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Field Installation of Cables and Connectors for MRI Systems

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To obtain the specified performance and achieve maximum reliability, magnetic resonance imaging (MRI) equipment requires reliable, easy-to-install cables and connectors

MRI systems are just one of the many unique applications for coaxial cable. MRI technology has advanced in recent years and is now capable of producing color graphics which resemble actual photographs. These machines have become instrumental in providing basic medical care and are now found in every hospital as well as many clinics, labs and doctor's offices. Most MRI systems operate in the range of 100-300 MHz, requiring coaxial transmission lines between the body coil unit and the RF power supply. A number of coaxial interconnects are required, including a high power interconnect which must handle many kilowatts. The body coil unit, which is the enclosure or tube that the patient would actually see or be placed into during a test, must be contained in a shielded room. The technician who performs the test sits at a control panel outside this room along with the power supply and other support systems for the MRI body coil unit.

The field cable installer is faced with a number of challenges. Each installation is a little different. The distance between the body coil and the power supply will vary, requiring cables to be terminated in the field. These are high-powered cables that must be terminated properly in order to provide optimal power handling. These systems are generally installed by electricians who do not have any RF background so there is a need to make these field terminations as simple and fool proof as possible. The high transmitted power requires rather large cables. The bend moment (stiffness) and minimum bend radius of the cable becomes an issue when working in the very tight space of a typical MRI room. The LMR® cable construction is well-suited for this application. Size for size, the LMR cable has superior bend moment and minimum bend radius performance compared to the other constructions that are on the market. This can be attributed to the ruggedized closed cell PE foam and unique Al-Mylar-Al composite tape outer conductor construction utilized in the LMR design.

Figure 1 · The 7/8-inch EIA flange connector. For this application, the rubber O-ring is not required and will be removed prior to mating with the bulkhead.

A second challenge encountered during the cable installation is the requirement to pass out of a shielded room with a large high powered cable while maintaining the integrity of the shielded room. The engineers at a major MRI manufacturer decided to use a 1/4-inch polished brass bulkhead with 7/8-inch EIA connectors. These EIA connectors are non-gender specific. They utilize a rugged, large diameter,

Figure 2 · Cable cutting tool.

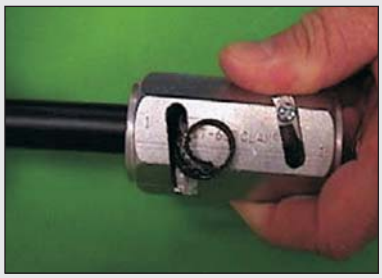
polished, three-hole flange to make the mechanical and outer conductor connection and a spring finger bullet to make the center conductor contact. It is important that the EIA connectors on both sides of the bulkhead are allowed to be brought together in such a way that the entire circumference of both connectors make contact with the bulkhead. The three bolts are then passed through the connectors and bulkhead and torqued so that the polished surfaces of the connector flanges and the bulkhead will be brought together with the force necessary to prevent RF leakage outside the test room.

Making the bulkhead connection may sound quite easy, but this is true only if you are able to easily tweak the length of the cables and form them in such a way so that the connector does not experience side loading. This requires a cable that is flexible and somewhat conformable as well as a cable that is easily trimmed and terminated. The ends of the large high power LMR cables may be quickly squared up and faced off with surgical precision, using a simple off the shelf PVC pipe cutter. This important first step in the termination process is often overlooked.

The various MRI systems all require custom cable kits. The typical kit will include a lower power coaxial interconnect and a number of short jumpers in addition to the larger high

(3190-1387)
EZ-600-NMC-2 Connector Installation Procedure on LMR-600

1) Flush cut the cable squarely.



2) Strip the cable end using side 1 of the ST-600 clamp tool.

3) Debur the center conductor using a file or deburring tool. All burrs must be removed.

4) Strip the jacket using side 2 of the ST-600 clamp tool.

5) Make sure the braid is straight. Square the connector with the cable and twist onto the cable until it bottoms on the jacket.

6) Flare the braid as shown.

7) Begin threading the front of the connector onto the back end while keeping the back end firm against the jacket.

8) Tighten firmly using two 15/16" open end wrenches, or adjustable wrenches.

power cable. Type Ns and type HNs (high power type N) are the other two interfaces common to the kits.

The typical kit will require four connector terminations to be made in the field. The connectors supplied with the kits for field termination are all EZ (spring finger) type. The EZ design utilizes gold or silver plated beryllium copper to form the required spring force. The cables that have a core diameter of 1/2-inch and smaller use a four finger contact which slips over the solid center conductor of the cable while the larger cables employ a six-segment spring pin which inserts into the hollow center conductor. All of these EZ spring finger designs provide outstanding surface contact between the pin and the center conductor. In many cases, better than a properly installed solder-on pin—and always better than an *improperly* installed solder-on pin. They have been optimized for electrical performance and simplified for ease of install. The typical six or seven pieces (flat washers, rubber grommets, gland washer, etc.) have been reduced down to two large components (the interface and the back body). This has done away with those old questions that were common upon initially opening the bag of a clamp connector, "Which piece do I place onto the cable first?" and, "Am I placing this part onto the cable in the proper direction?" Each kit includes a check off list, a number of pictorial instruction sheets, cable prepping and cutting tools, bolts, nuts, washers, etc. The 3190-1387 pictorial instruction illustrates the field installation of a two-piece type N male connector onto 1/2-inch flexible LMR cable while the second pictorial (3190-1450), illustrates the field installation of a 7/8-inch EIA right angle connector onto 5/8-inch flexible LMR cable. Both of these connectors may be reliably terminated in the field by relatively inexperienced installers in under a minute.

In this critical medical applica-

(3190-1450)
EZ-900-78EIA-RA-2 Connector Installation Procedure on LMR-900-DB

1) Flush cut the cable squarely.

2) Cut the corner of the lubricant packet and apply the lubricant liberally to the O-ring in the aft section of the connector.

3) Strip the cable end using the ST-900/1200C prep/strip tool by inserting the cable into the proper end of the tool. (Be sure there is no jacket material stuck in the tool before beginning this operation.)

4) Slide the back section of the connector over the braid without disturbing it. Be sure that the axis of the connector is in line with the axis of the cable.

5) Use the palm of your hand to snap the back end of the connector over the jacket. *Spinning the aft section in a clockwise motion while applying pressure will also help to properly position the connector.*

6) The braid should then be spread across the face of the connector.

Continued on the facing page.

(3190-1450)
EZ-900-78EIA-RA-2 Connector Installation Procedure on LMR-900-DB
(cont.)

7) Insert the spring finger pin of the forward section of the connector into the center conductor. ***You should hear a snap.***

8) While holding the back section firm with a 1-1/4" wrench, spin the front section snug. ***Now hold the front section firm while torquing the back nut till the O-ring is compressed.***

tion, the unique design of the LMR cable, the EZ connectors, the EZ prep tools and instructions have come together to provide a rugged, easily installable, high power interconnect system.

Author Information

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