Coax Connector Installation Complete with Text and Pictorial

This lesson is about how I make coax connections. It is important for emergency communicators to have good on-the-air operating skills, but it is also important to have equipment that is working effectively and that is reliable. I have never had a coax connector that I have soldered fail, although I have had several store bought crimped ones fail.
Hams can not talk about coax without talking about the PL-259 connector. It was designed in the 1930s by E. Clark Quackenbush, a design engineer working for the Amphenol company. Since its upper design limit was 300 MHz, it was called a "UHF" connector. Even though the impedance across a PL-259 is not a constant 50 Ohms and they are not inherently waterproof, they have low loss at HF frequencies and are normally used by hams up to 450 MHz.

PL-259s come in a variety of finishes. The bodies and the barrel come in nickel, silver or gold plated. The insulator comes in either Teflon or a phenolic plastic. The phenolic ones that I like to use have a yellow insulator while the Teflon is always white. I prefer the plastic because it is like Bakelite, which does not melt. It will actually burn and char if it gets too hot. The problem with Teflon is that the center pin can get loose or move off center if the Teflon gets too hot. If you are using Teflon insulated PL-259s, be sure to attach a female connector to it while soldering to keep the center pin in alignment.

I like to buy my PL-259s from The Wireman over the Internet. They have one (#1102) that has a silver plated body and pin with the yellow phenolic insulator and a nickel plated barrel. These are easy to solder. They are $1.73 each in quantities of six, which is very reasonable.

The PL-259 is designed to be used with RG-8 or RG-213 coax. This is the larger commonly available coax with an OD of .405 inches. Some types of coax like LMR-400 clones will either be this OD or not, so be sure to buy the right connector. To be safe always buy new coax that is .405 inches in diameter.

<u>Tools</u>
In order to make good coax installations you need some basic tools. You need a large hot iron. I know this is vague but it took me quite a while to find an iron that worked well. You might do OK with a torch or a soldering gun, but I have not had much luck with these. If you want to try these do some research on the Internet to see how other hams use these tools to make coax connections.

I use a very old iron called an American Beauty. It has a solid copper cylinder for a tip that I have filed on three sides to make a point. The point is actually small enough to protrude into the four side holes on the body of the PL-259. The iron takes a while to heat up. You also need a box of 100 safety razor blades. You need a heatproof surface. A large surplus ceramic tile will work. The solder can be any good 60/40 electrical solder designed for electrical use that has a rosin core flux. Do not ever use acid core

solder on anything electrical. Also get some liquid flux at Altex Computer on McArdle. Other tools will be mentioned during the lesson.

PL-259/RG-8 Installation

First you need to cut the outer plastic jacket of the coax about 1½ inches from the end. Pull the loose end of the shield off of the coax about ¾ of an inch, or just remove about a ¾ inch width of the jacket. You are using the loose coax jacket to keep the outer braid from getting loose and unraveling. You want the exposed metal braid to be tight against the inner dielectric. Place the coax end onto the ceramic tile and put a brick on the coax to keep the coax from pulling off of the table.

The braid should be shiny bright. If not the coax may be bad. If it is not too bad you can try to use some fine sand paper to brighten up the braid. However a dull braid usually means the outer jacket is compromised. Sometimes the outer jacket will deteriorate and the braid will be black. You can always cut a few feet of coax off and inspect the braid farther down the line.

Next add a little bit of liquid flux to the shield. Place the iron tip on the braid. Quickly add solder to the braid next to the iron. If the iron is hot enough the solder should disappear as the braid soaks up the solder like a sponge. If you have lumps of solder, or any thickness of solder visible on the surface of the braid, stop and wait until the iron gets a little hotter. You don't want to spend a lot of time with the iron tip touching the braid. If the tip is not hot enough and you leave the tip touching the braid for a long time the dielectric can melt.

Once you have tinned the braid it will be stuck together. You can now remove the loose piece of outer coax jacket. You must now trim the braid and the dielectric so that only about $^{5}/_{16}$ to ⅜ of an inch of braid remains. In order to do this you need to carefully cut the braid with a safety razor. If you had put too much solder on the braid previously you won't be able to cut through the braid. Once you cut through the braid continue to cut into the dielectric until you reach the center conductor. Be careful to not nick the center conductor if it is stranded. Remove and discard the loose piece of braid and dielectric. You may want to twist the dielectric off in the direction that tightens the strands of a stranded center conductor. Discard the used blade as it will be extremely dull. Hopefully the dielectric will not be crushed. You can bevel the edge of the braid with a toe nail clipper. If the dielectric is polyethylene it may be difficult to remove. The foam dielectric has lower loss and is very easy to remove. The only disadvantage to foam dielectric is that it can crush under large loads or if the coax is bent to a very small radius.

Now remove the barrel from the PL-259 connector body. Place the barrel onto the coax. Make sure it is facing the correct direction so it can screw onto the PL-259 body after it is installed. Now you must screw in the coax into the PL-259. This will require two sets of pliers: one to grip the connector and one to grip the PL-259. Make sure the one that grips the coax does not damage the plastic jacket. Twist (clockwise facing the front of the connector) until you see that the braid is visible in the four solder holes. You need to continue twisting some more, preferably until the braid/dielectric hits the front insulator.

Now you need to solder the braid to the body at the four holes. You will need to solder each hole until it is filled with solder, and then rotate the body (and the coax) 90 degrees and solder the next hole. You may not get the first hole hot enough to get the solder to form a nice smooth shiny concave shape. If not then just go to the next hole and continue soldering. The heat will gradually build up in the body. Once the four holes are soldered, reheat the other holes until the solder is smooth. The concave surface tells you that the solder has been sucked into the braid and you have a good connection.

Lastly, solder the center conductor to the pin. You do not need to fill the pin completely with solder, but the pin must be solidly attached to the center wire. Cut the extra center conductor off at the edge of the pin. Now take a file and smooth off the edge of the pin and also remove any solder that got on the outside of the pin. Do this slowly. Finally, test the connection by inserting it into a female connector. Test the installation with an Ohm-meter. You are done.

You are cautioned to allow the body to cool off during certain steps where you need to touch the connector body. The body absorbs a lot of heat and it takes a while to cool off. Don't burn yourself.

PL-259/RG-8X Installation

RG-58, RG-59 and RG-8X are smaller diameter coaxes that are good for HF and also for short jumpers in the shack. RG-58 has a smaller diameter than the other two and is often referred to as being coax for CB use. High grades of it are often used for 2 meter mag mounts. The RG-59 and RG-8X are a slightly larger diameter than RG-58. RG-59 is actually rated at 75 Ohms impedance and is more for receiving use only. RG-8X is a 50 Ohm impedance coax and is often referred to as mini-RG-8.

If you want to use a PL-259 with these coaxes, you need an adapter. The adapters are: UG-175 for RG-58, and UG-176 for RG-59 and RG-8X. These adapters screw into the PL-259 body. They therefore have the same OD but the UG-176 has a larger ID because of the larger OD of RG-59 and RG-8X. The UG-176 therefore has a thinner wall than the UG-175.

Since we will be demonstrating this with RG-8X, first slip a UG-176 onto the coax in the correct direction. Next remove about one inch of the jacket. Now comb out the braid so that it is completely loose and straight. A nail or plastic push pin works good for this. Once the braid is completely combed out push the UG-176 all the way to the end of the jacket. Then pull the braid over the adapter. Arrange the braid to that it goes all the way around the adapter. Next place the body on the table. Place a new razor blade on the braid on the adapter near where the screw threads start. Now roll the adapter and trim the braid. You will need to do this to every strand of the braid. Eventually the braid will be completely trimmed and look quite neat. Pull the braid against the adapter and trim any long threads.

Add a little solder to the center conductor if it is stranded so it will not fray.

Now screw the adapter into the PL-259 body. Be sure the combed out braid does not shift when you are doing this. You should be able to see the braid through most of the four holes in the body. Snug up the connector tight to the body with two wrenches.

The rest of the procedure is the same as for the RG-8. In fact, since you will be soldering the braid to the adapter it is even easier.

This is my American beauty iron. Very large tip about 3/8 inch diameter solid copper and filed to a point. You need a lot of heat and a lot of mass in the tip for heat transfer. The tip must also be tinned and shiny with solder for heat transfer.

Some 40 year old Kester #66 rosin core 60/40 solder. Do not use acid core.

Get some liquid rosin flux from Altex Computer on McArdle Ave.

The tip here is cold but your can see the point. If it does not take solder file the surface. Otherwise there will not be a transfer of heat.

This is a PL-259 body. The pin and body are silver plated. The insulator is phenolic plastic that does not melt. I consider it better than Teflon. Note the four holes for soldering the braid. I get mine at The Wireman. They are #1102, and $1.73 each in quantities of 6. The pin is also silver plated, but the barrel is nickel plated.

Note the threads on the inside. These grip any .405 inch OD coax.

This shows a female connector on the left with a Teflon insulator for connecting two PL-259s together, and a used bulkhead mount normally installed on an equipment chassis with a phenolic insulator.

For the demo I first tried some older coax. I do not recommend using old coax. Here the braid is tarnished quite a bit, and it was difficult to solder to it. I have taken off a piece of jacket about ¾ of an inch wide. The farthest cut is about 1½ inches from the end. The remaining jacket keeps the braid from unraveling, and keeps it tight against the dielectric. This braid needed to be sanded, but it is better to discard the coax if it is this bad throughout its length.

Here I have added solder to the braid. In this case I sanded the braid but could not get it really shiny. I also added a little liquid flux. The tinning it not perfect but usable. In theory all the solder should wick up into the braid leaving no bumps on the braid.

In this case trim off a little of the jacket on the coax side that was damaged by the heat so that the PL-259 body will screw on easily later on.

Cut the braid all around with a fresh safety blade about 5/16 to 3/8 of an inch from the jacket. If you used too much solder on the braid it will be hard to do this.

Completed cut in the braid. Be sure to cut all the way through the dielectric but do not damage the center conductor, especially if it is stranded.

Twist the braid/dielectric off in the direction to tighten the stands of the center conductor. Here the old stranded center conductor is tarnished…not a good sign.

Bevel the edge of the braid with a toe nail clipper.

This is a better example of RG-8. It is a new piece of LMR-400 clone coax. The braid is tinned copper.

After adding some solder. Be sure to trim the heat damaged part of the coax jacket.

Trimming the braid/dielectric.

Cut completely through.

You now need to screw the PL-259 body onto the coax. The inside threads of the body will grab the coax jacket securely. This connector is not screwed in completely. Note that you can still see the center conductor where you will eventually see braid. This is difficult to do. You need to decent pliers; one for the body and one for the coax. You must devise a way to not damage the coax jacket with the pliers.

Here you can see that the center conductor is the maximum allowed size.

Here the body has been completely screwed onto the coax. Note that you can see the braid through the solder holes.

Before we finish soldering these connectors we will review using smaller coax.

These are adapters. The adapter on the right is a UG-175 and it is for the smaller diameter RG-58 coax, which is sometimes referred to as "CB" coax, but is often used for VHF magnetic mounts.

The adapter on the left is for the larger RG-8X coax, which is often called "mini-RG-8". They both have the same outside dimensions.

I normally buy silver plated UG connectors but it is always good to scuff them up a bit with fine sand paper. I got these at The Wireman.

Here you can see the scuff marks.

Put the UG adapter on the coax going the correct direction also do the same for the PL-259 barrel.

Cut the jacket about 1 inch from the end. Be careful not to nick the braid.

Remove the jacket

You need to comb out the braid completely. A push pin or small nail will work as a tool.

Pull the adapter up to the end of the jacket. Throughout this procedure the adapter must stay in this position.

Fan out the braid wires equally all around the adapter and push them over the adapter.

Position a new razor blade at the beginning of the treads. Start rolling the blade all around the adapter until all the wires are cut. When you are done discard the blade.

Pull all the wires over the adapter and re-trim them if necessary.

Cut the dielectric about 1/16 of an inch from the braid.

Make sure the braid dowse not short the center conductor. Pull the braid tight over the adapter.

If the center conductor unravels you need to tin it with some solder to make it one piece. Then slowly insert the center conductor into the back side of the pin.

Make sure at this point that the barrel is facing the correct direction. Otherwise it won't screw onto the body.

The adapter is half way screwed into the body. You can see the center conductor in the hole.

The adapter is fully screwed in and snugged tight. Note that you can see the braid and the adapter through the solder hole.

The center conductor will touch one side of the inside of the pin. Solder the pin to the center conductor. You do not need to fill the center of the pin up with solder. Then trim off any excess length of the center conductor, and file the end of the pin smooth.

If there is any trace of solder on the outside of the pin, file it off. Test fit the body into a female connector.

You must now solder the braid to the body. Insert the tip of the iron into the hole. After a few seconds add the solder. At first the solder may sit on the outside of the body and not go into the hole. Rotate the tip in the hole to try to distribute the solder. The body must be hot enough so that the solder will suck in a bit and cause a concave smooth surface to the solder. If this does not happen, just continue to solder the other holes. Gradually the heat will build up in the body.

If any of the holes don't have smooth solder continue adding heat to those holes. If the amount of heat is correct eventually all the holes will be filled with solder. These last two photos show perfect soldering.

Do not get any solder on the threads. Otherwise the barrel will not screw onto the body.

This is proof that the PL-259 does grip the jacket of RG-8 coax very well.