

So you want to install network cables but don't know where to start.

You could enroll for some formal training, there are a few recognized courses on structured cabling systems which offer some hands-on experience, or you could take one of the many courses offered by the manufacturers of cabling components. Obviously the manufacturers try to sell their own products, but their courses are usually cheaper and they can still provide some of the basic cabling skills.

There are also lots of books on the subject of cabling and a selection of these can be found in the [Network Cabling Help shop](#), my personal favorite is The Cabling Handbook 2nd Edition by John Vacca. It has over 1300 pages covering all aspects of network cabling and includes chapters on The Standards, Network Design, Wireless Communications, Fibre and Home Wiring.

If you don't want to invest any money on training until you are seeing some financial results, then you can gain valuable experience by actually doing some work for an existing cabling company.

Here are some basic questions you may be asking yourself if you have never installed a structured cabling system before.

What are 'The standards'?

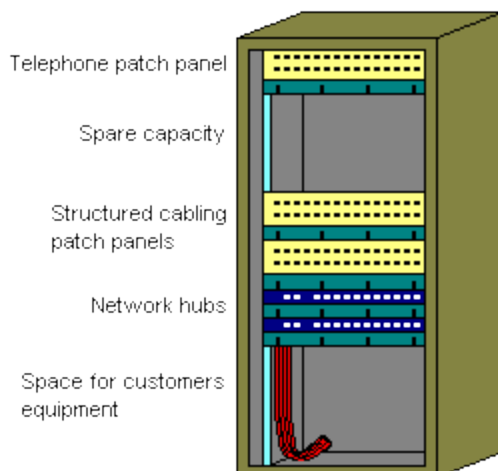
There are three main cabling standards:

- **EIA/TIA 568A** - This is the American standard and was the first to be published (1991).
- **ISO/IEC 11801** - The International standard for structured cabling systems.
- **CENELEC EN 50173** - The European cabling standard.

The reason for having a 'Standard' is to define a method of connecting all types of vendors voice and data equipment, over a cabling system that uses a **common media**, **common connectors** and a **common topology**. This means that a building can be cabled for all its communications needs without the planner or architect ever having to know what type of equipment will be used.

It is advisable to get a copy of one of the cabling standards documents, although once you have read through it once and understood some of what it describes, it will probably be filed away and never opened again. If you have ever tried to read a standards document you will know that it is hard work. Trying to separate the useful information from all the technical jargon can be very time consuming and even then you may not find the answer to your question. The bad news is, the Cabling Standards are no different, they are full of cross references, formulas and tables all of which can be a very daunting prospect and can make the installation engineer think twice about installing the stuff.

Now for the good news, the standards are mostly concerned with the performance criteria of the components of a cabling system, and, as that is guaranteed by the manufacturers of the different cabling components, you don't have to worry about it. Great eh!



What materials do I need?

Let's work on a hypothetical installation. It is for 30 double outlets, in one building, with an average run of about 30m. Each double outlet will be used for one PC and one telephone. A detailed breakdown of this list giving reasons for sizes and quantities is [Here](#)



- 1 x 27U, 600 x 600 cabinet.
- 3 x 32 way RJ45 patch panels.

- 6 x boxes of Cat 5e cable.
- 30 x double Cat 5e outlets and backboxes
- 30 x PBX master telephone adapters
- 30 x 1.5m patch leads
- 30 x 2m patch leads
- 30 x 3m fly leads.
- Trunking, cable ties and a method of labelling the system.

How do I install it?

Here are the basic do's and don'ts.

Although the maximum cable length for a Cat 5e/6/7 system is often reported to be 100m, this length is inclusive of patch and drop leads. Cable testers however, when set to perform a 'Basic Link' test, take this into account and you will find that the maximum length is set to either 90m or 94m depending on the standard you are testing to. Also, because the length is measured with a Cable Analyzer it is not the physical length of the run but the copper length that is measured. The copper length is longer due to the twists in the cable pairs, so if a run looks like it might be over 85m it would be wise to check it before it is tied up and terminated.

Each outlet cable should be run directly back to the patch cabinet that is one cable per outlet. A transition point or connection box is allowed if necessary, but in practice this can be more trouble than it's worth.

Care should be taken when pulling cables in to ensure that they are not kinked or nicked.

Cable routes should be planned to avoid fluorescent light fittings and power cables (exceptions can be made in the case of optical fiber). They should not be run in the same conduit as power, or the same channel of a trunking system, and where they are run parallel to power they must be at least 60mm apart (BS7671-92) . Crossing power cables is allowed but it must be at right angles, and some form of bridge should be used.

A means of supporting the cables should be installed such as cable tray, catenary wire or cable tie fixings, tying cables to ceiling hangers is not permitted. Cables should be tied at a minimum of 500mm intervals on horizontal runs and more frequently on vertical runs, with no more than 48 cables in a loom. Cable ties should only be finger tight to avoid crushing the cables as this could affect the cables performance characteristics. Do not use cable tie guns or staple guns.

Cable trays should be used under false floors, if not, a suitable method of keeping the cable off the floor slab should be employed. This is because the lime in the concrete apparently reacts with the cables sheathing, and over time could damage the cable. I personally think the cable will have outlived its usefulness long before this could have any effect on the cables performance.

Care should be taken when pulling cables into trunking to avoid damage due to snagging. Trunking partitions should be used to separate the data cables from power, and bridges should be used where data cables have to cross the mains.

When terminating patch panels, cable looms should not exceed 48 cables. Each cable loom should then be tied in a tidy manner to a cable tray fitted the full length of the cabinet.

All terminating should be carried out according to the manufacturer's instructions and guidelines, and the standards for generic cabling systems. The cable sheath should be stripped back no more than 13mm from the point of termination and the twist rates should be maintained.

Cable ties **MUST** be fitted to the individual RJ45 modules in the patch panels and outlets to support each cable.

When terminating outlets, care must be taken to avoid damaging the copper cores when stripping back the outer sheathing.

Excessive amounts of cable should not be left in the outlet backbox. Care should be taken when attaching the outlet faceplate not to kink, trap or strain the cable.

Cable tray should be fitted in cabinets housing structured cabling to keep cable looms secure and tidy, and to provide room for any additional cabling.

All cabinets must be earthed to the 16th edition IEEE wiring regulations (British regulations). Where shielded cable is used the earth should be clean and where two cabinets are linked with a copper backbone (shielded or unshielded) a minimum of 10mm² earth wire should also be installed to cross bond the cabinets.

Testing and documentation

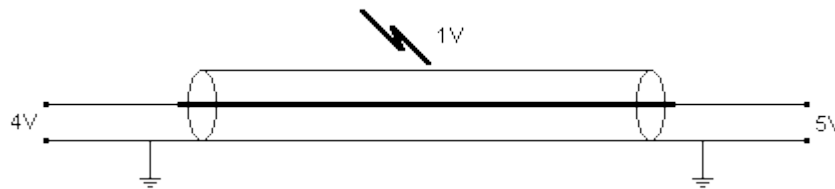
All testing whether copper or fibre should begin with calibration of test equipment, and batteries should be fully charged before testing begins. Descriptions of the various test parameters can be found on the [Cable Testing](#) page.



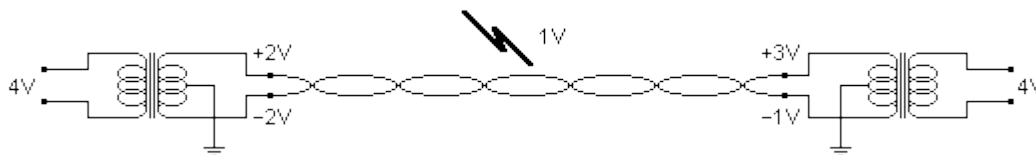
On all installations, and particularly on large jobs, two way radios, mobile phones or internal telephone lines should be used to ensure correct numbering of outlets and patch panels during testing.

What do they mean by Balanced line? How does it work?

Balanced line operation is a transmission method which helps to eliminate the effects of noise on the cable. In the first diagram a coaxial cable is transmitting a 4V signal, this is unbalanced as all of the 4V signal is carried by the centre core with respect to the grounded screen. If 1V of noise is introduced, it adds to the signal being transmitted making 5V, this could interfere with our data.



With a balanced line transmission our 4V signal is split into +2V and -2V on one twisted pair, so we still have 4V between the two. Now when we introduce the 1V of noise, the +2V becomes +3V, and the -2V becomes -1V, but the potential difference between the two is still 4V. The devices we put on the ends of the cable to make the line balanced are called baluns, this name is derived from the function of the devices of converting between **balanced** and **unbalanced** transmission modes.



These days, more and more equipment is being designed to operate on balanced lines without the need for baluns, but there are still a lot of older systems out there that still use these converters.

MHz? Mbps? Baud?

If you are confused about the different terms used in data communications this article written by Mark Barratt should help to clear things up.

Bandwidth is the difference between the highest and lowest frequencies which will propagate through an equipment or system. In many cases, the lower limit is DC, zero hertz, and so the bandwidth is the same as the upper frequency limit. The public telephone system constrains all signals to the range 300 Hz - 3 kHz. Its bandwidth is therefore 2.7kHz.

In the most obvious method of modulation (representing data electrically), two different voltages are used to represent a '1' and a '0'. The receiver expects a data bit at a certain time, and samples the input voltage to determine the value of the

bit. This is called "amplitude shift keying" (ASK). The maximum frequency of the signal will depend upon the slew rate (the time taken to change from 0 to 1, or vice versa). The maximum slew rate is the upper frequency limit, and the slew rate, in turn, limits the maximum data rate.

Plainly, the bandwidth of such a system directly limits the data rate, but in theory it need not. Consider a protocol which uses "frequency shift keying" instead. Here, two different frequencies (both of them within the legal bandwidth) are used to represent 1 and 0. The maximum data rate is now the maximum speed at which you can shift between the two frequencies. This is still limited by the bandwidth, but not so directly - the resulting maximum data rate is higher. And what happens if you use more than two frequencies? You can then transmit more than one bit of information per signal transition, upping the data rate again without increasing the maximum frequency of the signal.

It is techniques such as these which have allowed the development of 56k modems. Using a combination of multiple-level amplitude, frequency and phase modulation, they manage to extract up to 56,000 bits per second of performance from the aforementioned 2.7 kHz bandwidth. To achieve this using plain 2-level ASK would require a bandwidth of hundreds of kilohertz.

"Baud rate", strictly, is a measure of "signal elements" per second, and is not a useful measure where the above signaling techniques are being used. Such systems are generally rated in "bits per second" bps. It is worth noting that manufacturers will claim the highest figure they can for this parameter, so that the figure will include bits which are part of the signaling protocol rather than the user's data, and may even incorporate an assumption about the compressibility of the data. It is rarely (if ever) valid to divide bps by 8 to arrive at bytes of data transmitted/expected per second.

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