SBA Lab Act. 4.2.2.6 Building LAN Cable - Straight Thru

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

Straight-through cable is **a type of CAT5 with RJ-45 connectors** at each end, and each has the same pin out. It is in accordance with either the T568A or T568B standards. It uses the same color code throughout the LAN for consistency.

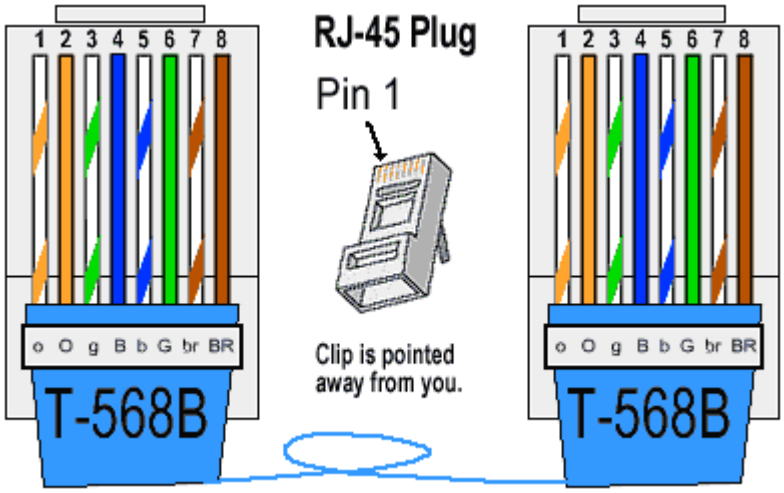
Fiber optic cable, twisted pair cable, and coaxial cable are the three main types of network cables used in communication systems. Each of them is different and suitable for various applications.

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.

The cable color code is the 568B standard on each end of a straight-through 10/100BaseT cable



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.

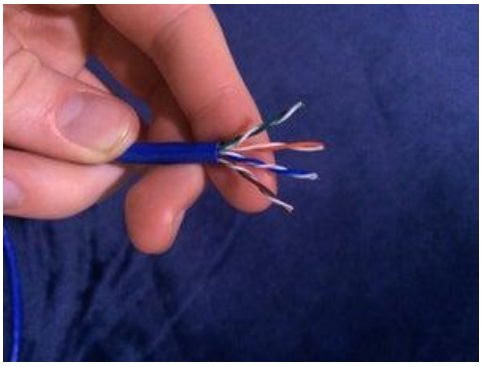
Step 1: Cable Inspection

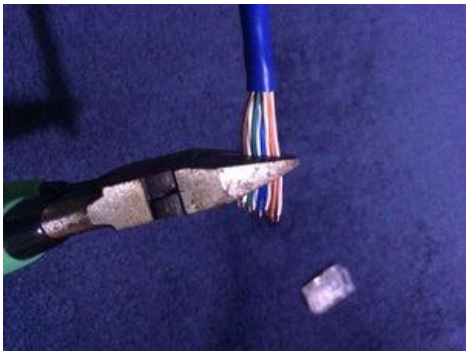
First, a Cat5e or Cat 6 cable will be required. This cable is mostly used with making an Unshielded Twisted Pair (UTP.) Make sure that the body of the wire has not been damaged, feel for lumps or anything unusual while examining the cables, as this can cause errors and may not even let your cable work. Also, avoid bending the cable to far past its bend radius because this can cause the copper inside to be damaged and not work correctly. The bend radius is usually where the cable jacket, will start to turn white.

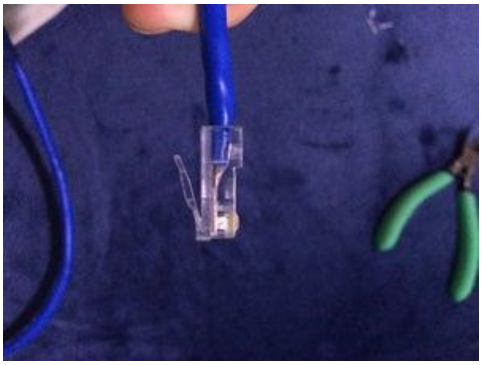
Step 2: Stripping the Cable

Second, a cable stripper will be needed. Start by only stripping off about an inch of the jacket, to expose approximately an inch of wires. Be sure not to take off too much of the jacket, because it will have to be clamped down inside of an RJ45 connector. If there is too much wire, they might have to be shortened, by cutting them directly with wire cutters. After there is a correct amount of the wires exposed, unwind the copper wires twisted together on the inside, while starting with the correct colors left to right. There are a total of 8 copper wires inside of the jacket, each marked with a different color. The colors are orange-white, orange, green-white, blue, blue-white, green, brown-white, and brown, in that order, for a T-968B pattern. When unwinding them, try to bend them back and forth a bit, so the copper can flatten easier.

Step 3: Putting the Wires in the Connectors





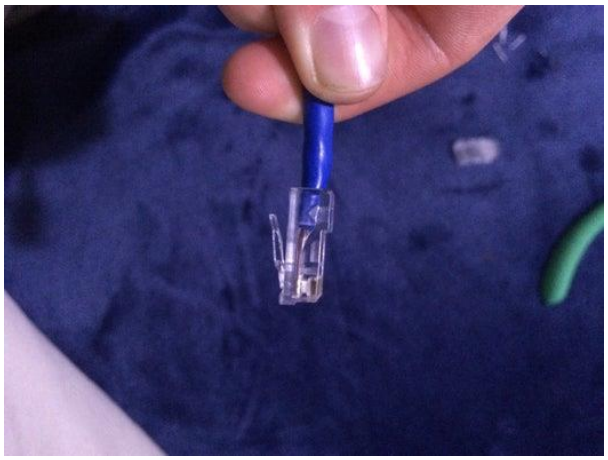


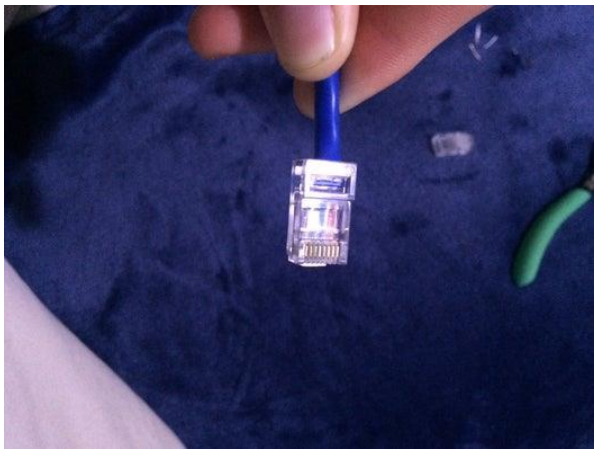
Next, this will need at least 2 RJ45 wire connectors, one for each side of the cable. After the wires have been spread apart, organize them into the correct color order of the desired cable. We are making the T-568B standard for a straight-through, which means that the color order for the wires is going to be the exact same on both sides. After the colors have been organized, if they don't all reach the same length, use wire cutters directly on the end, to make each wire the same length. Be careful not to trim the wires down too far, or the wires might not be long enough and might need to take a little bit more of the jacket off for the wires to be long enough to fit all the way into the RJ45 connector correctly. Once the wires are flat, in order, and can reach all the way to the end of the connector, start to put them into the RJ45 connectors. Make sure that the tab on the connector is facing down, and while holding the wires flat and in order, slide the wires down to the end of the connector, till you can see all of the copper wires at the end, through the end of the plastic. Remember that the jacket has to be inside the connector a bit, so the crimping tool will keep the wire inside the connector.

Step 4: Crimping the Connector

Then, RJ45 wire crimpers will be required, to hold the connector onto the cable. If the cable so far, has got all the wires correctly inside of the RJ45 connector, along with a bit of the cable jacket, then it should be ready to crimp the wire inside of the connector. The crimpers push down a wire locking piece inside, that cannot be undone. Note that, once the wire is crimped down correctly if there are errors with the connection and the wire doesn't work correctly, the only way to fix this is to cut off the RJ45 connector with wire cutters, and start from step 2, with a new RJ45 connector.

Step 5: Testing the Cable





Last, 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.

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:

1. What cabling standard did you use, and what makes it different from other standards?

Answer: T568B standards was used in building a Straight Thru cable. 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).

2. According to your research, how long is the distance of the cable before the signal diminishes/lost?

   Answer: There are a few different versions of ethernet cable, but they all have a maximum distance of 100 meters (328 feet). It should be noted that Cat7 cable has harsher distance limits than Cat5e, Cat6, and Cat6a. Cat7 gets advertised for its 100 Gbps speed, but that will only work for distances up to 15 meters (slightly over 49 feet). Beyond that, it drops to the same 10 Gbps speed of Cat6 and Cat6a (although it still retains its superior 850 Mhz bandwidth).

3. Can you use different colors or wiremap in creating a ST? Ex. you started with Blue-White Blue. Will that cable still works?

Answer: Yes. It does not matter what color the ethernet cable. The color of the cable does not have any performance characteristics that would make you want to choose a certain color over the other. If you are starting with a blue then to a White-Blue, the cable will still works.