

# **How to wire your own Ethernet cables and connectors.**

## **What You Need:**

### Required:

- Ethernet Cable - bulk Category (Cat) 5, 5e, 6, 6a, 7 or 7a
- Wire Cutters - to cut and strip the Ethernet cable if necessary
- **For Patch Cables:**
  - o RJ45 Plugs
  - o RJ45 Crimper
- **For Fixed Wiring:**
  - o RJ45 Jacks
  - o 110 Punch Down Tool

### Recommended:

- Wire Stripper
- Cable Tester

## **About the Cable:**

Bulk Ethernet cable is available at many computer stores, electrical retailers and online.

This cable comes in two types: **UTP (Unshielded Twisted Pair)** and **STP (Shielded Twisted Pair)** for extra resistance to external interference.

There are 2 basic categories, solid and braided cable:

**Braided Ethernet cable** tends to work better in patch applications for desktop use. It is more flexible and resilient than solid Ethernet cable and easier to work with, but really meant for shorter lengths.

**Solid Ethernet cable** is meant for longer runs in a fixed position. Plenum rated Ethernet cable must be used whenever the cable travels through an air circulation space. For example, above a false ceiling or below a raised floor. It may be difficult or impossible to tell from the package or labelling what type of Ethernet cable it is, so peel out an end and investigate.

## **Requirements for each cable:**

Cat 5 is required for basic 10/100 Megabits per second (Mbps) functionality.

Cat 5e for gigabit (1000BaseT) operation and Cat 6 or higher gives you a measure of future proofing. It is backward compatible and thus is shown widely as 10/100/1000 Megabits per second.

Here is what the internals of the Ethernet cable look like:



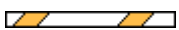
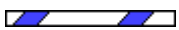
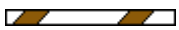
Internal Cable Structure and Colour Coding

Inside the Ethernet cable there are 8 colour coded wires. These wires are twisted into 4 pairs of wires, each pair has a common colour theme. One wire in the pair being a solid or primarily solid coloured wire and the other being a primarily white wire with a coloured stripe (Sometimes Ethernet cables won't have any colour on the striped wire, the only way to tell which is which is to check which wire it is twisted around). Examples of the naming schemes used are: Orange (alternatively Orange/White) for the solid coloured wire and White/Orange for the striped cable.

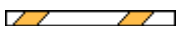
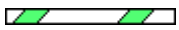
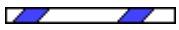
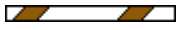
The twists are extremely important. They are there to counteract noise and interference. It is important to wire according to a standard to get proper performance from the Ethernet cable. The TIA/EIA-568-A specifies two wiring standards for an 8-position modular connector such as an RJ45. The two wiring standards, T568A and T568B, vary only in the arrangement of the coloured pairs. Your choice might be determined by the need to match existing wiring, jacks or personal preference, but you should maintain consistency. I've shown both below for straight through cabling and just T568B for crossover cabling.

Generally the T568B wiring is used in the UK but some use the T568A standard.

**Standard, Straight-Through Wiring Diagram (both ends are the same):**

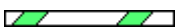
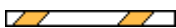
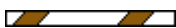
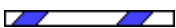
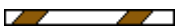
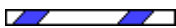
| RJ45 Pin # | Wire Colour (T568A) | Wire Diagram (T568A)                                                                | 10Base-T Signal<br>100Base-TX Signal | 1000Base-T Signal |
|------------|---------------------|-------------------------------------------------------------------------------------|--------------------------------------|-------------------|
| 1          | White/Green         |    | Transmit+                            | BI_DA+            |
| 2          | Green               |   | Transmit-                            | BI_DA-            |
| 3          | White/Orange        |  | Receive+                             | BI_DB+            |
| 4          | Blue                |  | Unused                               | BI_DC+            |
| 5          | White/Blue          |  | Unused                               | BI_DC-            |
| 6          | Orange              |  | Receive-                             | BI_DB-            |
| 7          | White/Brown         |  | Unused                               | BI_DD+            |
| 8          | Brown               |  | Unused                               | BI_DD-            |

Straight-Through Ethernet Cable Pin Out for T568A

| RJ45 Pin # | Wire Colour (T568B) | Wire Diagram (T568B)                                                                | 10Base-T Signal<br>100Base-TX Signal | 1000Base-T Signal |
|------------|---------------------|-------------------------------------------------------------------------------------|--------------------------------------|-------------------|
| 1          | White/Orange        |  | Transmit+                            | BI_DA+            |
| 2          | Orange              |  | Transmit-                            | BI_DA-            |
| 3          | White/Green         |  | Receive+                             | BI_DB+            |
| 4          | Blue                |  | Unused                               | BI_DC+            |
| 5          | White/Blue          |  | Unused                               | BI_DC-            |
| 6          | Green               |  | Receive-                             | BI_DB-            |
| 7          | White/Brown         |  | Unused                               | BI_DD+            |
| 8          | Brown               |  | Unused                               | BI_DD-            |

Straight-Through Ethernet Cable Pin Out for T568B

### Crossover Cable Wiring Diagram (T568B):

| RJ45 Pin # (END 1) | Wire Colour  | Diagram End #1                                                                    | RJ45 Pin # (END 2) | Wire Colour  | Diagram End #2                                                                      |
|--------------------|--------------|-----------------------------------------------------------------------------------|--------------------|--------------|-------------------------------------------------------------------------------------|
| 1                  | White/Orange |  | 1                  | White/Green  |  |
| 2                  | Orange       |  | 2                  | Green        |  |
| 3                  | White/Green  |  | 3                  | White/Orange |  |
| 4                  | Blue         |  | 4                  | White/Brown  |  |
| 5                  | White/Blue   |  | 5                  | Brown        |  |
| 6                  | Green        |  | 6                  | Orange       |  |
| 7                  | White/Brown  |  | 7                  | Blue         |  |
| 8                  | Brown        |  | 8                  | White/Blue   |  |

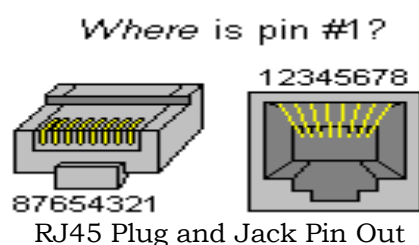
Crossover Ethernet Cable Pin Outs

N.B. The crossover layout is suitable for 1000Base-T operation, all 4 pairs are crossed.

### About RJ45 Plugs and Jacks:

The RJ45 plug is an 8-position modular connector that looks like a large phone plug. There are a couple variations available. The primary variation you need to pay attention to is whether the connector is intended for braided or solid wire. For braided/stranded wires, the connector has sharp pointed contacts that actually pierce the wire. For solid wires, the connector has fingers which cut through the insulation and make contact with the wire by grasping it from both sides. The connector is the weak point in an Ethernet cable, choosing the wrong one will often cause grief later. If you just walk into a computer store, it's nearly impossible to tell what type of plug it is. You may be able to determine what type it is by crimping one without a cable.

RJ45 jacks come in a variety of styles intended for several different mounting options. The choice is one of requirements and preference. RJ45 jacks are designed to work only with solid Ethernet cable. Most jacks come labelled with colour coded wiring diagrams for either T568A, T568B or both. Make sure you end up with the correct one.



### Ethernet Cable Pin Outs:

There are two basic Ethernet cable pin outs. A **straight through** Ethernet cable which is used to connect to a router, hub or switch, and a **crossover** Ethernet cable used to operate in a peer-to-peer (direct computer to computer) fashion without a router/hub/switch. Generally all fixed wiring should be run as straight through. Some Ethernet interfaces (routers) can cross and un-cross a cable automatically as needed which is very convenient.

### **How to wire Ethernet Patch Cables:**

1. Strip off about 2 inches of the Ethernet cable sheath.
2. Untwist the pairs - don't untwist them beyond what you have exposed, the more untwisted cable you have the worse the problems you can run into.
3. Align the coloured wires according to the wiring diagrams above.
4. Trim all the wires to the same length, about 1/2" to 3/4" left exposed from the sheath. There is NO need to bare the end of the wires.
5. Insert the wires into the RJ45 plug - make sure each wire is fully inserted to the front of the RJ45 plug and in the correct order (very fiddly and frustrating at times). The sheath of the Ethernet cable should extend into the RJ45 plug by about 1/2" and will be held in place by the crimp tool when finished off.
6. Crimp the RJ45 plug with the crimping tool.
7. Verify the wires ended up the right order and that the wires extend to the front of the RJ45 plug and make good contact with the metal contacts in the RJ45 plug.
8. Cut the Ethernet cable to length - make sure it is more than long enough for your needs.
9. Repeat the above steps for the second RJ45 plug.

### **How to wire fixed Ethernet Cables:**

1. Run the full length of Ethernet cable in place, from endpoint to endpoint, making sure to leave excess so the cable can 'relax'.
2. At one end, cut the wire to length leaving enough length to work, but not too much excess.
3. Strip off about 2 inches of the Ethernet cable sheath.
4. Align each of the coloured wires according to the layout of the jack.
5. Use the punch down tool to insert each wire into the jack.
6. Repeat the above steps for the second RJ45 jack.

If an Ethernet cable tester is available use it to verify the proper connectivity of the cable. Don't plug it into the network expecting immediate results. A simple visual check is often enough to detect faults in wiring or connections that are not right. Look closely at each end and see if you can find the problem. Often a wire ended up in the wrong place or one of the wires is making no, or poor, contact with the pins of the RJ45. Also double check the colour coding to verify it is correct. If you see a mistake or problem, cut the end off and start again.

When sizing Ethernet cables remember that an end to end connection should not extend more than 100m (328ft). Try to minimize the Ethernet cable length, the longer the cable becomes, the more it may affect performance. This is usually noticeable as a gradual decrease in speed and increase in latency.

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