PART ONE: TOOLS AND MATERIALS

Basic Tools. Many many brands and types will work.

A very sharp utility knife and spare blades. Start with a FRESH BLADE! Be careful.

Some close cutting side nippers for fine wire.   Some needle-nose pliers might also be handy.

Some wire strippers which include a good cable cutter. Perhaps a dedicated cable cutter if you are going to work with coax a lot.

A soldering gun capable of at least 140 watts. Rosin core solder, suggest a diameter of .050 to .062.
If you insist you can use a pencil type iron, but try to use at LEAST a 40-50 watt model and preferably one with a substantial tip that has decent ‘thermal mass’.

A modest heat gun if you are installing heat shrink tubing when connectors are complete.

MANDATORY Crimping Tools

The RG8X and LMR240 cables have nominal outside diameters of 0.240 inch and the crimping tools for the ferrules that go with the connectors for these cables are hex crimpers with a size of 0.255 inch. Similarly, the LMR-400, RG-213 and similar cables have an outside diameter of 0.405 inch and the hex dies for the ferrules for the matching connectors are sized at 0.429 inch. No one seems to sell one that have the 0.255 and 0.429 sizes in a single tool.

They are available from many sources at many prices. While many offer interchangeable die sizes, be cautious and DO NOT assume that the dies from ‘brand X’ will fit on tool from ‘brand Z’.   I have not found it necessary to use ‘premium’ brand crimpers and do very well with some tools from Amazon. I have not bothered with interchangeable dies because the tools are inexpensive enough that I just keep one crimper ready for RG8X and the other for LMR400 and avoid fussing. I believe I’m using these two, but many others will work as long as they are hex crimpers of the correct size, and it is advisable that they have the ‘flare’ illustrated later in the instructions.

https://www.amazon.com/dp/B00HDPA4XI/ref=sspa_dk_detail_6?psc=1&pd_rd_i=B00HDPA4XI&pd_rd
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https://www.amazon.com/rmsdeal77-Coax-Connector-Crimping-RG-
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<u>Some OPTIONAL Specialty Tools That Can Save Time.</u> You can do the whole job with a utility knife but you must measure and cut VERY carefully. These strippers save a lot of time though you'll still need to 'trim up' with the box cutter and/or side nippers. The grippers are nice to have too, though non-skid gloves can work. These strippers are specifically targeted at these exact crimp/solder type connectors. Others may well have the wrong spacing of cuts. **<u>Watch out for the blades inside the strippers!</u>** DX Engineering sells replacement blades, but not fingers.

DX Engineering DXE-UT-240C-P1 Cable Stripping Tool for RG-8X / LMR-240 size cable $43.00

As an add on accessory, this further item can make it easier to hold the cable and keep it from twisting while you strip it: DX Engineering DXE-CGH-8X Cable Gripper for RG8X/LMR240 size cable. $16.00

If you wish to work on LMR-400 / RG213 and similar sized cables, then the stripper and gripper below are useful:
DX Engineering DXE-UT-405C-P1 Cable stripping tool for LMR-400 and similar cable $43.00

DX Engineering DXE-CGH-8U DX Engineering cable gripper for LMR-400 and similar cable. $16.00

I also find a small portable vise with rubber padded jaws handy for things like soldering. But DON'T crush that cable material! If you are not using the stripping tools above, you'll need a good ruler too.

Raw Materials Aside from Cable:

Here are some desirable crimp/solder connectors in both RG8X and LMR400 sizes from DX Engineering:
https://www.dxengineering.com/parts/dxe-pl259cs8u-6
https://www.dxengineering.com/parts/dxe-pl259cs8x-6

And here are very similar connectors from HRO:
https://www.hamradio.com/detail.cfm?pid=H0-013834
https://www.hamradio.com/detail.cfm?pid=H0-012024

In addition, you may like to have some 3:1 ratio marine grade heat shrink tubing (the type with adhesive) in ½ inch diameter for RG8X and ¾ inch diameter for LMR-400 and similar. You may use an inch or so per connector. These materials are readily available from Amazon.

https://www.amazon.com/ELECFUN-8in-Heat-Shrink-Tubing/dp/B08SQRKXH2/ref=sr_1_6?crid=1NB5HKY212UPY&keywords=3%2F8+INCH+HEAT+SHRINK+TUBING+3%3A1&qid=1657636688&sprefix=3%2F8+inch+heat+shrink+tubing+3+1%2Caps%2C138&sr=8-6

https://www.amazon.com/XHF-Inch-19mm-Waterproof-Insulation/dp/B07FP6ZT8Q/ref=sxts_rp_s_1_0?content-id=amzn1.sym.14b5a3ec-ddf3-42f1-bf1e-8515f8d25a34%3Aamzn1.sym.14b5a3ec-ddf3-42f1-bf1e-8515f8d25a34&crid=L8PLRXUANNAB&cv_ct_cx=3%2F4+INCH+HEAT+SHRINK+TUBING+3%3A1&keywords=3%2F4+INCH+HEAT+SHRINK+TUBING+3%3A1&pd_rd_i=B07FP6ZT8Q&pd_rd_r=d2276a13-ec9d-401f-912c-505c2b759368&pd_rd_w=J8fNw&pd_rd_wg=B39jh&pf_rd_p=14b5a3ec-ddf3-42f1-bf1e-8515f8d25a34&pf_rd_r=DQT3ZNB1FP4YA91H1C8T&psc=1&qid=1657636754&sprefix=3%2F4+inch+heat+shrink+tubing+3+1%2Caps%2C134&sr=1-1-f0029781-b79b-4b60-9cb0-eeda4dea34d6

PART 2: ASSEMBLY INSTRUCTIONS

1. The pictures show RG-8X but the process is identical for either 0.240 or 0.405 diameter cables. That said, you MUST have the right connector size and crimping tool. Start by cutting the end of the cable neatly 'square' – no angle cuts. Optionally, place a flag of adhesive tape about 12-18 inches down the cable from the end to stop components from sliding away while you work.

2. Place the heat shrink tube, the ferrule and the connector outer ring on the cable and slide them out of the way. Make sure the outer ring is oriented correctly (read to thread onto the connector body). If you get it backwards, all is lost! The tape you placed should stop these from sliding away. Set aside the main body of the connector for now. **Don't drop these parts – to get a spare you must buy a whole new connector! If you forget to slide them on before crimping you are stuck!**

3. If you are using a stripping tool as suggested, place the end of the cable in the tool. **USE GREAT CAUTION AROUND THE EXPOSED RAZOR BLADES IN THE SLOTS AS SHOWN!** Position the cable end so that it is FULLY into the grove, right against the stop. Then close the tool on the cable gently. Hold it somewhat closed while you position any optional gripping tool so that the cable doesn't move (you don't want double cuts). You will close it more firmly as we rotate the cable and deepen the cuts. **See manual stripping instructions in step 6 below if not using a stripping tool.**

4. If using an optional gripping tool, position it on the cable close to the stripping tool. Be careful not to dislodge the cable from the stripping tool as the act of closing the stripper has already partially cut the cable. The gripping tool helps to turn the cable in the cutter and is especially helpful with gummier more flexible cable sheath materials and especially so on the smaller RG8X material. An alternative is to wear a grippy rubberized glove that can grab the cable. Do NOT use a hard tool like pliers – it will crush the cable and destroy it's RF performance, possibly even shorting it out.

5. Twist the tools in opposite directions for a number of turns, gradually increasing the closure of the stripping tool. Even if the stripper does not fully complete the cuts, it will have done so partially as well as clearly marking the dimensions. This makes it easier to finish up with a utility knife. Once you remove the cable from the tools, do NOT REINSERT IT. Finish up with a knife. The cut cable should look like this. The cut nearest the end should be about down to the center conductor. The middle cut should have cut through the outer jacket and shield braid, but NOT the inner dielectric insulator. The left most cut should only cut the outer jacket. Because different brands of cable have slightly different dimensions and because the blades wear, don't be surprised if the cuts are incomplete. The shallowest cut may even be hard to spot. We'll finish these with the knife.

6. **Manual stripping with a utility knife: Skip this step if you have used the tools illustrated above.**
   a. Cut the end of the cable square if not done already. Put a fresh sharp blade in the utility knife. A dull blade is both more dangerous (you will use too much pressure) and will not result in neat work. You will need to develop some 'feel' for how to proceed. If you cut too deeply at a given step you will damage the parts you want to keep. Work slowly. If you want, practice on a spare piece of cable. You'll only use about 1.25 inches of cable for each

practice strip so a few inches of cable and you'll start to feel like an old hand. When checking cut depts, it can help to SLIGHTLY flex the cable at the point of the cut to widen the opening. In this matter you can often better see if you have cut as deeply as you wish and whether any material remains for you to clear with a gentle push on your knife blade.

b. Here are the dimensions I use when cutting manually. They are different by a vanishing amount from the official dimensions such as those published by DX engineering but much easier to measure and, frankly, I think they work better. Measure very carefully for your first cut and then work your way around the cable. Make the cuts in the order shown, A, B and then C. If not using stripping tools, I usually start by marking each cut position by scoring (only) the outer jacket as guided by a good ruler and my knife.

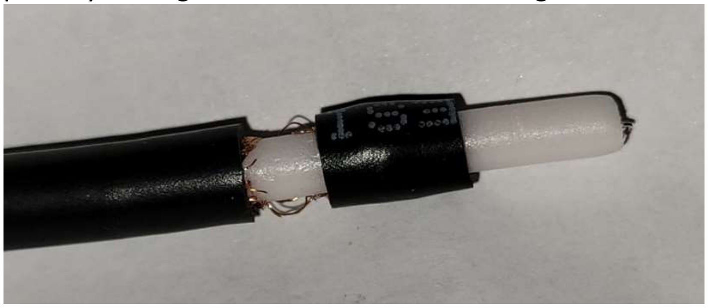
   - First Cut 'A' – all the way in to the center conductor: 9/16 (0.562) of an inch from the end of the cable. [DXE suggests the oddball number 0.544]

   - 2nd cut 'B' – through the jacket and shield braid but no deeper: 3/8 (0.375) inch from cut 'A' or, in other words, 15/16 (0.962) inch from the end of the cable. For this cut, you might find it easiest to first cut ONLY through the outer black jacket, remove the jacket piece neatly, and then fold the braid out and back so that you can trim it off right against the remaining jacket. It can be helpful to gently slit down the length of the section of outer jacket you are removing in order to peel it off neatly. [DXE suggests the oddball number 0.347].

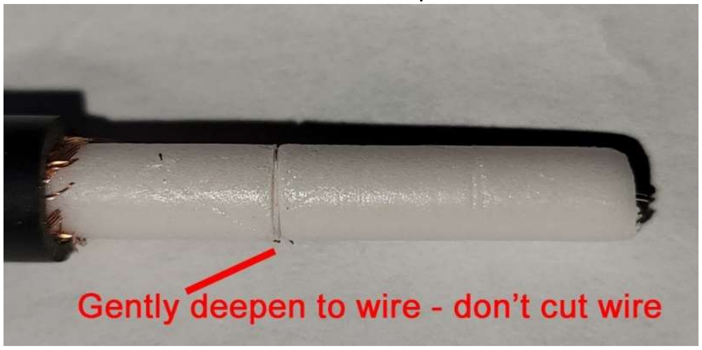
   - 3rd cut 'C' – only through the outer jacket: 5/16 (0.312) inch from cut 'B' or, in other words, 1.25 inch from the end of the cable. Be very carful to not cut too deeply, gentle pressure should do. Slip the ring of jacket off towards the end of the cable leaving the braid minimally disturbed. [DXE suggests the oddball number 0.327].

7. This is a long step. Take your time. Whether using the stripping tools or cutting with a knife, these photos illustrate the removal process. If you used stripping tools then this illustrates the process of finishing up and trimming the cuts with the knife. If not, this is what you'll see as you make the entire cuts with the knife (but do measure your cut placements CAREFULLY). Here we are focused on the first and deepest cut. It isn't quite clear whether we made it all the way to the center conductor but we are slipping off the outer jacket and braid which clearly ARE cut through. The cut into the center dielectric is being hidden by that 2nd piece at present. We'll see it in a moment.

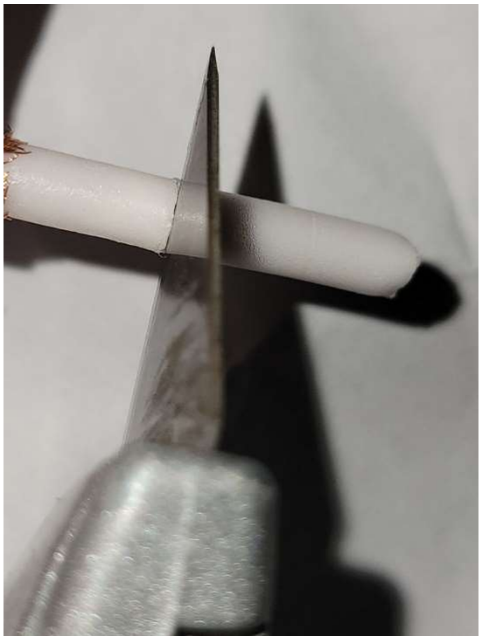
Now, sliding off the 2nd section it again appears that the tool has, mostly, cut through both the jacket and braid as intended, possibly leaving some shreds of braid. We'll get this out of the way.



With those two pieces out of the way, we can see that the first cut didn't quite make it all the way to the center conductor – it is only partially through the center dielectric insulator. But it is immediately obvious where the cut must be so all we need to do is deepen it with our knife.

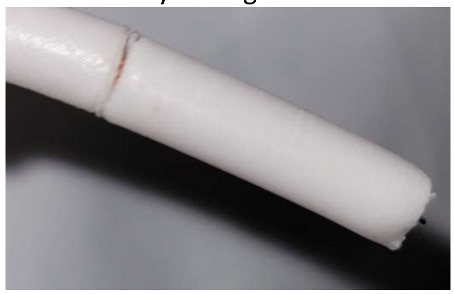


Here we are using the utility knife to deepen that first cut. Watch your pressure on the blade as we only want to cut the plastic and not the wire inside (or you have to start over). Try to keep the end of the plastic 'square' and not ragged.

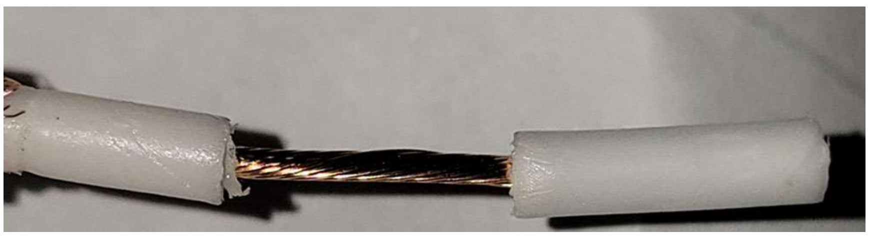


It can be a little touch to slide the plastic off the wire, especially when using the more flexible cables that have braided center wire. During manufacture the plastic will have formed around the wire strands a bit. Use the 'slight flex' technique to make sure you can see a glimmer of copper or tin wire all the way around.   Sometimes you can use the knife blade as a bit of a pry-bar to push the two sections of plastic a bit apart from one another. Once you are sure they are separate (no tendrils of plastic remain) it can help to gently twist the end piece of dielectric slightly clockwise as viewed from the end of the cable while you pull on it. That direction will work 'with' the existing twist of the wire strands.   **If you do cut the wires, you probably have to start all over, so take your time.**

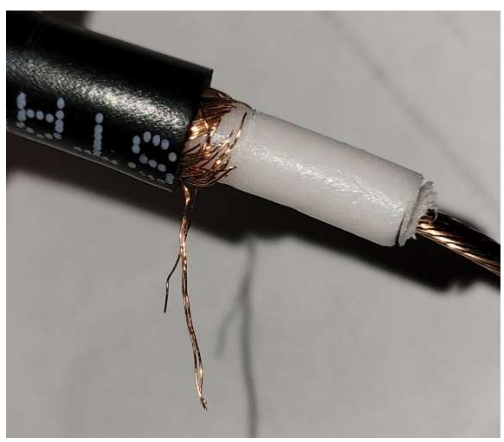
Here we can see that, as we slightly flex the cable at the point of the first cut, we see the copper conductor peeking through. We are all the way through the dielectric – at least on this side of the cable.



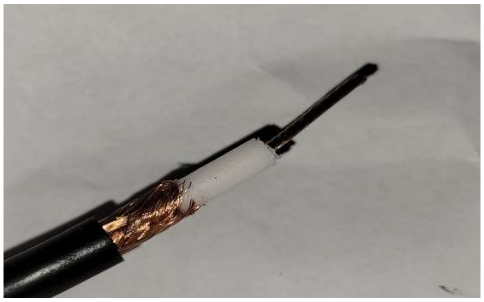
Once fully separated, slide off that section of dielectric exposing the center wire. Sometimes I leave the bit of dielectric partially on the wire just to protect the tip of the center conductor during subsequent handling, pulling it off the last bit just before I slide on the connector body. Here we see it just about all the way off.



Focusing on cut #2, with the center conductor exposed we see that we have a little trimming to do at the 2nd cut. Let's bend that braid out and back and use our close-cutting side nippers to get rid of all that is exposed, as close as possible. We also have a little flake of white dielectric to trim off back at the site of the first cut. That can come off easily with the knife to yield a nice square end.



Once the braid was trimmed neatly at cut #2, we went ahead and removed the last bit of jacket back to the final cut #3, leaving about 5/16 inch of braid exposed and not too much disturbed. Notice that the center conductor is also fairly neat and not all twisted up and deformed and that the end of the dielectric is fairly well squared off. We are ready to slide on the connector body. Check again that the ferrule, outer connector threaded ring and heat shrink are already on the cable and oriented correctly.

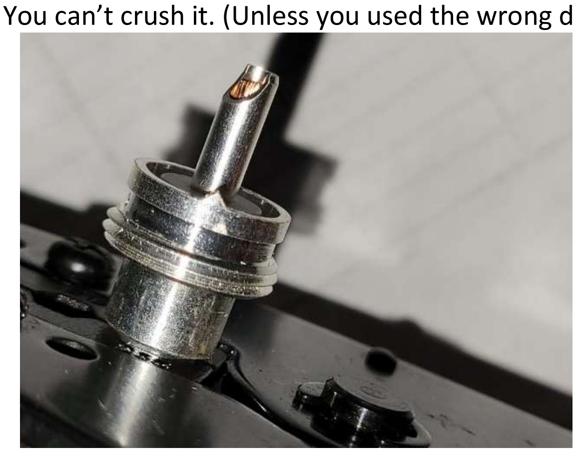


8. Here we have the connector body in place. The center conductor slid nicely into the center hole without resistance or any bent wire strands because we kept it neat. The crimping area has slid neatly between the braid and the dielectric. (Sometimes flaring the braid SLIGHTLY with your fingers eases this. Our dimensions are good – the braid is coming right up the thicker body of the connector but not overlapping it and, while not nicely visible in this photo, the tip of the center conductor is extending just about out to the center tip of the connectors solder hole. We want to keep the connector pressed firmly to the left in this photo as we slide on the crimp ferrule AND as we perform the crimp. If you encounter resistance with the center wire, stop and start over. If the center wire starts folding up and misbehaving, you'll end up with a short or poor RF performance.

9. We slide the ferrule off the cable where we stored it and slipped it up over the braid. We check to see that we can still see the center conductor in the solder hole, affirming that we have not moved the connector body.

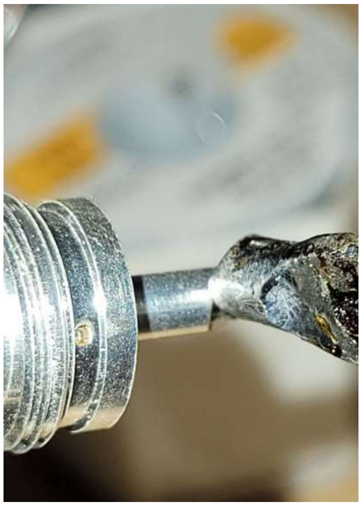
10. Take a moment and examine the crimping tool. Make sure you know which die position we need to use. (probably labeled 0.255 for RG8X or 0.429 for LMR-400 sized cable). Look closely at that position and compare it to the photo below. Notice the area I've circled in red where the die pocket flares larger. This will be visible only one ONE SIDE of the die pocket. That side MUST be positioned AWAY from the end of the cable and away from the main connector body. The other side (with no flare) should be right up against the wide portion of the connector body. A look ahead at the resulting crimp will show that the hex crimp area goes right up to the connector and the 'flare' left in the ferrule is towards the cable run (providing some strain relief for the cable). Resist the temptation to re-crimp this area.

11. Here we see the crimp action in progress with the tool, connector body and ferrule properly positioned relative to each other. Referencing the earlier discussion, this face of the crimping tool is the side WITHOUT the flare. (The flare is on the other side facing the long run of cable). Here we can see the copper center wire plainly visible in the solder hole – it hasn't moved so the connector has not shifted in position on the cable. Give the handles a VERY good firm squeeze or two. Don' take it out till it's done. You can't crush it. (Unless you used the wrong die pocket).



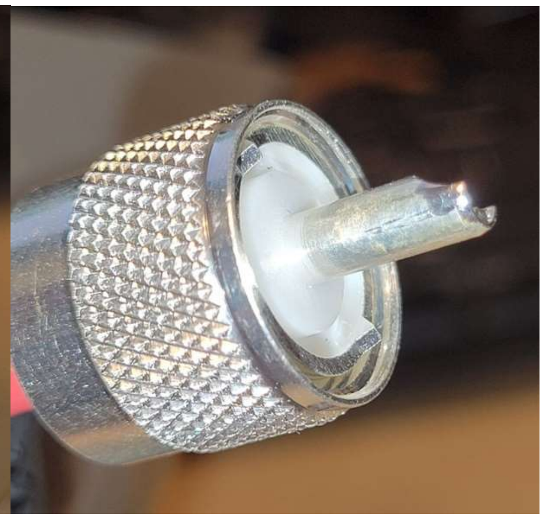
12. Here is the finished crimp. It's hard to see here but we re-verify that the center conductor wire has not moved. We see the flare in the ferrule is correctly oriented. We see that the hex crimp is right up against the thickened portion of the connector body. This looks good.

13. I've positioned the cable in a rubberized vise that won't crush it and oriented the connector so it is largely horizontal. I don't need a flood of solder rolling back into the connector, nor rolling out onto the floor. Level is good. Here I'm applying heat to the center contact just instants before the solder is applied. Remember your good soldering technique – the solder must melt onto (into in this case) the work itself, NOT onto the soldering iron tip. Using a powerful enough iron actually subjects the connector and cable to LESS heat because we get the job done faster. Avoid tiny irons.

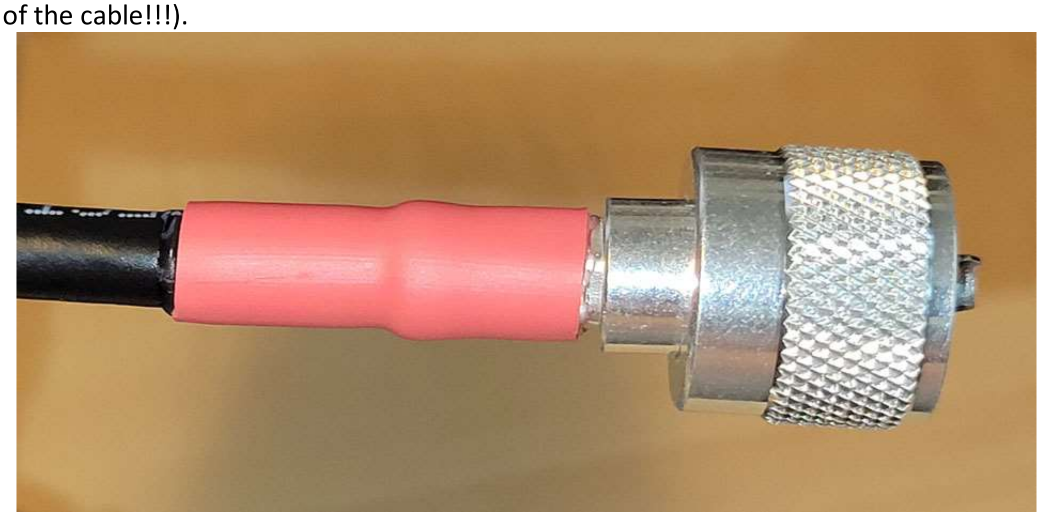


14. Here we see the finished solder joint. The hole is filled with solder – no air space that will permit water in and the wire is firmly embedded in solder.

15. Inspecting the center pin of the connector on all sides, we see that some solder flux is clinging to the outside of the pin. If still hot we might wipe it off with a paper towel, otherwise it will scrape off easily with any small tool or screwdriver tip. Don't leave it there as it may interfere with a good connection to the mating connector. After scraping, wipe it off with a paper towel to shine it up and ensure that it is clean. Here are pictures before and after cleaning. These have been taken after the outer threaded shell has been moved up off the cable (where we stored it earlier) and onto the connector body. Sometimes the flux will run onto the white Teflon of the connector. If so, knock if off that also.

16. Last step is to slide the heat shrink tube up over the ferrule and shrink it in place. The heat shrink isn't absolutely needed but adds some strain relief to the assembly.   Here is the fully complete connector. Check it for shorts and opens. All Done! (Except you have to do it again on the other end of the cable!!!).



ADDENDUM: Why Are We Assuming/Using Crimp/Solder Type Connectors?

Hint: Why are all of the cables sold pre-manufactured using crimp type connections? Why does the military use them?

This is a hot-button topic for some old-timers who insist that using the older connectors that also solder the outer braid is the only way to go. The problem is that modern high-performance cables that use foam inner dielectrics (like all LMR-400 siblings and RG8X) were not designed to take this much heat. The older solid-plastic dielectric such as that used on RG-213, RG-58 or old RG-8U were much different. They were lower in RF performance but took more punishment. If you want to use soldered connectors then perhaps you ought to consider using those cable types.

Crimp connections work well on the outer conductor. The center conductor is still soldered. The one case where I'd be worried about the crimp would be in a very corrosive environment such as a beachfront site or on board a marine vessel. In those cases I'd be tempted to use RG-213 outdoors with soldered connections – and would work hard to keep my cable short to avoid signal loss. I'd still use crimp/solder connectors indoors and for all jumpers.

If you do use soldered connectors you can read about the installation process elsewhere. I will comment that the 'bane' of that process is puny soldering irons. Unlike the process above, you will need to heat the entire connector body to become hot enough to melt and flow solder into the shield solder holes on the solder type connectors. If you use a small iron, here is what happens:

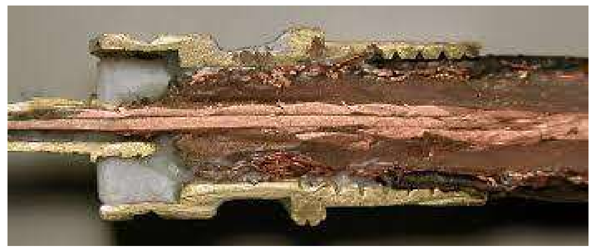
a) The iron gets hot. Then you touch the iron to the cold connector body
b) The connector body has more metal (thermal) mass than the solder iron tip area so instead of the iron heating up the connector, the connector initially cools down the iron so far that solder won't melt on either. So you keep the iron in pace while it SLOWLY re-heats.
c) All this time, the heat may not be enough to melt metal solder, but it is certainly hot enough to melt the dielectric plastic – or gets to that temperature more quickly than to the solder-melt temperature. So while you wait, the plastic melts and deforms. How much? You can't see or tell because it's all hidden inside. If it is modern foam-dielectric, it probably melts and shrinks as the 'bubbles pop' and you end up with an undersized pool of crud that no longer serves it's RF or insulating missions effectively.
d) Eventually the solder melts at the first solder hole. You flow some in then (quickly I hope) move to the 2nd and third holes and repeat. It won't flow well on the more modern cables because the foil layer in the shield carries the heat away too quickly (to melt more plastic). Lots of You-Tube videos showing people proudly applying heat for a LONG TIME with small irons.

This is the soldering iron you should have used. It has so much thermal mass it overwhelms the little bit of cold metal of the connector and you get the job done fast, before so much plastic melts. It costs as much as all the crimping and stripping tools above. (Presently about $207 at Amazon). And I still advise against using this approach with modern foam-dielectric cable, but it's roughly how they started before WWII with old cable types. Another option is a torch.
https://www.amazon.com/American-Beauty-3158-200-Heavy-Duty-Soldering/dp/B007S1WS5E/ref=sr_1_3?crid=1X743PZCKFTGD&keywords=american%2Bbeauty%2Bsoldering%2Biron&qid=1657644811&sprefix=american%2Bbeauty%2Bsoldering%2Caps%2C151&sr=8-3&th=1

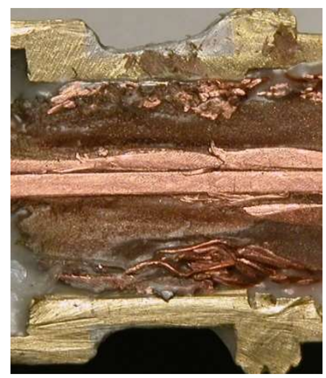
Here is one fellow's cutaway view of an outwardly SUCCESSFUL soldered connection using old style coax and a small iron. The author describes use of a high-end mil-spec silver/gold and Teflon connector. Credit to Paul B. Peters VE7AVV. http://www.bcdxc.org/pl259_crosssection_photos.htm

The inner dielectric has melted and deformed a good bit so the outer braid is getting closer to the center conductor than the design dimension, degrading power/voltage handling and SWR.

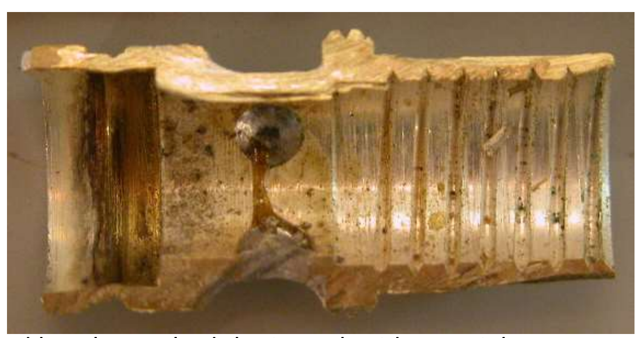
For all the enthusiasm for 'solid solder connections' there is VERY little solder flow through the solder holes on the side of the connector and almost zero solder flow down into the braid area beneath the connector housing. (Look for silver coloration rather than copper or brass colors).



There appears to be some melt damage to the white Teflon center insulator of the connector body itself. That seems to be more severe on the interior side than on the center pin size, making it somewhat likely that this was from heating coming from the shield connection rather than from soldering the center pin which, presumably, went faster. It is to be expected that the amount of dielectric melt would have been a good deal WORSE with a foam dielectric cable such as LMR400 types or RG8X.



Here are closeups of shield braid migration due to dielectric melt. That inner dielectric plastic looks to have become quite fluid – there is a lot of displacement. Not sure I'd want to run a kilowatt down this, nor subject it to the high voltage spikes of a high SWR condition. You can tell from the photo that this is the more robust old-style solid dielectric cable. To bad the solder isn't flowing a tenth as well as all this plastic material is. And again, had this been foam, it would really be a lot worse.



Here is a section of the outer wall of the connector fully removed. Notice the circle of solder at the solder hole near the center. There is almost no flow down the inside wall of the connector, explaining why we see so little flow into any of the braid in the other photos. This does NOT appear to be a very effective solder connection in spite of all of the damage to the cable material. And all invisible. Probably looks fine outside. Looks like the solder filled the hole and barely touched the inner braid material.

I'd rather have a crimped outer conductor and be comfortable using modern cable types.

Elmering at the Park – July 16th and August 6th

Suggested materials donation to the club for an RG8X cable is $12.00 For the Bury-Flex cable which is more useful at UHF or for higher power levels but is somewhat less flexible: $17.00 Checks payable to GOTAhams or cash – Please assume that I will probably not be able to make change. We'll make the jumpers about 3 feet long. All tools will be provided and the cables will include heat shrink sleeves at each end. The donation covers the connectors, cable, heat shrink, blades, solder, demonstration board, etc. Silver plated Teflon type connectors will be used and your result should be a very good quality cable.

If we have too many participants in July we'll continue in August. Ditto if we run out of one type of material or the other. Please plan to spend some time on this as stripping the cable takes time, particularly your first time through.

We'll plan on starting at 10AM with the introduction of cable types. You'll have a chance to touch and feel a range of different cable types as well as see the internal construction with samples of each that have been prepared.