TEJ – Computer Technology

Making Ethernet UTP Cables

Communication in a networked environment requires a source (that sends data), a destination (to receive the data), and a channel along which the data will travel. In a small local area network (LAN), this channel may be wired or wireless. A wired channel that is local will commonly be unshielded twisted pair (UTP) cabling, terminated with RJ45 jacks.

UTP cabling is the most common wired connection medium for LANs in the world. Removal of the outside protective jacket on TP cabling will show four pairs of insulated copper wires that are twisted together and housed in a protective jacket. Like all copper cables, twisted pair uses pulses of electricity to transmit data. UTP cable is inexpensive, offers a high bandwidth, and is easy to install.

Constructing any type of cabling requires adherence to cabling standards. These standards have been created to ensure that data networks perform at a given level, in terms of reliability of data transmission, safety, integrity, etc. Standards specify cable limitations regarding the surrounding physical environment, for example, is the environment exposed to frequent electrical storms or one that contains heavy machinery, and therefore, electromagnetic and radio frequency interference. Cabling standards also specify the minimum component materials, the length of the cable, the connector types, the pinouts, etc.

Cabling standards will be indicated and should be kept in mind during cable construction, to ensure the highest integrity of signal reception.

LAN cabling may require the use of a straight-through or a crossover cable, depending on the network devices that will be connected. (Note that there are additional types of twisted pair cabling occurring in networking, including rollover cables that will not be discussed and are not required for small LANs.)

A straight-through cable is required when connecting the following:

- Switch port to PC
- Hub port to PC
- Switch port to router port

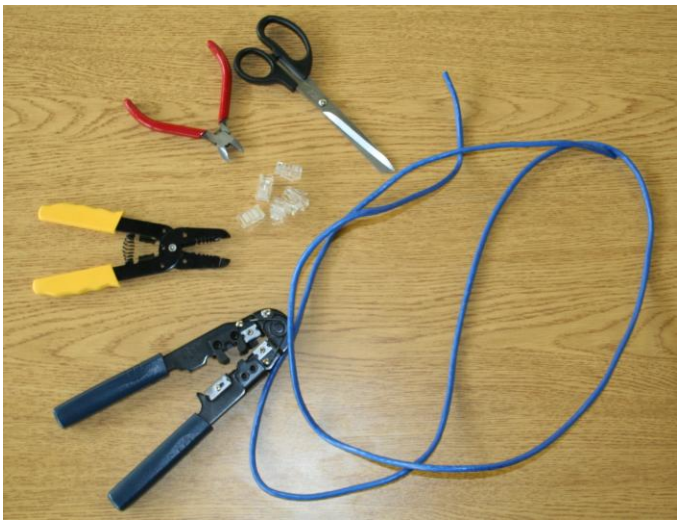
A crossover cable is required when connecting the following:

- PC to PC
- PC to router port (not an Integrated Services Router)
- Switch port to switch port
- Switch port to hub port
- Hub port to hub port
- Router port to router port

Hence, a crossover cable is required when the devices are *like* devices, meaning, two equivalent devices, or two devices whose wiring of the NIC card sending device is equivalent to the wiring of the receiving device. The wiring being referred to here is the order of the eight wires (pins) inside the RJ45 jack.

Regardless of which type of cable is required (straight-through or crossover) you will need the following materials:

What You Need

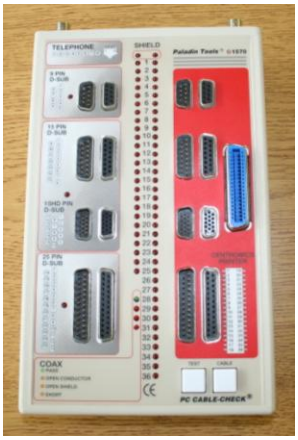


Cable – Cable should be rated as Cat or Cat5E, and can be purchased in 1000' spools from an electronics supplier. Cat5 cable supports 100 Mbps data transmission rate, up to 1000 Mbps (though not recommended). Cat5e supports 1000 Mbps data transmission.

RJ45 Jacks – RJ 45 jacks can be purchased in bulk from an electronics supplier. RJ45 jacks have a front and a back (indicated by a clip). The front of the jack has eight raised gold pins, that when crimped, will securely hold the arranged copper wires fed inside of the jack.

Wire Stripper – This tool will assist in stripping off a portion of the plastic jacket on the cable, exposing the twisted pairs of copper wires inside the cable.

Scissors – Used to snip of the rip cord inside the cable.



Crimper – used to affix the RJ45 jack on to the end of the cable, by depressing the gold pins on the jack firmly into the aligned copper wires. Purchase a high quality crimper (approx $50-60). Some crimpers include a wire stripper and wire cutters as part of the device. If the crimpers include a wire cutter, instruct the students on safe usage.

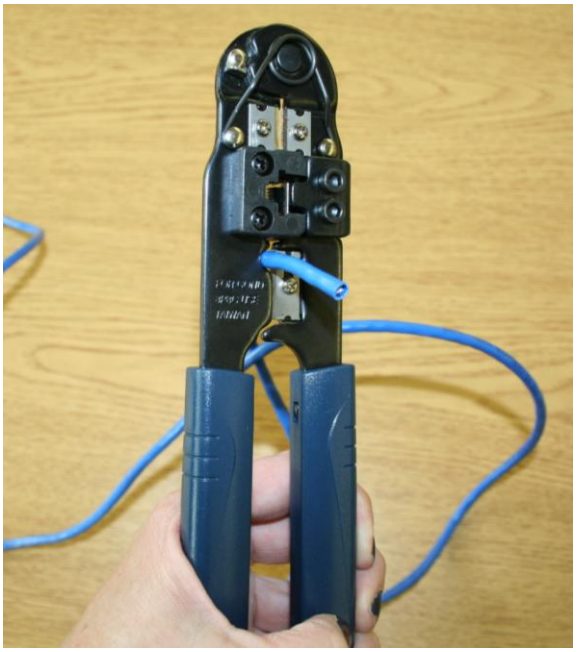
Wire cutters – used to cleanly snip off the copper wires, in a straight line.

Cable Tester – Allows testing of the pinouts.

Initial Steps

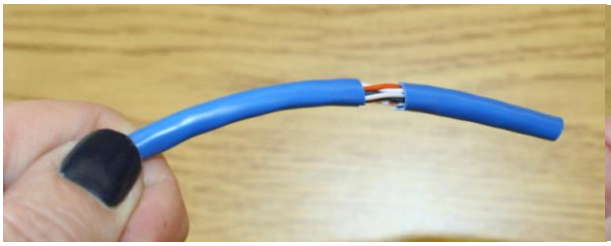
1. Cut off a length of cable (approximately 1 metre) for each student.
2. Distribute two RJ45 jacks to each student, instruct them to store them in their pocket until needed.
3. Strip off about 1 inch of the plastic jacket from both ends of the cable, exposing the four pairs of twisted wires and rip cord. I use the stripping edge of the multi-purpose crimpers for this activity. Run the cable allowing the jacket to be gently scored, then remove the jacket.

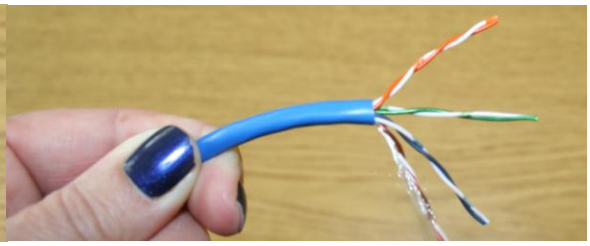
Note: Use caution to avoid nicking or breaking the copper cabling inside. Check the exposed wires for nicks or cuts. If there are any, cut the entire end off and start again.



These crimpers have a groove that allows easy stripping of the PVC jacket, as shown in the diagram.

4. Spread the four pairs of twisted wires apart, and untwist approx 1" of each pair (to the beginning of the outside jacket).
   Note: It is very important to untwist the minimum required, as the twisting of wires provides noise cancellation.



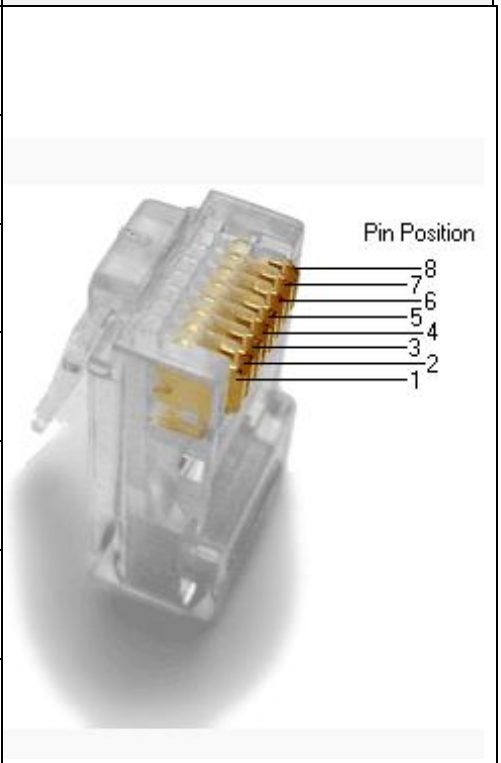


Your next step is ordering the wires.

Wiring Order

CAT 5/5E cabling consists of four pairs of colour coded wires: green and white/green, orange and white/orange, blue and white/blue, and brown and white/brown. These colour coded wires are twisted within the cable, and must be untwisted and ordered correctly, before inserting into the RJ45 jack for crimping.

The order that these wires must take within the jack is defined by a standard developed by the TIA/EIA organization. The two different patterns, or wiring schemes are called T568A and T568B, and are as follows:

Pin	T568A Color	T568B Color	Pins on RJ45 Jack
1	white/green	white/orange	
2	green	orange	
3	white/orange	white/green	
4	blue	blue	
5	white/blue	white/blue	
6	orange	green	
7	white/brown	white/brown	
8	brown	brown	

The two schemes are similar except two of the four pairs are reversed in the termination order. The graphic shows this color-coding and how the two pairs are reversed.

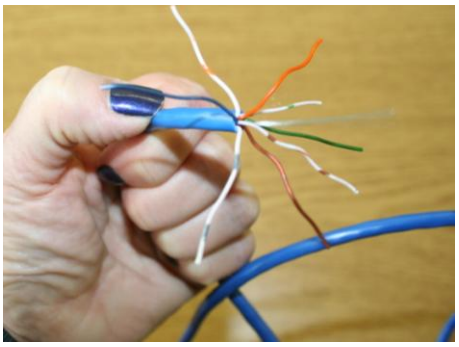
Wiring order, or pinout, is dependent on the cable being constructed. For straight-through cables, the pinout on BOTH ends of the cable will follow either T568A or T568B. On a network installation, one of the two wiring schemes should be chosen and followed. It is important that the same wiring scheme is used for every termination in that project.

For crossover cables, the pinout on ONE end of the cable will be T568A, and the pinout of the other end will be T568B.

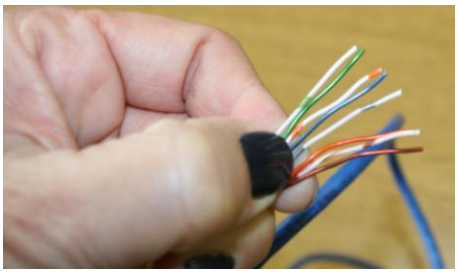
Making a Straight-Through Cable

Choose a pinout alignment that corresponds to that which is followed in your school, either T568A or T568B. Both ends of the cable will follow the same standard. For the purposes of example, let's choose T568A.

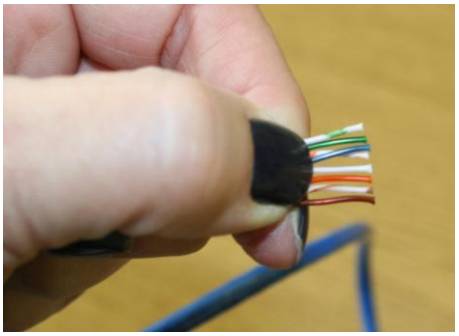
At this point, one inch of the plastic PVC jacket has been stripped, the exposed rip cord has been cut, and the four pairs of wires have been untwisted to the beginning of the jacket.



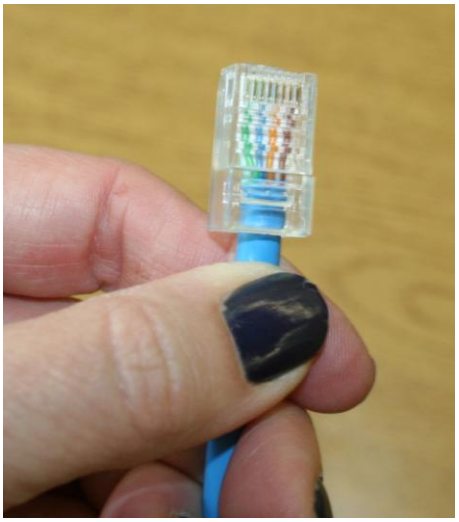
1. Spread the wires apart, taking care to hold firmly onto the base of the jacket with your other hand. You do not want the wires to become untwisted down inside the jacket.



2. Align the coloured wires in the pattern indicated by T568A, that is, the first wire will be white/green, then orange, then green, etc. Straighten the wires as you align them, and grasp tightly with your thumb. The wires will not want to align in this manner and need to be held tightly.



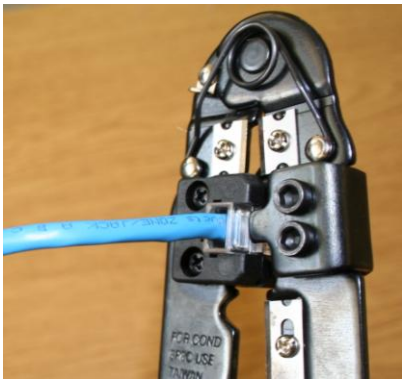
3. With your thumb over the end of the plastic jacket, trim the ordered wires with your cutters to no more than 1 centimeter long. It is important that all wires are trimmed straight, and cut cleanly, maintaining the required order, and no longer or shorter than one centimeter.



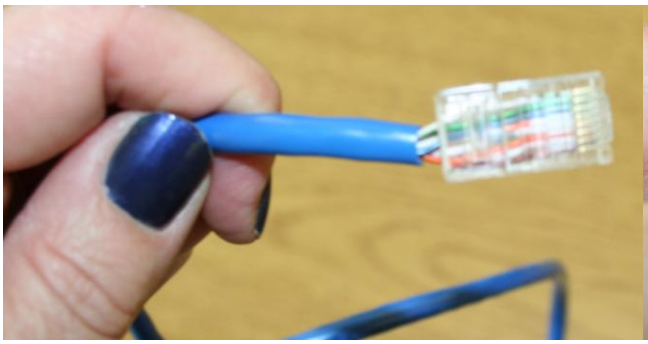
4. With the front of the jack facing you (the clip is the back of the jack), insert the wires stiffly and firmly into the end of the jack. The jacket of the cable will fit inside the jack, and all copper wires MUST extend to the end of the jack.

5. Visually inspect the copper wires from the top of the jack. Ensure that the alignment follows the proper order, and that the PVC jacket is within the jack, by several millimetres (eg. 3+ millimetres.) Visually inspect both sides of the jack. Ensure that the copper wires extend fully to the end of the jack.

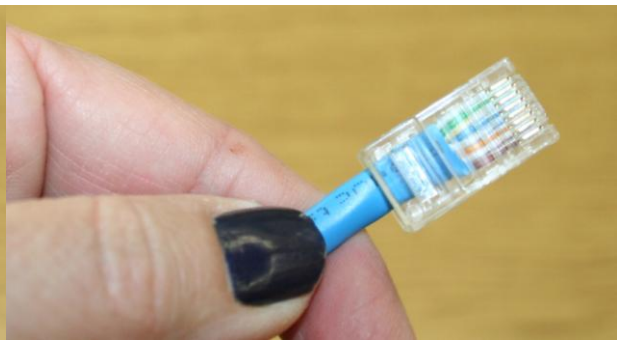
6. Insert the jack into the crimper, and crimp it good (you may hear a clicking sound). (At this point, the raised gold contacts will be pressed into the copper wires and hold them firmly in place.)



7. Repeat the steps for the other end of the cable.



Bad cable – too much wire exposed



Good cable

Testing the Cable

With your cable tester, insert both ends of the cable. Choose the appropriate cable setting, and test each pinout. As each end of a straight-though cable is identical, the wire mapping will indicate:

1-1
2-2
3-3
4-4
5-5
6-6
7-7
8-8.

This indicates a successful straight-through cable construction.

Making a Crossover Cable

As mentioned earlier, a crossover cable is required when connecting two like devices in a Local Area Network. For example, this cable can be used to directly connect two computers to each other without

the use of a hub or switch. The ends on a crossover cable are different from each other, whereas a normal 'straight through' cable has identical ends.

In a crossover cable, one end of the cable will follow the T568A pinout, and the other end of the cable will follow the T568B pinout.

Implementation in Classroom

Have students successfully create a straight-through cable (both ends following T568A, for example). Once marked, instruct the student to cut off one end of the cable, provide the student with one additional RJ45 jack, and, on this same end, create a T568B pinout arrangement, effectively converting a straight-through cable to a functioning crossover cable.

Testing the Cable

With your cable tester, insert both ends of the cable. Choose the appropriate cable setting, and test each pinout. As each end of a straight-though cable is identical, the wire mapping will indicate:

1-3
2-6
3-1
4-4
5-5
6-2
7-7
8-8.

This indicates successful crossover cable construction.

Additional Notes

With their newfound expertise, students may wish to construct a lengthy cable for home use (eg. for connecting their gaming system directly to their home router). You may give the opportunity for the students to create a longer straight-through cable for home use, and charge a nominal amount (eg. 10-15 cents per foot of cable required.)

YouTube Reference:

http://www.youtube.com/watch?v=482VtesZwZ8