"Tieing It All Together"

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How and why of connector usage is reviewed along with some pointers as to the selection of connectors sizes and types. Testing of connectors for return loss and center conductor strength is described, noting some of the pitfalls that can be encountered in this testing. The objective of this report is to enable the reader to "Tie it all Together" and have a smooth running cable system.

Without connectors a cable system is no more than a lot of Coax Cable and electronics with nothing to do.

There are many things to be considered in the selection and application of aluminum cable connectors, and I will present some thoughts on the various applications of these connectors. These considerations can be divided into two broad classes, mechanical and electrical, and then these can be further subdivided. We will first cover the many mechanical considerations in connector selection.

First and seemingly very simple is the matter of what size connector has to be selected. I say simple, but it must be realized that all aluminum cable of the same size designation (1/2 - 3/4, etc.) is not created equal. To go back and review, the impedance of a coaxial structure is determined by the ratio of the outer diameter of the inner conductor, to the inner diameter of the outer conductor, modified by the dielectric constant of the material in between. Since the different manufactures of cable all have different methods of "creating" a dielectric in the cable, there are almost as many variations of ratios of diameter of cable within any one size designated as there are cable manufacturers.
See fig. 1

$$Z_0 = \frac{138}{\sqrt{\varepsilon_r}} \log_{10} \frac{b}{a} \text{ ohms}$$

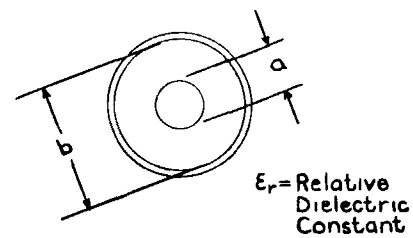


figure 1

Thus, much attention has to be paid to what particular type of cable one is buying connectors for. Going furthur, make sure that you are using the connector the manufacturer recommends for the particular cable you are using.

This selection must be done without the user making any assumptions as to which connector goes on which cable. For example: just because one connector company groups cable connector combinations in a particular way, don't assume that another connector company does the same. This doesn't mean one is right and the other wrong, just that they have chosen their mean dimension of their connectors at a different point. In a practical connector design the center conductor seizure terminal will only reliably close a finite amount from its full open size, therefore, the choice of this starting size will influence the range of center conductor sizes that can be accommodated in any one connector size.

The type of connector to be used is a matter that should be considered early in the design phase of your system build or rebuild. By type I mean pin type, feed through and with some connector companies,which family of connectors you want to use. Each type can have some finite advantage, and disadvantages for the way you may want to use it.

Feed through connectors have a major advantage in that they are cheaper to buy, but some of the cost can be used up in the type needed for a longer center conductor preparation along with the increased difficulty removing equipment (taps, etc.) once they are installed. Feed through connectors generally have better electrical specifications due to their lack of internal parts. This same lack of parts is interpreted by some people to mean a greater reliability, but this point can be argued to great length, since the same basic steps must be followed in installation, the connector is subjected to the same errors as other types. Feed through connectors may be used in conjunction with splice blocks which gives the user some finite advantages with this type of construction. In the older systems and in partial rebuilds, the splice block may be used to join two different types of cable and can even be used to splice two different sizes should the need arise.

Splice blocks have the additional use of allowing maintenance personal access to the center conductor of the cable without interrupting service or opening up a housing simply by removing the access plug on the splice block. Most connector companies also offer a test adaptor that may be screwed into the splice block which then has a test point for both RF and powering brought out in a usable manner. This test adaptor should only be used as a trouble shooting tool and not to set amps or balance the systems. This is due to the error introduced by making a "T" connection in the coax structure instead of going through a transformer as one does in a directional tap. The "T" connection introduces a mismatch of about 10db at the higher frequencies which would introduce about 1db error in the through loss.

Feed through connectors in the larger sizes (3/4) require a reducing pin to be used in many pieces of equipment due to the inability of the center conductor. This reducing pin must be crimped in place with the proper tool in order to achieve the reliability desired. This is important because this crimp is the actual means of holding the center conductor and making good mechanical and electrical connection.

While on the subject of crimping, this is a good time to discuss the use of Nicropress type splices. These fittings have been around for a good many years and probably will be around for a good many more. These fittings are very simple to use and have very good mechanical and electrical specifications, the only disadvantage is that they require the use of individual radiation sleeves and this is distasteful to some.

However, properly installed these fittings will give service that compares very favorably with the so called "State of the Art" fittings.

A second broad classification of connectors generally in use is the Auto seize variety which are sometimes referred to as "seized center conductor" fittings, both in the entry and splice configuation. These connectors are the variety that with some form of internal mechanism close the center terminal around the cable center conductor in a manner that seizes or holds the cable center conductor for good mechanical and electrical performance. See fig. 2

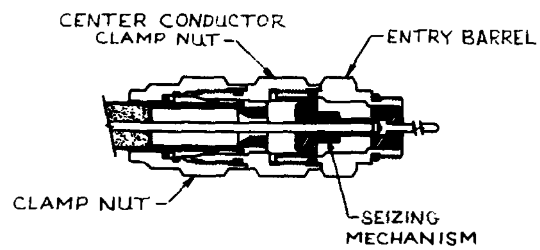


figure 2

The more common configuration of this type of connector is to have a separate closing mechanism for the center conductor and the cable sheath ferrule. These connectors all have radiation sleeves, but have different internal mechanisms from manufacturer to manufacturer. As with any connector it cannot be stressed enough times to read and follow the suppliers instructions for assembly of his connector on to the cable. In preparation of cable for auto seize connectors always pay alot of attention to the center conductor prep length, remembering "more is not better" in the length of the center conductor preparation because too long a center conductor could hold the center terminal open or it will not allow the sheath in thecable to bottom in the ferrule. Not allowing the cable sheath to go all the way into the connector ferrule can produce both mechanical and electrical problems. Mechanically, the ferrule does not have the full gripping surface and the pull strength of the holding nut will be reduced by a fair amount. A mismatch in impedance can be introduced by the radiation sleeve not being all the way in to the cable end and allowing cable with no dielectric around the center conductor for too great a length.

Another style of connector now being offered by some manufacturers combines the action of the center seizing nut with the action of the ferrule seizing nut in the same device, this type of connector is much simpler to use and because of its simplicity is rapidly gaining acceptance in the industry. With these connectors a pusher that surround the plastic center conductor closing mechanism is driven forward by the cable ferrule while it is closing around the coaxial cable sheath, thus gripping the center conductor with the same tightening nut. That closes the ferrule on the cable sheath. See fig. 3

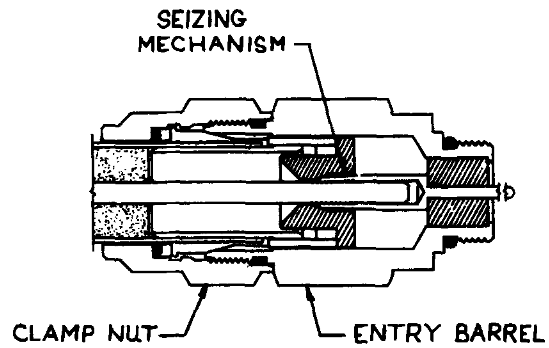


figure 3

With any seized center conductor connector the user should be concerned with the "pull strength" specification of both the center conductor and the sheath gripping mechanism on the type of cable that he is going to use.

In fig. 4 a plot of pull strength vrs. distance is shown as they are run on a typical connector. Notice the straight leading edge that gradually "rounds off" near the maximum pull strength of the connector, then rapidly drops about a third of the pull, and holds at about two-thirds of the maximum pull while the center conductor slides out of the gripping terminal.

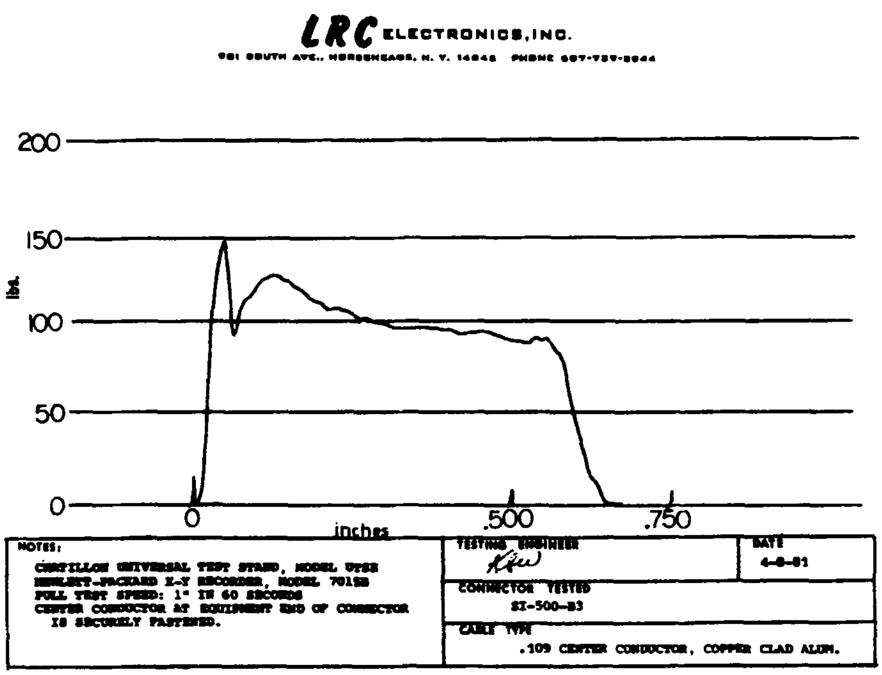


figure 4

It is only necessary to stretch the center conductor of the cable, because as it stretches it slides out of the terminal due to the reduced diameter. The conductor can be gripped harder, but this only results in a stress point on the conductor causing it to break at a lower strength, with the overall effect of a higher likelihood of a catastrophic failure.

Notice in the figure presented that all of the data needed to come to a conclusion is presented on the plot. (i.e.; cable size, type, center conductor seize) not like some of the information circulated in our industry which show a plot but with no accompaning information or description.

As the system requirements are expanded to a greater number of channels and services that must be provided, it becomes necessary to examine the electrical requirements of the connectors used in these systems. These requirements, fall into only two categories that will effect system performance, insertion loss and return loss.

On the surface it would appear that measuring either one of these parameters would be quite simple, however, if one gives these measurements some thought it becomes evident that this can become real problems as to test fixtures methods, etc. "How does one test an entry connector?" "Easy", one answers. "Install it in a housing and run your tests." This sounds easy and is, if the test connectors, cable, housing and terminations are all perfect.

But now lets come back to earth and see what we can do about testing a connector by itself. In order to test a connector for return loss, the cables, test fixtures and termimators must be considerably better than the connector to be tested. To be assured that the test is valid much pretesting needs to be done, and methods developed that will minimize the contributions of the test fixture to the overall result.

Fig. 5 shows one type of test fixture that can be used to run return loss measurements on an entry connector. The fixture is a standard 1/2" Test Connector, Lumafoam III Cable, and a special connector bored out to permit the cable to go all the way thru. The cable adapter has 5/8-24 female threads and allows the terminatied cable to go all the way thru to butt the ends of the cables. Calibration is then made with no connector in place. To test entry connectors the cable must be prepared and the connectors substituted for the bored out entry. The center pin of the connector is cut flush with the 5/8-24 male thread and the special adapter and termination are screwed on to complete the test. To test splice connectors both pieces of cable are prepared and the splice inserted between them, but in all cases it is possible to first run the complete test fixture by itself before adding the connectors to be tested.
See fig. 6

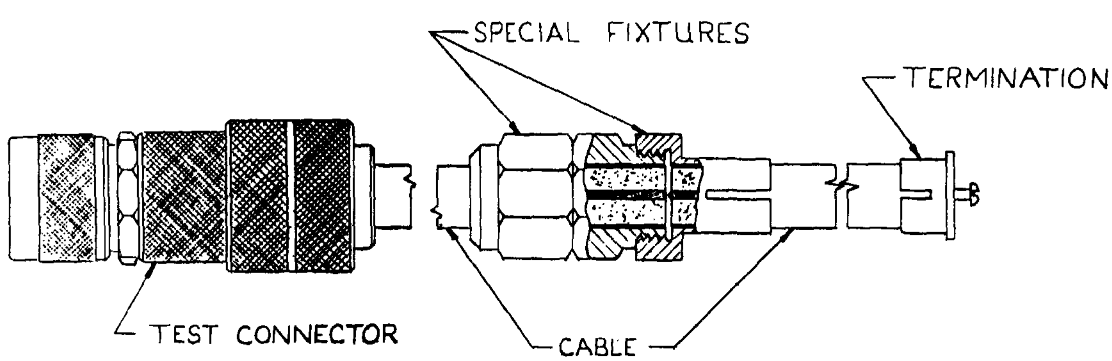


figure 5

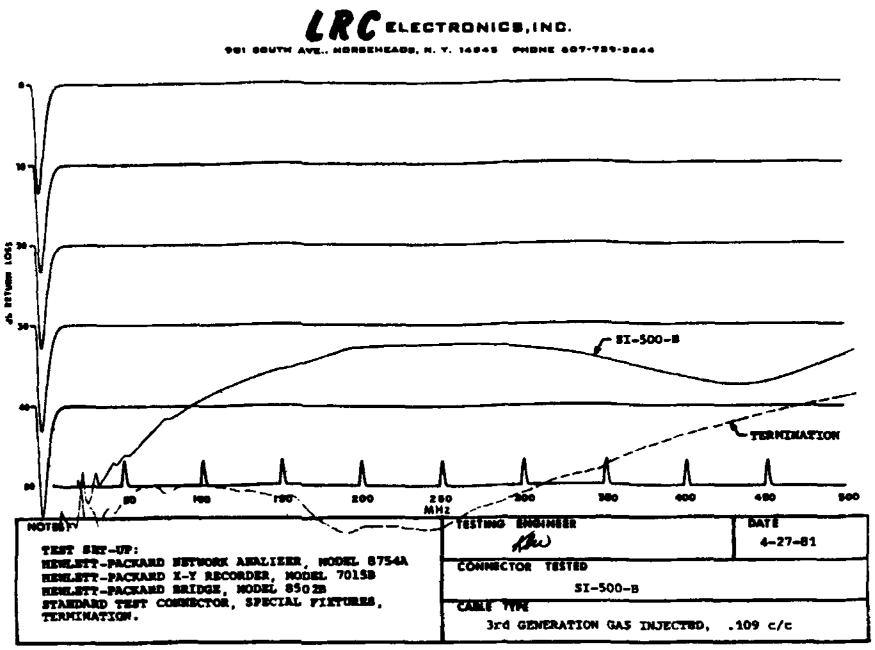


figure 6

After considering the many features of the connectors offered the final step in your selection process should defintely included a "hands on" session with connectors you are considering. With the instruction sheet in hand go through step by step the actual installation of a connector on a sample of the cable you are going to use and pay close attention to any problems that may arise such as cable twisted or difficulty of assembly.

After installation remove the connector from the cable and note the amount of gripping shown on both center conductor and cable sheath.

Much information has circulated in the cable industry as far as the electrical specifications of connectors and associated equipment with little thought given to the overall effect on the system performance. Until the cable industry has some equipment performance standards, it is up to the technical staff of the user to determine practical specifications for the system that is to be built.