mentioned above. This IM potential can be dramatically reduced through use of solid connectors with no ferromagnetic materials and cables with single inner and outer conductors and no junctions. Connectors should use silver plating on the body and the inner pin to resist corrosion. In addition the use of “7/16” DIN connectors can provide a benefit for IM performance over Type N connectors due to their coupling mechanism which provides higher contact pressure over a greater surface. In addition, it is recommended that weatherproofing be used on the connectors. Use of these connectors and cables may cost more on initial installation but reduce maintenance cost in the long run.

D. Insertion Loss and Size

When the same outside diameter of the cable is measured, the insertion loss performance for multi-layer outer conductor cable is similar to that of a solid outer conductor.

	Outside Diameter	**Dielectric Diameter**	**Insertion Loss/100 ft @ 900 Mhz.**
Andrews			
LDF4 – 1/2"	0.63 in.	0.50 in.	2.200
LDF5 – 7/8"	1.09 in.	0.87 in.	1.230
LDF6 – 1-1/4"	1.55 in.	1.25 in.	0.907
LDF7 – 1-5/8"	1.98 in.	1.62 in.	0.767
Times Cable			
LMR – 500	0.50 in.	0.37 in.	3.130
LMR – 600	0.59 in.	0.45 in.	2.500
LMR – 900	0.87 in.	0.68 in.	1.700
LMR – 1200	1.20 in.	0.92 in.	1.270
LMR – 1700	1.67 in.	1.35 in.	0.936

The LMR1200 is comparable to the LDF5-7/8 in costs, physical make-up, and insertion loss. The main advantage of the LMR1200 is its flexibility.

E. Conclusion

The Andrew solid outer conductor type coax would perform better in an area where there are several RF frequencies due to its IM performance. With its multi-layer outer conductor, the Times Cable might be better suited to indoor applications due to its flexibility where there is little likelihood of RF interference. The comparison also assumes that proper installation practices were adhered to for both types of cable that includes bending radius', connector installation, etc.

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