

Making UTP (CAT 5 / 5e / 6) Network Cables

There are lots of sites providing instructions as to how to make your own network cables, but the ones I've seen (usually from cable providers) don't cover any effective techniques for producing such cables quickly and accurately. This document will hopefully address this deficiency by illustrating some helpful cable building techniques for stranded network patch cables. This document is intended for a technically competent audience accustomed to working with wiring.

Wiring Standards (T568-B and A) and Crossovers

The 8-conductor (4-pair) 24-gauge **stranded** wire that we will be working with is color-coded. Which color-coded wire goes to what pin in the RJ-45 housing depends on the wiring standard being followed. Conventional (non-crossover) cables are strictly straight through, thus it would seem that it really doesn't matter which colors go where as long as the cable is straight through. But there is a difference: UTP works by using twisted pairs, and those pairs are specifically setup to expect specific signals to pass through them to afford the signal protection that such twists provide. The vast majority of Ethernet cables are constructed to the T568-B wiring standard, with the T568-A scheme representing the 10/100 Mbps crossover cable definition (T568-B on one end, T568-A on the other). Only two pairs of the four are crossed over in that scheme. For a 1000 Mbps crossover all four pairs must be crossed. These details are dealt with in the following instructions. Only cables of like wiring standard should be interconnected, due to the signal concerns discussed earlier.

Each of the following tables describe the wire assignments of a standard RJ-45 Ethernet connector against several wiring schemes, with pin #1 being the leftmost pin of the connector when viewed clip down with the cable slot facing you:

T-568-B

1	2	3	4	5	6	7	8
white/orange	orange	white/green	blue	white/blue	green	white/brown	brown

T-568-A (2-pair flip with T-568-B makes 10/100 Mbps crossover cable)

1	2	3	4	5	6	7	8
white/green	green	white/orange	blue	white/blue	orange	white/brown	brown

Gigabit Crossover (4-pair flip with T-568-B makes 10/100/1000 Mbps crossover cable)

1	2	3	4	5	6	7	8
white/green	green	white/orange	white/brown	brown	orange	blue	white/blue

Cable Assembly Prep

For this patch cable example we will use 24-gauge stranded CAT 5e cable, RJ-45 connectors, and anti-snag boots to build a common 10/100 Mbps Ethernet cable. The most important points in this discussion are the techniques involved.

For starters, obtain the following items (seemingly insignificant items are significant, see Figure-1):

- Length of CAT 5e **stranded** 24-gauge Ethernet UTP cable
- Two RJ-45 connectors
- Two anti-snag boots
- Sharp long-handled scissors
- Heavy duty rubber band (extremely important)
- Sharpened pencil and a piece of graph paper
- Crimp tool
- Fine point permanent marker



Figure-1: Basic cable-making goodies.

Cable Assembly Steps (T-568-B straight thru common cable)

1. Carefully trace the RJ-45 connector as shown in Figure-2, marking the cable jacket limit and the individual wire run length. This template can be reused for future cable construction.

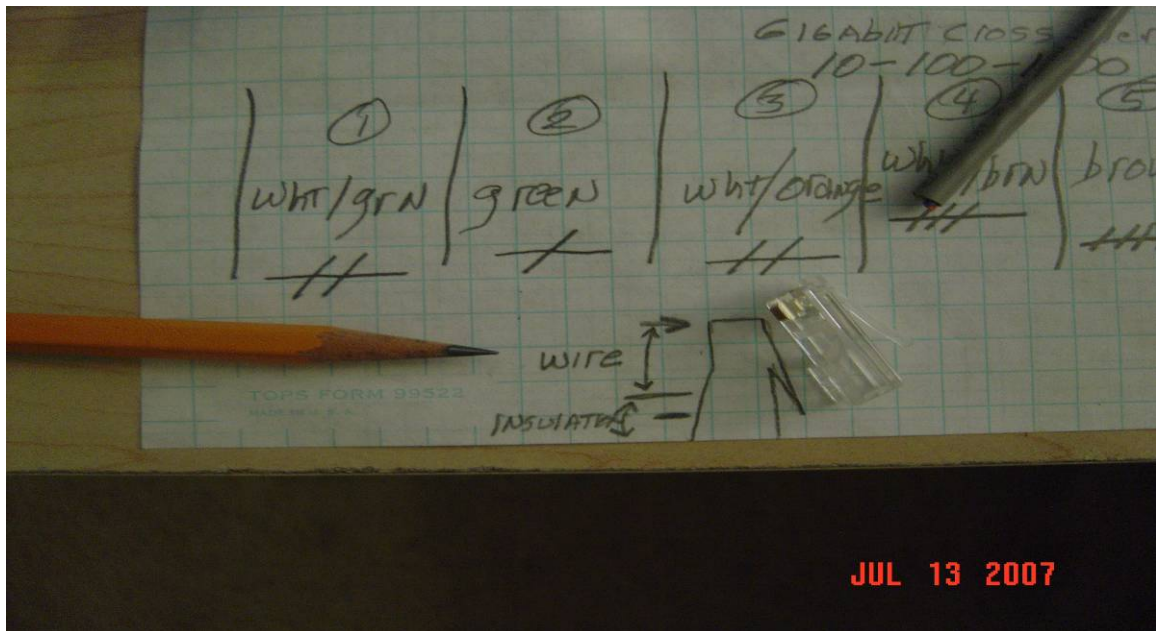


Figure-2: trace a template at the edge of the paper using the RJ-45 blank as a guide.

2. Put an S-bend in the cable and secure with the rubber band. Using the cable crimp tool cut off a centimeter or two (half an inch) from the cable end so that all of the wires are straight across (Figure-3).

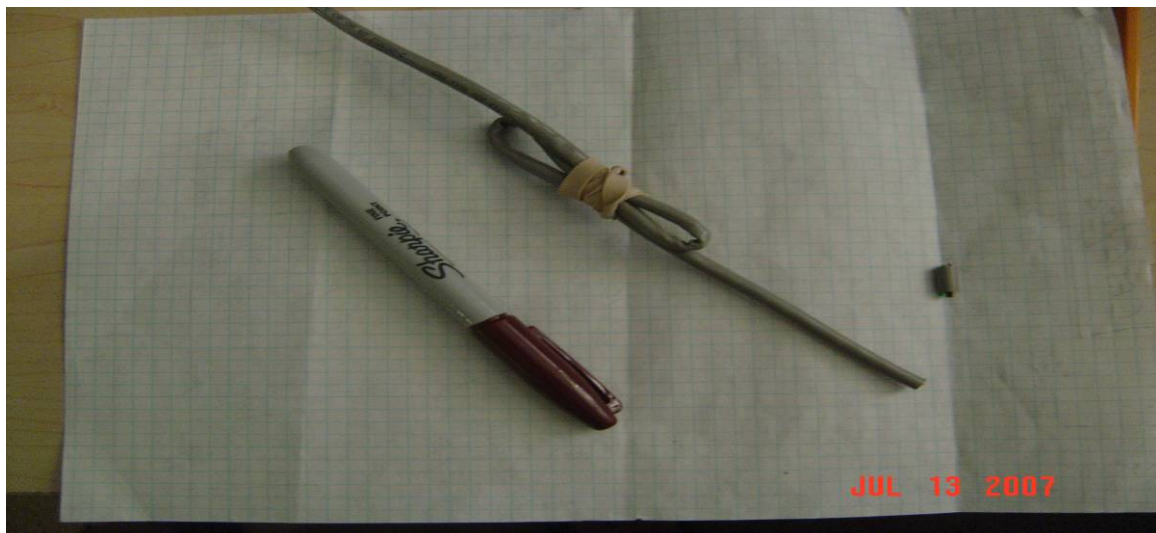


Figure-3: the bends...and a little off the top.

- Using the template, mark off the cable's jacket limit with the fine point marker as shown in Figure-4.

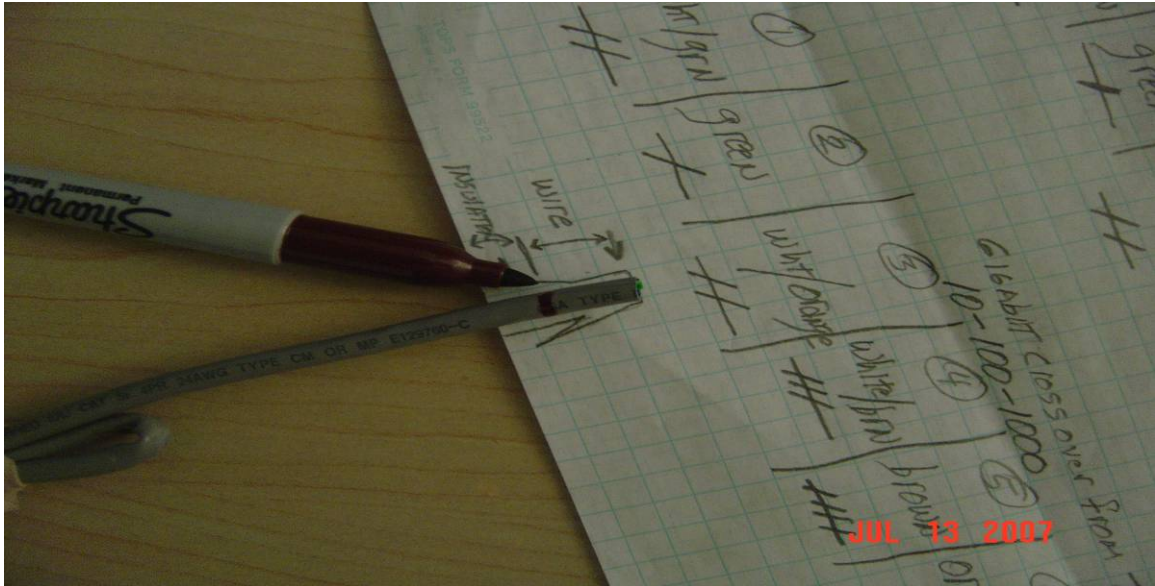


Figure-4: marking the cable jacket.

- Cut the cable jacket along the jacket limit mark of step 3 (Figure-5). The S-bend provides a good handle from which to help control the cut.



Figure-5: cutting the cable jacket. Rotate the wire not more than one time around.

- Bend the orange wire pair left and the brown pair right, untwisting and straightening both. Bend the blue pair left 30 degrees and the green pair right 30

degrees, untwisting and straightening as well (Figure-6). Arrange the orange and brown pairs in the order specified by the T-568-B wiring scheme.



Figure-6: untwisting, straightening, and (somewhat) ordering the wires.

6. Arrange the remaining wires according to the T-568-B wiring scheme and flatten them tightly between your thumb and forefinger (Figure-7). Trim wire ends with the long-handled sharp scissors to ensure that the wires are the same length. Such trimming is usually not required.



Figure 7: flatten and arrange the wires forward.

7. Slide the wires into the RJ-45 connector with the connector's clip side down. If you are lucky you will get the wires in their proper position on the first try. More likely there will be one or two wires not properly in place. This is to be expected. The main thing to keep in mind is that in this step we are using the RJ-45 connector to further straighten the wires into their eventual position. So if the wires are off their mark don't worry about it and instead work the wire/connector assembly so that the wires adjust their form to the connector (see Figure-8). The other thing to bear in mind is that what we are doing is similar to rolling an 8-sided die: each insertion attempt will have a degree of randomness to it as the wires find their way through the connector. The idea is to observe whatever mismatches occurred and then slightly bend the offending wire(s) in such a way as to increase the probability of correct insertion next time. **This is somewhat contrary to the more novice action of trying to get the wires perfectly in order prior to insertion, and then retrying over and over again.** *Such technique is counterproductive when taken beyond simple wire prep because a properly ordered set may not be properly ordered after transitioning the RJ-45.* Thus, it is most efficient to observe the results of the insertion and adjust accordingly rather than attempting to maintain perfect order throughout the process. In preparing this document it took me 3 tries to get the wires right, taking less than two minutes total (the other side of the cable took only 2 tries, at less than a minute). This is typical.



Figure-8: Working the wires into the RJ-45. Failure to position all wires correctly the first time is hardly a failure as insertion serves regardless to orient the wires to the RJ-45's wire guides. This photo shows initial insertion of the wires. Fully inserted the cable jacket will pass beneath the RJ-45's strain relief.

8. Butt all the wires of a successful insertion against the end of the RJ-45 and crimp (Figure-9). They should be straight across, thanks to the S-bend which keeps the individual wires from creeping around in the jacket during cable construction.



Figure-9: crimp city. The tool is designed to allow you to give it everything you got, so please do. The tool should (and must) completely close.

9. Remove the rubber band and insert two anti-snag boots as shown in Figure-10.



Figure-10: one side completed, and both anti-snag boots installed.

10. Repeat exactly for the other side, double checking that the anti-snag boots are properly installed on the cable. Finally, enjoy your new low-cost, high-performance cable (Figure-11).



Figure-11: the 5 minute, \$1.50 custom network cable.

11. Total time: under 5 minutes. Savings: about \$20 per cable compared to COTS, much more over a custom-built cable, whose costs are truly nosebleed.

TIP: buy your RJ-45s and anti-snag boots from an electronics supply store. The prices elsewhere are crazy, and of course most other kinds of stores won't be carrying anti-snag boots. Also, keep all your cable-building goodies together in a single bag or box so that there is less inclination to burn cash for sub-optimally sized store-bought cables. One last tip: keep your cable tools protected. Any nick or deformity on their cutting surfaces will render them unreliable. I keep mine in their original packaging.

Reliability: I have yet to build a cable that did not work first time. I have also never had a cable of my building fail for any reason. Some I use are 10+ years old now, and have seen many projects, though I have had commercial cables fail. Most commercial cable failures were due to improper cable jacket cutting which resulted in no strain relief afforded to the cable. I have also seen cables from custom shops not properly butted against the RJ-45 connector terminator block, resulting in flakey connections. No cable lasts forever, but I've yet to see one of mine fail. Building your own cables allows you to avoid a lot of snafus while at the same time affording significant savings to your projects.

Happy cable building.