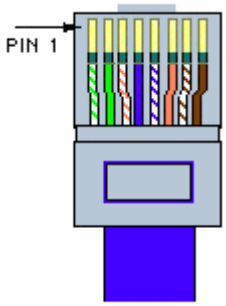
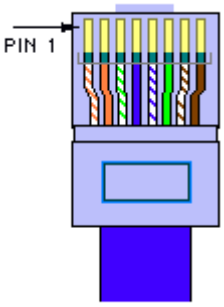
SBA Lab Act. 4.2.2.7 Building LAN Cable - Cross Over

1. XO Wiremap - identify the type of cable used, the standard.

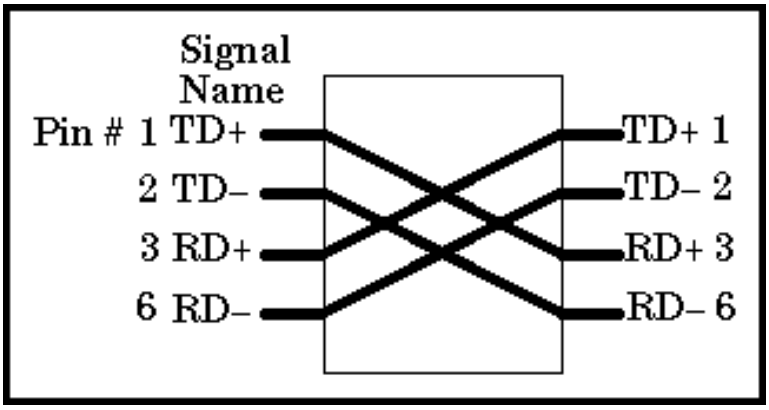
Crossover Cable	
RJ-45 PIN	**RJ-45 PIN**
1 Rx+	3 Tx+
2 Rc-	6 Tx-
3 Tx+	1 Rc+
6 Tx-	2 Rc-
 568A Male	 568B Male
Straight Through Cable	
RJ-45 PIN	**RJ-45 PIN**
1 Tx+	1 Rc+
2 Tx-	2 Rc-
3 Rc+	3 Tx+
6 Rc-	6 Tx-

A crossover cable is required when connecting a Hub to a Hub, or a Transceiver to Transceiver, or NIC to NIC card, or Transceiver to NIC card. When connecting a Hub to a transceiver or NIC card, a straight through cable is always used. Please Note: Some products are equipped with internal switches that can internally cross the twisted pairs.

10BASE-T Crossover Wiring

When connecting two twisted-pair MAUs together over a segment, the transmit data pins of one eight-pin connector must be wired to the receive data pins of the other, and vice versa. The crossover wiring may be accomplished in two ways: with a special cable or inside the hub.

For a single segment connecting only two computers you can provide the signal crossover by building a crossover cable, with the transmit pins on the eight-pin plug at one end of the cable wired to the receive data pins on the eight-pin plug at the other end of the crossover cable and vice versa.



However, when you are wiring multiple segments in a building it's much easier to wire the cable connectors "straight through," and not worry about whether the wires in the jumper cables or other twisted-pair cables in your building have been correctly crossed over. The way to accomplish this is to do all the crossover wiring at one point in the system: inside the multiport hub.

The standard recommends that the signal crossover be done internally in each hub port. If the crossover function is done inside a hub port, then the standard notes that the port should be marked with an "X.

The two standards for wiring Ethernet cables are T568A and T568B. T568B is the most common and is what we'll be using for our straight Ethernet cable. The tables below show the proper orientation of the colored wires to the pins.

TIA/EIA-568-B.1-2001 is likely the most commonly used and talked about feature of the specification created in 1988. 568-a is the definition of pin assignments for the pairs within Category 3 (CAT3), Category 5 (CAT5) and Category 6 (CAT6) unshielded twisted-pair (UTP) cables (eight conductor, 100-ohm balanced twisted pair cabling). The Pin/Pair assignments were named T568A and T568b, both of which define the pinout or specific order the UTP pairs need to be terminated within 8P8C (Eight Position, Eight Conductor) modular connecters, also known as RJ45 connectors.

The 568A and 568B standards were developed to provide more effective communications for longer distances in a Cat5e cable segment than using non-standard schemes. Fiber Optic cable is the only medium that is completely immune to crosstalk and EMI since it uses light to transfer data instead of electrical current.

An example of an Ethernet Media Standard is 10Base-T. The first part of the previous Media Standard "10" specifies the transmission speed (in this case 10, Mbps). The second part of the name "Base" specifies that the type of signal used for data transfer in this particular Ethernet standard is baseband signal. The final part of the Ethernet Media Standard specifies the kind of cable used. Here "T" specifies twisted-pair cable.

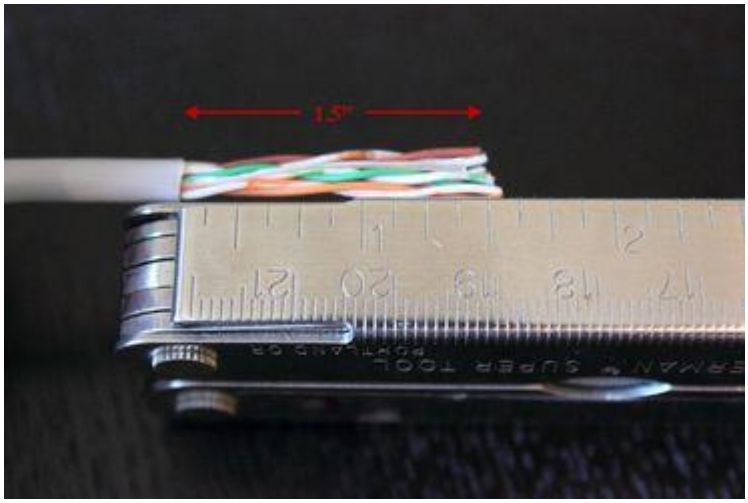
Ethernet Media Standards, type of cable used, supported bandwidth speed and maximum supported cable length for data transfer.

Media Standard	Cable Type	Bandwidth Capacity	Maximum Length
10Base2	Coaxial	10 Mbps	185m
10Base5	Coaxial	10 Mbps	500m
10BaseT	UTP (CAT 3 or higher)	10 Mbps	100m
100BaseTX	UTP (CAT 5 or higher)	100 Mbps	100m
10BaseFL	Fibre Optic	10 Mbps	2Km
100BaseFX	Fibre Optic	100 Mbps	HD 400m/FD 2km
1000BaseT	UTP (CAT 6 or higher)	1 Gbps (1000 Mbps)	100m
10GBase-T	UTP (Cat 6a or higher)	10 Gbps (10000 Mbps)	100m
1000BaseSX	Fibre Optic	1 Gbps (1000 Mbps)	MMF 550m
1000BaseLX	Fibre Optic	1 Gbps (1000 Mbps)	MMF 500m/SMF 10km
1000BaseCX	Fibre Optic	1 Gbps (1000 Mbps)	100m
10GbaseSR	Fibre Optic	10 Gbps	300m
10GbaseLR	Fibre Optic	10 Gbps	SMF 10km

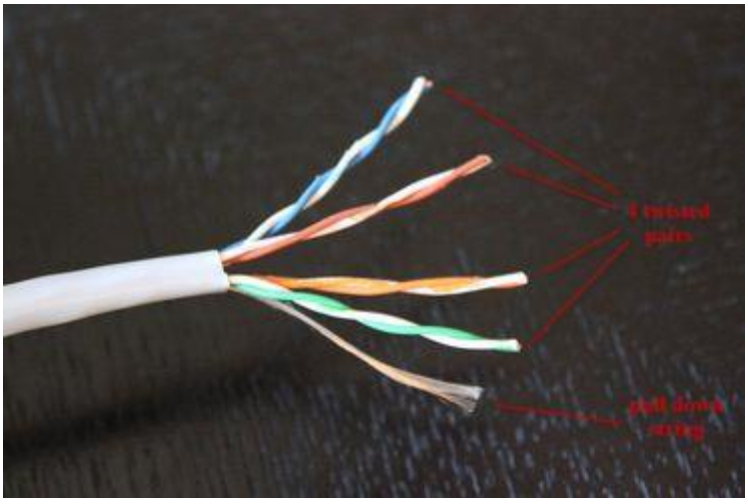
Note: X represents a higher grade of connection, and 100BaseTX is twisted-pair cable cabling that can use either UTP or STP at 100 Mbps. With fiber-optic cable such as 100BaseFX, the speed is quicker than standard 10BaseF. The “L” stands for “Long” in long wave length lasers and "S" stands for Short Wave Length.

2. Step by Step procedure in building cable.

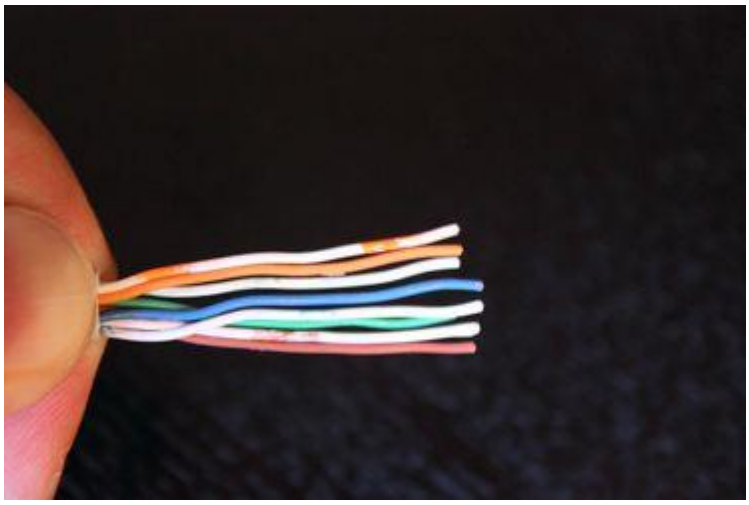
Step 1: Strip the cable jacket about 1.5 inch down from the end.



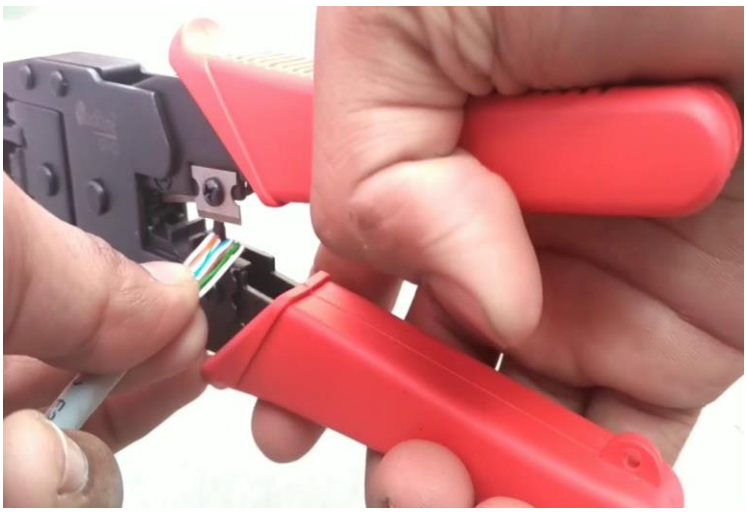
Step 2: Spread the four pairs of twisted wire apart. For Cat 5e, you can use the pull string to strip the jacket farther down if you need to, then cut the pull string. Cat 6 cables have a spine that will also need to be cut.



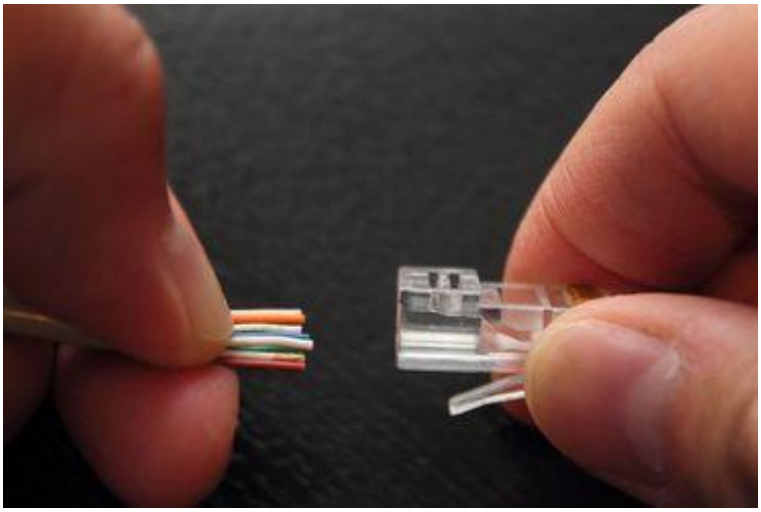
Step 3: Untwist the wire pairs and neatly align them in the T568B orientation. Be sure not to untwist them any farther down the cable than where the jacket begins; we want to leave as much of the cable twisted as possible.



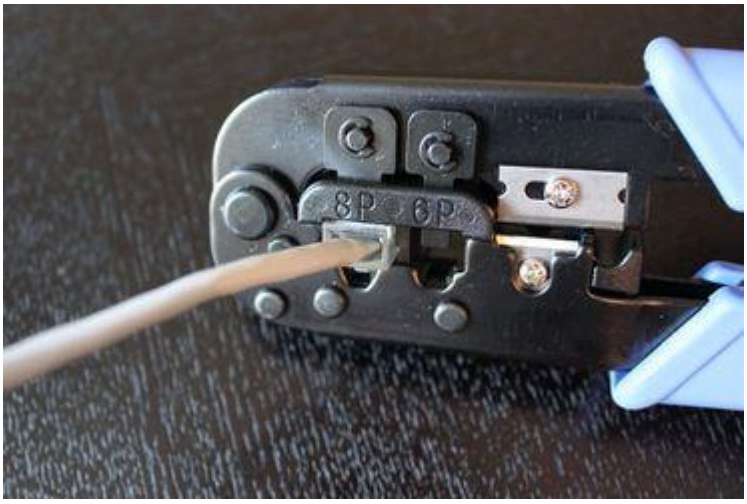
Step 4: Cut the wires as straight as possible, about 0.5 inch above the end of the jacket.



Step 5: Carefully insert the wires all the way into the modular connector, making sure that each wire passes through the appropriate guides inside the connector.



Step 6: Push the connector inside the crimping tool and squeeze the crimper all the way down.

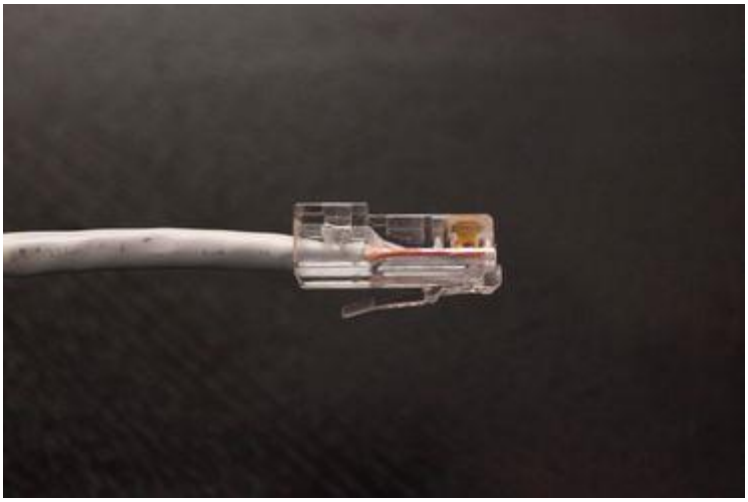


Step 7: Repeat steps 1-6 for the other end of the cable.

Step 8: To make sure you've successfully terminated each end of the cable, use a cable tester to test each pin.

In order to test the wire, either try using it on the live machines or use a cable tester to get detailed information about the wire in specific such as, what wires are where and how long is the whole cable. A tester can also determine what wires are in incorrect spots.

When you're all done, the connectors should look like this:



3. Tools used for building LAN Cables

- Unshielded twisted pair (UTP) patch cable
- Modular connector (8P8C plug, aka RJ45)
- Crimping tool
- Cable tester (optional, but recommended)

4. Cable Testing procedure.

- Compare cable data with drawings and specifications. Pay attention to the number of sets, the cable size, routing, and insulation ratings. Note these items on the test sheet.
- Check uncovered parts of cable for material damage. Look at the condition of the cable jacket and insulation of exposed sections. Verify that the connection points match what is shown on the project single-line diagram.
- Check bolted electrical connections for high resistance with the use of a calibrated torque-wrench, low-resistance ohmmeter or thermographic survey.
  - When using a calibrated torque wrench, reference ANSI/NETA Table 100.12 US Standard Fasteners, Bolt Torque Values for Electrical Connections.
  - The values of similar bolted connections must be compared and check which value shift by more than fifty percent of the smallest value in the case where a low resistance ohmmeter is utilized.
- Look at the condition of the exposed cable jacket and insulation when performing a visual inspection on low voltage wire and cable.
- Inspect compression-applied connections by verifying that the connector is properly rated for the installed cable size and has the proper indentations.
- Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test period must be for 1 minute using a voltage according to manufacturer's published data.
- If no literature from the manufacturer is available, apply 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Insulation-resistance values must be according to the manufacturer's published data. If no data from the manufacturer exists, the values should be no less than 100 megohms. Perform continuity tests to ensure correct cable connection and phasing.
- Verify uniform resistance of parallel conductors using a low-resistance ohmmeter. Measure the resistance of each cable individually and investigate deviations in resistance between parallel conductors.

Given below are various kinds of tests that are conducted on cables:

The following tests are type test of electrical power cable.

1. Persulphate test (for copper)
2. Annealing test (for copper)
3. Tensile test (for Aluminium)
4. Wrapping test (for Aluminium)
5. Conductor resistance test (for all)
6. Test for thickness of insulation (for all)
7. Measurement of overall diameter (where specified) (for all)

Physical tests for Insulation and Sheath

1. Tensile strength and elongation at break
2. Ageing in air oven
3. Ageing in air bomb
4. Ageing in oxygen bomb
5. Hot set
6. Oil resistance
7. Tear resistance
8. Insulation resistance
9. High voltage (water immersion) test
10. Flammability test (only for SE-3, SE-4)
11. Water abortion test (for insulation)

Acceptance test: The following shall constitute acceptance test:

1. Annealing test (for copper)
2. Tensile test (for Aluminium)
3. Wrapping test (for Aluminium)
4. Conductor resistance test
5. Test for thickness of insulation and sheath and overall diameter
6. Tensile strength and Elongation at break of insulation and heath
7. Hot set test for insulation and sheath
8. High voltage test
9. Insulation resistance test

Routine test: The following shall constitute the routine test.

1. Conductor resistance test
2. High voltage test
3. Insulation resistance test

How is Cable Testing Performed?

Given below are the tests done while cable testing is done:

Continuity Test

- The continuity test (also called low resistance measurement) is measuring the low resistance of cables, from 1 mΩ to 250 Ω.
- The continuity test can be made in 2 or 4 wires according to the resistance to be measured: 2 wires for resistances > 1 Ω, and 4 wires for resistances < 1 Ω.
- The continuity test in 2 wires mode consists in injecting a programmable current and measuring voltage and current at the terminals of the resistance to be tested. Ohm's law will give the exact value.
- In four wires mode or Kelvin method continuity test divide the switching matrix into 2 internal buses
- directing the test current
- conveying the voltage of the terminals of the element under measurement.

Even-addressed points are allocated to the SENSE of the measurement, odd points to injection of the current. This layout is doable all the way through the switching matrix and can be joint with two wire continuity tests.

- To give you an example, the continuity test in 4 wires mode lets you carry out measurements on wires of 50 cm length and 5/10 mm cross-section (between 7 and 13 mW) with good resolution.

Insulation Test:

- The insulation test also known as high resistance test is always made DC. The insulation test is combined with a short-circuit test and high voltage test in DC.
- The insulation test combines several functions.
- The insulation test can perform:
  - determining insulation resistances from fifty kilo ohm to two thousand mega ohm at high voltage i.e. from 20V to 2000V.
  - measurement of dielectric strength and detection of short circuits.
- The insulation test proceeds as follows:

- An initial test at low voltage (continuity measurement) to detect any short circuit (1). If a short circuit is found, the insulation test stops (the message SHORT CIRCUIT appears in the error list).
- If there is no short circuit, the high voltage is applied. During the programmable rise time (2), if breakdown occurs, the voltage is displayed and the test stops (the breakdown voltage is given in the error list).
- If no breakdown occurs and if the voltage does not reach the required value (±10%), the message U<Uprog appears in the error list.
- Next, the voltage is applied for the duration of the programmed application time (3). If breakdown occurs during this period, the moment when the fault appears is displayed in the error list and the test stops.
- Lastly, if all goes well, at the end of the application time (4), the insulation test is made, and the insulation resistance measured. The tester will add a measurement time as a function of the range requested. The measurement time varies from 20ms to 240ms according to range.
- To end the sequence, the tester reduces the high voltage and then discharges the unit tested to an earth resistance (total time 20ms).
- This procedure is identical at the end of every measurement of insulation.
- The dielectric strength test detects any sudden variation in the increase of the test current outside the programmed limit.
- The short circuit test or high voltage test can be programmed out of the test.

Phasing Test:

- The correct phasing of all LV circuits shall be checked at all positions where the LV cables are terminated into fuse bases and where any LV cable is run from point to point.
- This test shall be performed with an instrument designed for the purpose. Mains frequency voltage of 240 Volts is not acceptable for this test.
- The neutral conductor shall be connected to the earth stake for this test.

Earth Resistance Test:

- In any overhead or underground network, the earth resistance at any point along the length of a LV feeder is to have a maximum resistance of 10 ohms prior to connection to the existing network.
- In any overhead or underground network, the overall resistance to earth Shall be less than 1 ohm prior to connection to the existing network.

High Voltage Test:

- The high voltage test (also called dielectric strength test or hipot test) can be made in AC or DC. If the high voltage test is made in DC, it is then combined with insulation; if the high voltage test

is made in AC, it is then, this is then, more stressful for the sample and made according to the sketch below.

- Measurement of high voltage test under alternating current is performed using an alternating voltage (50Hz) adjustable to an effective 50V to 1,500V. As is the case with direct current, the high voltage test detects any sudden rise of current up to a programmed threshold.
- The short circuit test is maintained by default. The rise time is more than 500 ms and the application time at least one period.
- Warning: The high voltage test under alternating current is penalized by the capacitive value of the tested equipment. It must be remembered that the generator power is limited to 5 mA.

Benefits of Cable Testing

- Product warranties are limited
- Testing is less expensive than repair
- Periodic testing will futureproof the infrastructure

Reflection:

What is the use of a cross-over cable?

Crossover cables These are used **to connect two computers or similar devices directly together, such as computers or hubs**. To create a crossover cable is to rearrange the wires on one end of a standard Ethernet cable, so that they are in the following order. While in the past a crossover cable was required to connect two host devices directly, it is no longer necessary.

Give examples of the use of cross-over cable.

- Connecting a computer to a computer
- Connecting a router to a router
- Connecting a switch to a switch
- Connecting a hub to a hub and
- Connecting a router to a PC because both devices have the same components

What is the reason why do you use a wiremap when building cable?

Wiremapping is a simple test that confirms that each wire is hooked up correctly, with no opens or shorts. UTP intended only for POTS (plain old telephone service) voice applications actually only needs to be tested for wiremap. Wiremapping is very straightforward. Structured cabling standards do not consider simple voice grade cable, only cable of Category 3 or above, so most cable testing will require more than just wiremapping. Each pair must be connected to the correct pins at the plugs and jacks, with good contacts in the terminations. A "wiremapper" is basically a continuity checker that determines if pins are correctly connected.