

DINTEK

LAN CABLING SYSTEMS



Network Cabling

Installers Practical Manual

Network Cabling Installers Practical Manual

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Introduction

The manual is summarizing from DINTEK Structured Cabling Systems for 25yrs warranty program and the accompanying course.

It will cover the definitions of Networking and telecommunications cabling systems for office buildings, and will also cover the design and installation practices of the DINTEK structured system.

All material in this document is based on both published documents and draft documents of national and global telecommunications standards.

Purpose

This Manual is provided in the expectation of being useful to a wide range of telecommunications professionals, including cabling installers, designers, equipment designers, manufacturers, architects and project owners.

The purpose of this Manual is to provide the student with the information to properly design and install a DINTEK Cabling System which will attain a DINTEK 25yr Certification Warranty.

1. Standards Organizations

ISO (International Standardization Organization)

This is the main international telecommunications systems standards organization.

IEC (International Electro technical Commission)

This is an organization that certifies component parts for electrical performance. Along with the ISO, the IEC developed the ISO/IEC 11801 (Generic cabling for customer premises) standard.

CENELEC (European Committee for Electro technical Standardization)

CENELEC developed the ENS0173 standard used throughout parts of Europe - they basically regionalized the ISO/IEC 11801 standard.

ANSI (American National Standards Institute)

ANSI is an organisation that has other organisations and standards bodies reporting to and through it, including:

- TIA (Telecommunications Industry Association)
- EIA (Electronic Industries Association)

The ANSI and TIA joined forces to develop communications standards for commercial premises, including the ANSI/TIA-568, (Commercial Building Telecommunications Cabling Standard), which is similar in scope to the ISO/IEC 11801.

Communications Standards

The ISO/IEC 11801 is called the Generic cabling for customer premises Standard. Its purpose is to provide a world standard for the design, installation, and administration of commercial building telecommunications systems.

ANSI/TIA 568 is called the Commercial Building Telecommunications Cabling Standard. Originally published as ANSI/TIA-568 in July of 1991, with the latest ver. being ANSI/TIA-568E.

Its purpose is to enable the planning and installation of a structured cabling system for commercial buildings... specifying a generic telecommunications cabling system that will support a multi-product, multivendor environment. In other words, to provide a common baseline for the design and installation of telecommunications cables and connecting hardware in commercial buildings.

The ANSI/TIA-569 is the Commercial Building Standard for Telecommunication Pathways and Spaces.

Its purpose is to standardize specific design and construction practices within and between buildings, which are in support of telecommunications media and equipment.

The ANSI/TIA-606 standard is the Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

Its purpose is to provide a uniform administration scheme that is independent of applications, and establishes guidelines for owners, end users, manufacturers, consultants, contractors, designers, installers, and facilities administrators involved in the administration (and labeling) of Telecommunications infrastructure.

The ANSI/TIA-606 Standard recognizes the importance of adequately documenting the telecommunications infrastructure in order to facilitate accurate administration of the installed cable plant for the life cycle of the facility, including cables, connecting hardware, pathways and spaces, and telecommunications facilities.

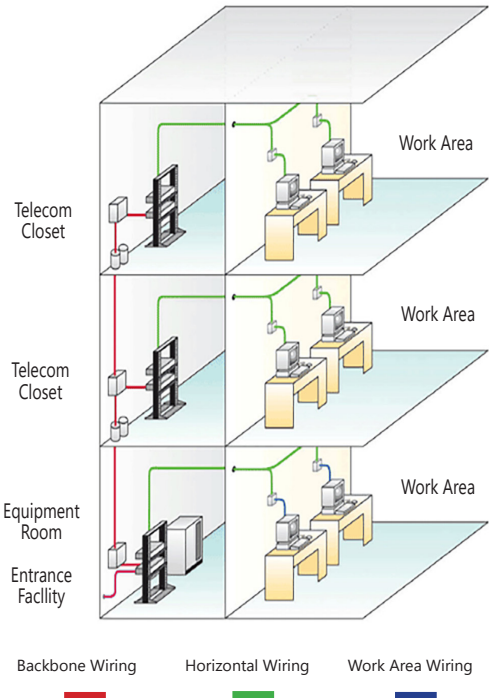
The ANSI/TIA-607 standard is the Commercial Building Grounding and Bonding Requirements for the Telecommunications Industry.

Its purpose is to enable the planning, design and installation of a telecommunications grounding system with or without prior knowledge of the telecommunications systems that will be subsequently installed. This telecommunications grounding and bonding infrastructure supports a multi-vendor, multi-product environment as well as the grounding practices for various systems.

2. UTP STRUCTURED CABLING SYSTEMS (SCS)

Advantages of an SCS.

- Flexible cabling scheme, without regard to its ultimate use
- Support voice and data (and even video for short distances)
- Allow easier moves, adds and changes



Structured cabling falls into six sub-systems

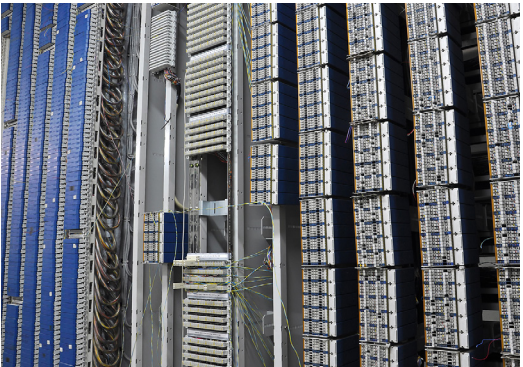
- A. Entrance Facilities
- B. Equipment Rooms
- C. Backbone Cabling
- D. Telecommunications Rooms
- E. Horizontal Cabling
- F. Work-Area Components

A. Entrance Facilities

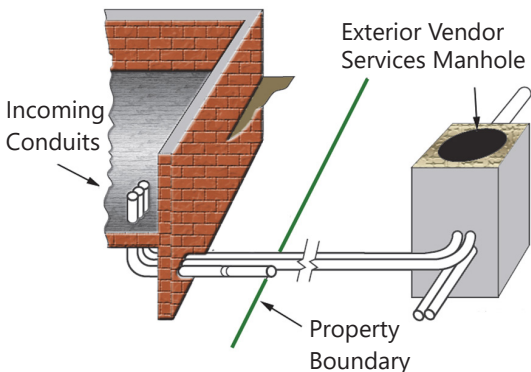
Entrance facilities are where the building interfaces with the outside world. It contains the cables, demarcation point, connecting hardware, protection devices etc. that connect to the access provider or private exterior network cabling.

Essentially is contains the connections between outside plant and inside building cabling.

Typical Entrance Facility



Building Entrance Facility Structure



B. Equipment Room

The equipment room in a building is a centralized space for telecommunications equipment that serves the occupants of the building. It is considered a building serving environment.

Typical Equipment Room



C. Backbone Cabling

The backbone cabling provides interconnection between telecommunications closets, equipment rooms and entrance facilities. This includes:

- Vertical connection between floors (risers)
- Cables between an equipment room and building cable entrance facilities
- Cables between buildings (inter-building)

Design Requirements

- Bridges and taps are not allowed
- Main and intermediate cross-connect jumper or patch cord lengths should not exceed 20 meters (66 feet)
- Grounding should meet the requirements defined in ANSI/TIA 607
- Equipment connections to backbone cabling lengths of 30m (98ft) or less.
- A total maximum backbone distance of 90m(295ft) is specified for high band-width capability over copper. This distance is for uninterrupted backbone runs. (No intermediate crossconnect)
- The distance between the terminations in the entrance facility and the main cross-connect shall be documented and should be made available to the service provider.

Keeping in mind the perils of EMI

Electromagnetic Interference (EMI) is an important factor during the design and installation of backbone cabling and pathways.

D. Telecommunications Closet

A telecommunications closet is the area within a building that houses the telecommunications cabling system equipment. This includes the mechanical terminations and/or cross-connect for the horizontal and backbone cabling system.

Telecommunications Room recommendations

1. The Equipment room should be located where there is easy access to cabling pathways linking to either the horizontal cabling or to telecommunications rooms.
2. The Telecommunications Room size should be based on the floor space used.
3. Equipment room should be environmentally stable at 20 deg Celsius or 68 deg Fahrenheit.
4. Consideration should be given to the installation of an air conditioning unit in the Equipment Room in order to maintain a stable temperature and minimize humidity levels.
5. No sprinkler heads or water supplies should run through or over room.
6. Access to the Telecommunications Room should be restricted to authorized service personnel and should not be shared with building services that may interfere with the telecommunications systems or be used for building maintenance services (such as sinks, cleaning mops and buckets).

E. Horizontal Cabling

The horizontal cabling system extends from the telecommunications outlet in the work area to the horizontal cross-connect (Patch Panels) in the telecommunications closet. It includes the telecommunications outlet, an optional consolidation point or transition point connector, horizontal cable, and the mechanical terminations and patch cords (or jumpers) that comprises the horizontal cross-connect.

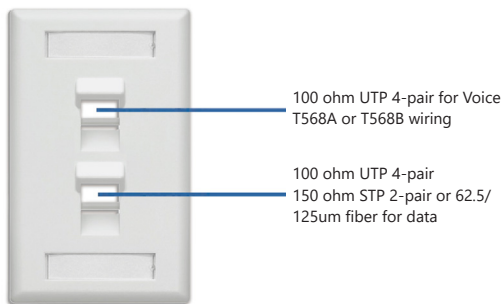
Horizontal Cabling Configurations At The Outlet

The first Telecommunications Outlet/ connector must be supported by a four-pair balanced twisted-pair cable (Cat. 5e or higher).

The second Telecommunications Outlet/ connector must be supported by either:

1. Four-pair, Cat. 5e or higher balanced twisted-pair cable,
2. Two-fiber, 62.5/125 μm or 50/125 μm multimode optical fiber cable.

Telecommunications Outlet / Connector:



A minimum of two telecommunication outlet/
connectors are required at each work area.

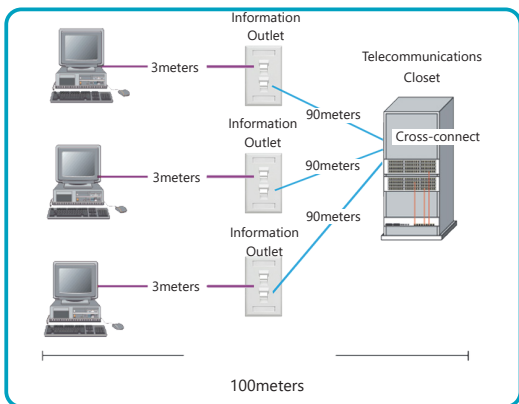
Some points specified for the horizontal cabling subsystem include:

- The proximity of horizontal cabling to sources of EMI shall be taken into account.
- One transition point (TP) is allowed between different forms of the same cable type (i.e. where under-carpet cable connects to round cable)
- 50 ohm coax cabling is recognized by ANS/TIA 568, but is not recommended for new cabling installations.
- The horizontal cabling shall be configured in a star topology; each work area outlet is connected to a horizontal cross-connect (HC) in a telecommunications closet (TC)
- A maximum limit of two fiber splices is permitted in the horizontal cabling between a transmitter and its receiver.
- The length of cable between the Telecommunications Outlet/connector and the Horizontal Crossconnect shall not

exceed 90 m (295 ft) and should not be less than 15m

- The total length of 24 AWG balanced twisted-pair or fiber cables, which make up the Horizontal Cross-connection, including the equipment cable, shall not exceed 5 m in the cross-connect facility.

Maximum Distances Horizontal Cabling:



F. Work Area

The work area is defined as the connection between the telecommunications Outlet and the station equipment (such as telephones, printers and video monitors).

It consists of cords, adapters, and other transmission electronics, such as wireless access points, that permit the station equipment to connect to the horizontal media via the Telecommunications Outlet.

3.UTP Structured Network Design

Desired Standards and Performance Characteristics

Flexibility

No network is a stagnant entity. As new technologies are introduced, companies will adopt them at different rates. When designing a cabling system, you should plan for moves, adds, and changes so that if your network changes your cabling design will accommodate those changes. In a properly designed cabling system, a new device or technology will be able to connect to any point within the cabling system.

Longevity

If your customer has to upgrade their cabling system or you are currently designing their system, it is usually best to upgrade to the most current technology they can afford. But you should also keep in mind that budget is almost always the limiting factor.

Ease of Administration

Another element of a proper cabling design is ease of administration. This means that a network administrator (or subcontractor) should be able to access the cabling system and make additions and changes, if necessary. Some of these changes might include the following:

- Removing a station from the network
- Replacing hubs, routers, and other telecommunications equipment
- Installing new cables
- Repairing existing wires

Many elements make cabling-system administration easier, the most important of which is documentation. Another element is neatness. A rat's nest of cables is difficult to administrate because it is difficult to tell which cable goes where.

Economy

You have to do some very basic value-proposition work, factoring in how long you expect to be tied to your new cabling system, what your bandwidth needs are now, and what your bandwidth needs might be in the future.

Guideline Summary

Step 1: Which group of standards will you conform to?

The three principle design standards give the details of how to design and specify a structured cabling standard, they are;

ISO 11801

EN 50173

ANSI/TIA 568

Step 2: Horizontal cabling - Basic rules

- Two outlets per work area
- Two outlets per 10m² of useable floor space
- Outlets to be within 3m of the user station
- Both outlets to be RJ45
- Max cable run to be 90m
- Max total length of patchcords at both ends of the link to be 10m
- Cable and RJ45 to be minimum Cat5e grade

Optical fibre can be used

- If optical fibre, select 50/125 or 62.5/125 multimode
- If using fibre select SC or ST connectors
- Cat 6/Class E can be specified
- Cat 5e Cable can be unshielded, UTP, Foil shielded, FTP, or Foil and Braid shielded S-FTP.
- Each grade, in ascending order, has a better performance in fire situations but at a correspondingly higher price.
- The exact density of cables, number of outlets and their position is up to the end user, or else at the proposal of the installer/designer

Step 3: Backbone Cabling

- Bridges and taps are not allowed
- Main and intermediate cross-connect jumper or patch cord lengths should not exceed 20 meters
- Equipment connections to backbone cabling lengths of 30m or less.

- A total maximum backbone distance of 90m is specified for high band-width capability over copper.

Step 4: Campus Cabling

- The campus cabling links different buildings together.
- Either single or multimode fiber
- Type of cable and cores depends on requirements and environment

The campus cabling links different buildings together. It can be up to 1500m long. It can be copper cable but is more likely to be optical fibre, either multimode or single mode. The kind of cables and the number of cores needs to be decided.

Step 5: Positioning and design of Telecommunications Closets to link horizontal and backbone cabling.

- Telecommunications closet should take into account best position for horizontal cabling
- Out of public access ways
- In a locked room preferably

Step 6: Cable containment system

- How will the cables be protected?
- Take into account cable volumes, aesthetics, proximity to interference
- Remember to refer to ANSI/TIA 569 if needed

Step 7: Cable Administration system

- End user should be consulted for labelling scheme
- Labelling should be logical
- Remember to refer to ANSI/TIA 606 if needed

Step 8: Earthing Scheme

- Electrically clean earths are required at termination points
- Exposed metalwork of containment system must be earthed
- Remember earth impedance mismatching on copper building links
- Refer to ANSI/TIA 607

All exposed metallic elements of the cable system and cable containment system need to be earthed (grounded) for safety and also electromagnetic compatibility requirements. If screened cables are used then special attention must be given to effective bonding of the screening elements. Poorly earthed screened cabling may behave worse than unscreened cabling.

Step 9: Testing regime

- Provision must be made to test all cables completely
- Points to remember are; What is being tested? Channel or permanent Link. What level is being tested? Cat5e, Cat6, Cat6A etc

- For optical cables... Light source and power meter test on short links.. OTDR testing on longer links.

All cables must be tested to demonstrate compliance with the standards and specification to which they were bought. Testing can be split into copper cable testing and optical fibre testing. Ideally all cables should be 100% tested.

4.UTP Cable Installation



Note on the box you are using the proper placement of the box for pulling to insure the cable is not twisted or kinked when pulled from it.

The most efficient way to pull horizontal cables is to pull bundles.

Pulling Cables



- For a single cable - use electricians tape to make a loop on the end to attach a pulling rope



- For cable bundles



- Tape bundle for about 6-8 inches on the end



- Loop the pull rope through bundle behind tape



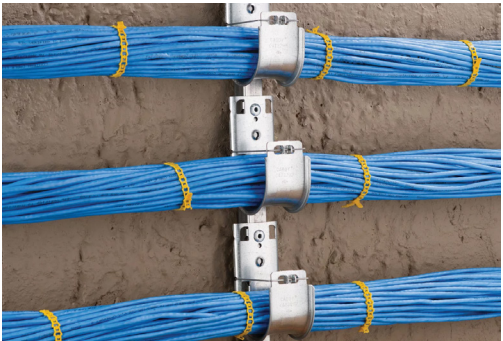
- Tape the pull rope at the end
- Now you are ready to pull cable

Pulling Into Conduit



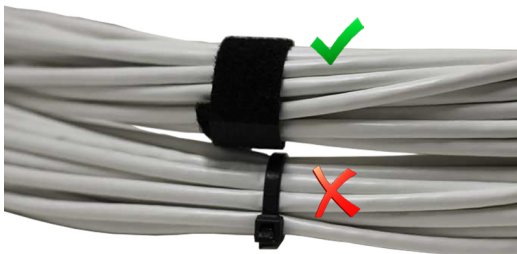
Cable may be damaged by the rough hack sawed end of conduit, so special nylon bushings are used to prevent abrasion
Use lubricant if long pull with high friction
Make short pulls through intermediate boxes

Hanging Cable



- You cannot lay cable on ceiling tiles or grids
- Use cable trays or j-hooks
- To prevent kinks, do not lay cable bundles in wire hooks
- Use wide j-hooks
- Do not overload trays or hooks

Bundling Cable



- Be careful with cable ties - too tight and it will cause crosstalk failure
- Do not use cable tie "guns" - hand tighten and cut off ends to prevent future tightening
- Preferably use "hook and loop" fasteners
- Hook and loop fasteners can be reopened for adding or removing cables
- To minimise the adverse effects of alien cross talk, minimise the length of long parallel runs
- Cat6 Cable bundles should be laid in a random fashion

Number of Cables in a Bundle

When any number of cables are bundled together in long parallel lengths, the capacitive coupling of pairs in different cables in the bundle with the same twist rates (eg. blue pair to blue pair) causes cross talk interference to increase sharply. This is known as "alien cross talk". The best ways to minimise the adverse effects of alien cross talk is to minimise the length of long

parallel runs and install bundles of cable in a pseudo-random fashion (ie. Do not go for the aesthetically pleasing uniformed looms) . Historically, we would have “combed” out the cables in a run for neatness. Forming the cables into bundles as they lie is the best way to avoid the chance of any two pairs from different cables lying parallel with each other for any significant length.

Correct Box Placement



Correct Placement



Incorrect Placement

Installation Pull or Tensile load

The maximum installation pull of Cat5e, Cat 6 or Cat 6A (as stated in the ANSI/TIA standards) should not exceed 110N of force.

One thing to remember is that when pulling multiple cables the stress load limitation does

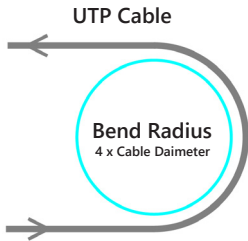
not increase (i.e. 2 cables does not equal 220N.) and the installer needs to be a little more aware not to exceed the maximum limits.

The installer should keep the pull tension as low as possible, because the higher the tension - the higher the probability of damage to the cable.

The following are some tips, and guidelines from the standards are listed below to help ensure that the maximum tensile load is not exceeded.

- Limit the 90° bends in a single cable run in conduit to two (2).
- Cable should not be pulled through a length of conduit exceeding 30meters
- Support the cables every 1.2mtrs – 1.5mtrs to prevent excessive weight strain and hanging load.
- Avoid sharp objects, turns and corners.
- Use a third man at turns and corners.
- If cable becomes "tight" or "stuck", do NOT jerk cable - go back and free the cable.
- Pull around obstructions such as air conditioning ductwork as required.

Bend Radius



When installing cabling, you will need to keep the cable bend radius to no less than 4 times the cable diameter for four-pair UTP cable, and where multi pair UTP cabling (for example 25pair cat5e) then you will need to keep the cable bend radius to no less than 10 times the cable diameter.

The standards do not differentiate between the bend radius when the cable is being pulled and when the cable is static. Also, bending twisted pair (balanced) cables into service loops is not recommended.

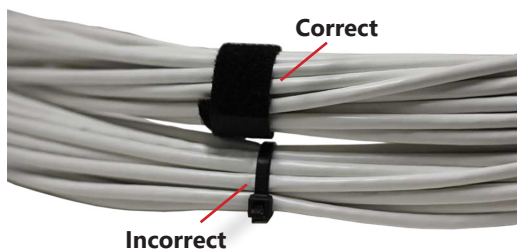
Compression

Excessive compression of the cable adversely affects the cable's characteristics both physically and electrically. The following guidelines will help prevent unwanted compression of the cable.

- Avoid stepping on the cable.
- Avoid the over-tightening of cable ties.

The compression of the pairs from the over-tightening of cable ties or excessive weight placed on cables may change the position of the pairs and affect performance.

The cables should be supported by the cable tie but still be able to be moved back and forth inside the tie. If stapling is necessary, do not use an automatic stapler, and be careful not to put any stress on the cable jacket. Use a specific UTP insulated staple or nailed clip. Also, do not overload cable pathways - the weight of the cable bundle may crush cables underneath and possibly pull the pathway away from its attachment.



Use a specific UTP Insulated staples
or nailed clips only

Cat.6 and Cat.6A UTP cables are created in a different way to Cat.5e. These cables have a central spacing member designed to reduce NEXT and ACR-F. This makes the cable diameter larger and hence the room available for cable pairs to move is also increased.

Compression has an even greater effect on Cat.6 & Cat.6A cable performance - which means that even greater care must be taken when pulling these cables and also dressing the cables compared to Cat.5e.



Cat. 5 Cable
Compression



Cat. 6/6A Cable
Compression



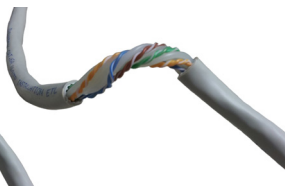
Cable Kinking

- Be conscious of the possibility of the cable becoming kinked
- Kinked cables should be regarded as damaged and replaced

As Cat. 6/6A UTP cables contain a central spacing member it is also of vital importance to ensure that cables are not kinked or that bends are below the minimum. Again this spacing member is critical to the performance and once a cable is kinked there is a very marked difference in its electrical performance.



Cable kinks should be replaced



Damage happens internally

When installing UTP cabling and in particular Cat.6/6A, be conscious of the possibility of the cable becoming kinked. If the cable kinks, it should be regarded as damaged and replaced.

While installation pressures will tempt the installer to straighten the kink, the damage however, has already been done as will be seen when the cable is tested, which will result in much more time wasted at the other end of the project.

Remember that all these effects are cumulative so whilst one kinked cable is unlikely to produce a fail, when added to the deterioration factors and the reduced headroom of say, Cat.6/6A, it may do.

Electromagnetic Interference (EMI) & Other Interferences

When installing UTP cabling, avoiding the laying of cables near noise sources, electrical wiring, electric motors, fluorescent lighting and other Electromagnetic Interference (EMI) / Radio Frequency Interference (RFI) devices is imperative.

These environmental parameters can have a severe effect on cabling performance. Installing the cable in a closed metallic pathway such as conduit will help reduce the effects of EMI.

- A minimum distance of 300mm away from Electrical cabling, and electrical fittings, particularly fluorescent fixtures shall always be observed.
- All local codes, standards and regulations shall be observed. For ANSI/TIA-569 standard (Industry recommendations for performance)

Miscellaneous

Avoid areas where the cables will be exposed to high temperatures, such as lighting, heat, open flame, etc. High temperatures affect attenuation.

Avoid laying cable in areas with excessive moisture such as damp basements and areas where steam will form condensation on the cable.

Cable Management Guidelines

Correct management of cable and slack, not only in the comms cabinet but also at the outlet end is imperative as it provides the following advantages:

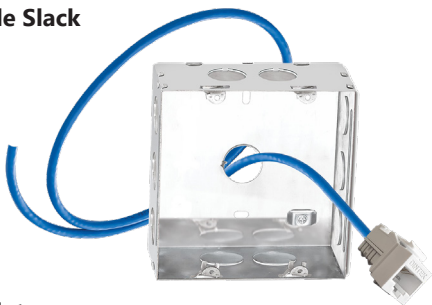
- A professional looking installation to all
- Makes it easier for Documentation, Labeling & Fault Finding

Cable Management

Allowing adequate cable management/ support hardware and management

accessories in the equipment cabinet is vital for the management and looming of the cables.

Cable Slack



Outlets

It is good practice to leave at least 300mm of slack at the outlet, to allow for possible re-termination.

Comms Room

Ideally allow enough cable to reach the opposite end of the room to the Cabinet location and then enough to reach the floor.

Documentation

Mark the cables with a permanent marker with the same identification at both ends.



Doing it exactly the same each time will make later identification of the cable in the closet easier and make tracing unnecessary.

Cat.6/6A UTP - What do I have to do differently?



Basically, the same installation practices that were specified several years ago for Cat.5e cabling are also applicable to Cat.6/6A cabling.

The difference is that, because Cat.6/6A has such a demanding performance criterion, it is less forgiving in the quality of the installation.

Any errors or short cuts in a Cat.6/6A installation will be more likely to result in a marginal pass or fail.

We therefore strongly recommend adhering closely to the installation practises outlined in the cabling standards documents and the manufacturer's recommendations.

Some important issues to consider during installation:

- Cable Pulling Tension - Do not exceed the cable pulling tension of 110N as specified in ANSI/TIA standards.
- Cable Bend Radius - For a typical Cat.6/6A cable, that means a bend radius of greater than at approx. 28 mm or more.
- Cable Compression & Cable Kinking
- Cable Forming (Leave the cables as they bundle to reduce ANEXT)

Cable Pulling Tension

Do not exceed the cable pulling tension of 110N as specified in ANSI/TIA standards. Excessive tension will deform the lay of the pairs in the cable and severely affect the cable's ability to reject unwanted noise (NEXT, FEXT and their derivatives. This can result in pair untwist and potential conductor damage.

Cable Bend Radius

Avoid sharp bends in the cable, as it will alter the lay of the pairs in the cable. In excessive bending, pairs may untwist, causing an impedance mis-match and an unacceptable return loss performance. Alternatively, the relationship between the lay of the 4 pairs within the cable may be altered. That, in turn will cause problems with noise rejection. We recommend that cable bend radius should be no less than 4 times the diameter of the cable post installation. For a typical Cat.6/6A cable, that means a bend radius of approx. 28mm or more.

One crucial area where this is a problem is the cabinet, where large a qty of cables are brought into the patch panels and the tendency to make the cable looms neat causes some cables to be compressed and bent too tightly. Often this is unseen, and even the best of installers may be affecting the performance of the cabling system.

For example, when replacing Cat.5e for Cat.6/6A, it may be that the Cat.5e was run in 16mm capping with corners. Not only will there be less room in that capping now, but the bend radii created in order to use the same 16mm capping would be unacceptable, therefore other means of reticulating the cat 6/6A might need to be employed.

This can also be a problem when fitting off jacks into wall mounted anodized trunking or Mounting blocks. Using traditional 90deg jacks in this instance is not advisable as it does not allow enough room behind the jack for adequate bend radius. In this situation it would be best to use Dintek 180deg jacks, meaning that the cable can lay straight onto the keystone without the need to bend around and into trunking.

Cable Forming

Due to the high speeds of data on Cat.6/6A and the resulting chances for interference, it is advised not to run cabling in a uniform bundle. Running cables in a haphazard fashion inside the cable bundle will minimize the chances of alien cross-talk.

4. Terminating DINTEK ezi-JACKs™

1. The DINTEK ezi-JACK™



Online Instructional PDF

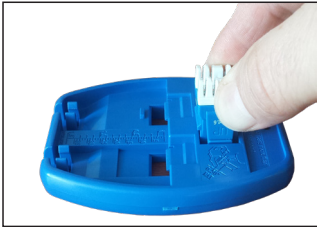
- DINTEK ezi-JACK™s provide performance that exceeds connecting hardware performance specifications.
- The DINTEK ezi-JACK™ comes as Cat.5e, Cat.6 & Cat.6A, in both shielded and unshielded options.

2. Jack Pin-outs (Color Codes)

The DINTEK ezi-JACKs™ Pinout color codes show both T568A and T568B versions.



3. Place the Jack in DINTEK Working Base



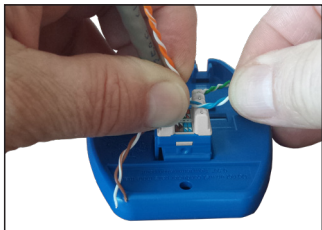
- DINTEK offers a working base to allow for handling the jack easily when punching down the wires
- Place the jack in the working base
- Alternatively, you need a hard surface to rest the jack against while punching down the wires

4. Strip The Cable Jacket



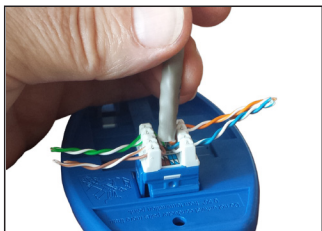
- Using the DINTEK jacket stripper, strip off about 2-3 inches of cable jacket
- The stripper should be set to cut almost through the jacket but not so deep it cuts the insulation on the wires which can affect the performance of the cable

5. Separate The Wires



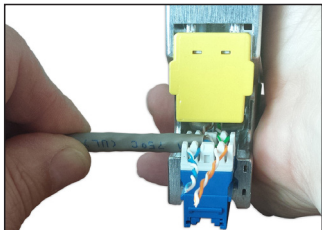
- Place the wire pair over the IDC
- Use the thumb to secure the pair at the rear of the IDC, and unwind the section on top of the IDC.
- This helps to ensure the pair twist extends all the way to the IDC, therefore lowering NEXT.

6. Place Wires In Applicable Color Coding



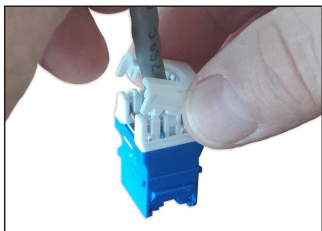
- Lay the wires in the slots according to the termination type you will use, T568A or T568B
- Follow the color code on the jack exactly
- Keep the twists as close to the jack as possible to minimize crosstalk!

7. Terminate using the ezi-TOOL™



- Make sure the color codes match whichever wiring scheme is being used in the install (T568A or T568B)
- Don't mix them up!
- Insert the jack into the ezi-TOOL™ and crimp cable, removing wires at the same time.

8. Snap Cover On Jack



Snap the plastic cover on the back of the jack and it's complete

5. Terminating DINTEK ezi-PLUG™ (RJ45 plug)

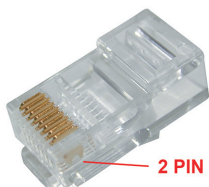
1. Terminating Passthrough RJ45 Plugs



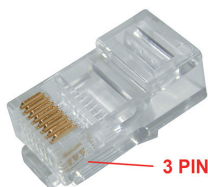
Solid wire can fail more quickly if used for patchcords, since it is not flexible like stranded wire.

2. Using The Right Plugs

There are 2 different types of 8 pin plug.



Stranded Style Plug



Solid Style Plug

The solid cable type has split pins in order to pierce the insulation and make contact with the cable on either side.

The stranded cable type has a solid pin which pierces through the centre of the cable core.

Using a stranded cable plug on a solid core cable will quite often cut through the whole copper core causing faults. The cable, if it survives the initial crimp will eventually break cores due to the patch cable being moved about.

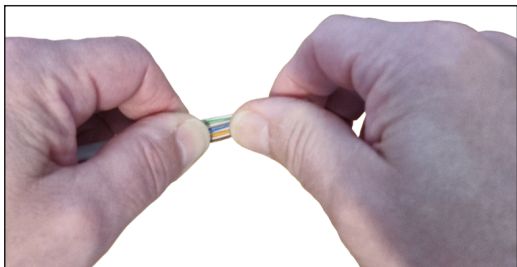
3. Strip Cable Jacket



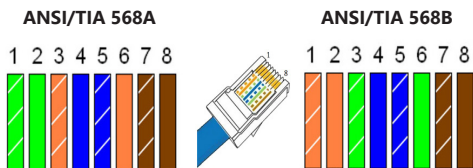
Begin the process by stripping approx. 40mm of jacket from the cable. Untwist back to the end of the jacket this time. When we crimp the plug on the cable, we want to crimp the cable in place also. As you separate and order the strands, the color codes must match the jack that will be used. This will be either ANSI/TIA 568A or ANSI/TIA 568B.

4. Arrange Wires

Hold the wires between your thumb and first finger to flatten the wires and put them in order. As you separate and order the strands, the color codes must match the jack that will be used.

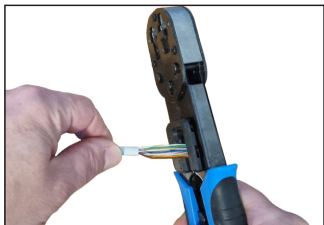


This will be either 568A or 568B (see below). Note the wires are not in exact pair order - pair two (orange) and pair three (green) are reversed in 568A or 568B, so make sure you have the right order.

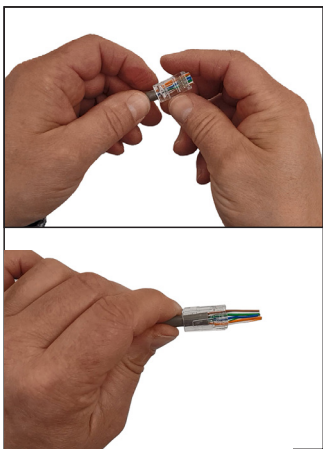


5. Cut Wires

The wires must be laid out in order, and they must be flat, and very close together. They need to be parallel for most of the exposed length to fit into the plug properly. Once they are in order and flat, cut the wires straight across so that only 1/2 inch of the strands protrude from the cable.



6. Insert Wires Into The Plug



Carefully slide the cable into the plug. The wires must stay in order. The wire tips have to slide all the way into and out through the front of the plug. Once the wires are through the plug, check the color code once more. Then carefully push the cable into the plug as far as it will go, to bring the cable twists as close to the termination points as possible.

7. Crimp The Plug



Once you are satisfied that the wires are seated fully inside the plug, insert the plug into the crimping tool and crimp the cable to the plug.

8. Plug Ready To Test

Test with the DINTEK Wire-Map Tester, the DINTEK DCT-020 Copper & Optical Tester, or a comparative product for testing twisted pair connections.



6. UTP Performance Testing

Attenuation

- Attenuation (also called loss or insertion loss) is the weakening of a signal as it travels down the cable
- It varies with cable length.
- Lower dB is good in Attenuation, Higher dB

in crosstalk is good; don't get confused.

- Attenuation has a direct relationship with both frequency & cable length. As frequency increases so does attenuation. Also the longer the cable the greater the attenuation.

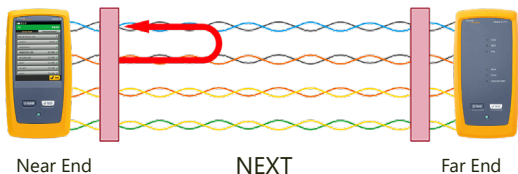


Near End Crosstalk (NEXT)

In a cable that has four pairs of electrical conductors, whenever one pair is carrying signals, it may couple some of its energy into an adjacent pair. If a signal is being transmitted from the other end, that signal may be compromised by interference from the crosstalk.

Each pair works like an antenna; the pair carrying a signal is the transmitter and every other pair is a receiver. Crosstalk is frequency dependent, so must be tested over the full frequency range specified for the Category of cable being installed.

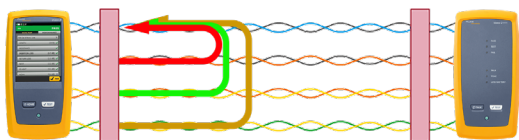
Near End Cross Talk (NEXT) is crosstalk created from one pair into another at the transmitting end.



At the terminals is where crosstalk is most critical. Standards state the twists of each pair must be within 1/2 inch or 13 mm from the terminals to reduce crosstalk. DINTEK encourages installers to bring the twists right up to the terminals to maximise performance.

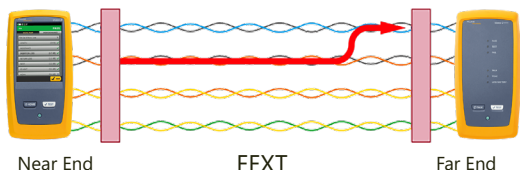
Powers Sum Crosstalk (PSNEXT)

PSNEXT is the mathematical combination of NEXT on one pair when all three other pairs are carrying signals. This is realistic with 1000Base-T Gigabit Ethernet where all pairs carry signals simultaneously.



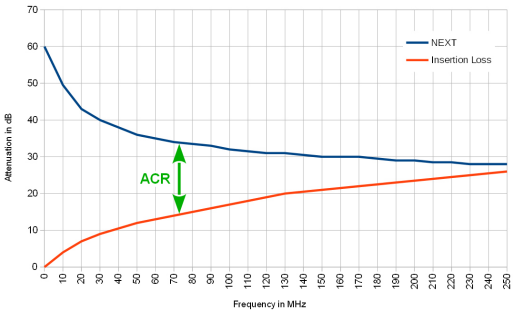
Far End Crosstalk (FEXT)

Far-end crosstalk, abbreviated as FEXT, is akin to NEXT. However, unlike NEXT, FEXT is measured at the remote end of the channel. Yet, FEXT alone doesn't provide substantial insights due to signal attenuation over distances. To derive a more meaningful assessment, the attenuation (insertion loss) is factored out from the FEXT reading, resulting in ACR-F



ARC-N

ACR-N, or Attenuation to Crosstalk Ratio - Near end, is a parameter used in the evaluation of the performance of twisted-pair cabling systems, such as those used in Ethernet networks. It measures the difference between the signal attenuation and the near-end crosstalk (NEXT) at a given frequency. ACR-N is expressed in decibels (dB) and is an important factor in determining the quality of a cabling system's performance, especially in high-speed data transmission.



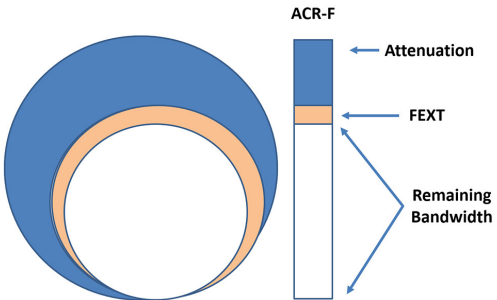
In simple terms, ACR-N compares the strength of the signal (which decreases or attenuates as it travels through the cable) to the amount of interference (crosstalk) picked up from adjacent cables at the near end (the end where the signal is transmitted). A higher ACR-N value indicates

- As frequency increases, both attenuation and crosstalk increase

- Margin between signal and noise falls below 3 dB the transmitted data becomes corrupted
- This results in retransmissions & slow network response time

ACR-F

ACR-F, or Attenuation to Crosstalk Ratio-Far end, is another important parameter in evaluating the performance of twisted-pair cabling systems, similar to ACR-N. However, while ACR-N measures the difference between signal attenuation and near-end crosstalk (NEXT), ACR-F measures the difference between signal attenuation and far-end crosstalk (FEXT) at a given frequency.

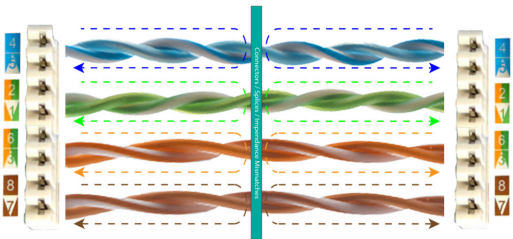


A higher ACR-F value indicates better performance, as it means that the signal remains strong relative to the interference from far-end crosstalk. This is important for ensuring clear and reliable data transmission, especially in high-speed networking applications. ACR-F is a critical parameter in the design and testing of cabling systems to meet certain standards.

Return Loss

Impedance is akin to the "resistance" a cable offers to the signals transmitted at certain frequencies. Return loss is the term used to describe the signal reflections that occur due to changes in impedance, most often at connection points. These signal reflections can lead to transmission errors if they are substantial. UTP cable is designed to maintain an impedance around 100 ± 15 ohms. In high-speed data applications, both impedance and return loss vary with the frequency of the signal, and typically, impedance decreases as frequency increases.

- Return loss: Reflections caused by impedance mismatches, which can occur at connectors, during cable installation (like punchdowns), or due to physical deformities in the cable (such as kinks).
- Component mismatches can cause significant issues in signal integrity.



This image illustrates return loss as reflection of signals returning on the same pair.

Propagation Delay

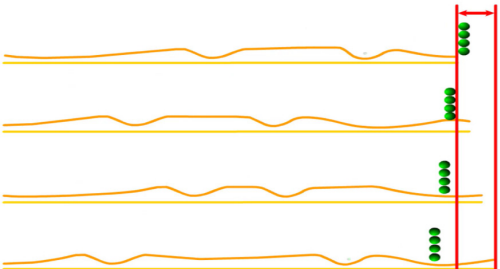
Propagation delay (or simply delay) is a measure of the time it takes for an electrical signal (traveling at about $\frac{2}{3}$ the speed of light) to reach the far end of the cable. Testers measure delay as part of the process of measuring length.



Delay Skew

Delay skew in Cat6 cables refers to the difference in signal propagation delay between the fastest and the slowest of the four pairs of twisted wires within the same cable.

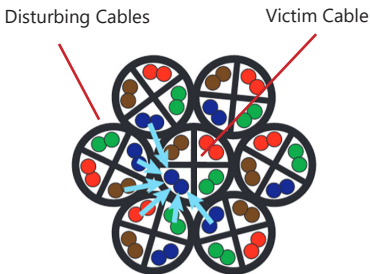
- Important for networks like 1000Base-T that use all 4 pairs
- Measures how much simultaneous pulses on all 4 pairs spread out at the far end.



Alien Crosstalk (AXT)

Alien crosstalk is defined as: Unwanted signal coupling from one balanced twisted-pair component, channel, or permanent link to another.

Alien crosstalk is not adversely impacted by common mode noise (e.g. noise from motors, transformers, or florescent lights) that is present in the environment.



4.1.2 Test Equipment (Continuity Testers)

The Dintek Wiremap continuity testers are used to identify installation-wiring errors. They provide verification of links, which means a cable is capable of carrying ethernet.



Continuity Tests

- Proper pin termination at each end
- Continuity to the remote end
- Shorts between any two or more conductors
- Crossed pairs
- Split pairs
- Reversed pairs
- Any other mis-wiring.

Dynamic Testing

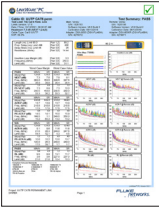
Certification testing of twisted pair cabling is a detailed process to ensure that a cabling installation meets the various performance standards set for high-speed data networks. This type of testing is crucial for certifying that the network will operate efficiently and reliably under the specified parameters.

Tests include:

- Wire-map
- Length
- Attenuation
- Return Loss
- Return Loss
- Near-End Crosstalk
- ACRM & ACR-F
- Propagation Delay



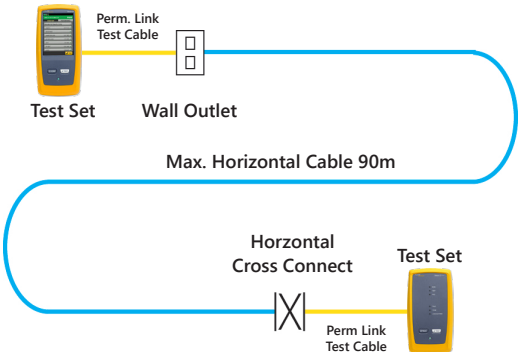
Permanent Link Testing



Online Performance Testing

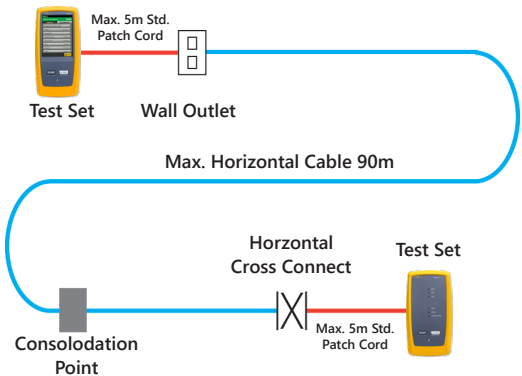
A permanent link is the fixed part of the cabling, which is to be tested after installation, and which gives information on installation quality.

- Up to 90 meters of horizontal cable
- Connection at each end i.e. jack & patch panel
- High performance testers (e.g. Fluke DSX-8000) must be used for this testing using calibrated test cords called permanent link adaptors.
- Permanent links tests are favored by cabling manufacturers because they do not include the patch cords at each end, often third party products and a frequent source of failure.



Channel Testing

The channel configuration has been defined for application purposes. It represents the complete end-to-end path between user equipment (PC, phone, printer, video equipment) and the active equipment at the cabinet side (switch, hub, PABX, video equipment)



7.UTP Trouble Shooting Testing

When – Wiremap issues gives FAIL result

Faults & Possible Causes

Wire Map: open

- Wires connected to wrong pins at connector or Punch down blocks
- Faulty connections
- Damaged connector
- Damaged cable
- Wrong Outlet Configuration selected in setup
- Wrong application for cable

Wire Map: split pair or reversed pair

- Wires connected to wrong pins at connector or punch down block.

Wire Map: crossed wires

- Wires connected to wrong pins at connector or punch down block.
- Mix of 568A and 568B wiring standards (12 and 36 crossed).
- Crossover cables used where not needed (12 and 36 crossed).

Wire Map: short

- Damaged connector
- Damaged cable
- Conductive material stuck between pins at connector.
- Improper connector termination
- Wrong application for cable

When - NEXT, PS NEXT, ELFEXF, PSELFEXT gives FAIL, FAIL*, or PASS* result

Possible Causes

- Excessive untwisting of pairs at connector
- Poor quality patch cords
- Poor quality connectors
- Poor quality cable
- Poorly matched plug and jack (Cat 6/Class E applications)
- Incorrect link interface adapter
- Cable compression (tight cable ties, pinches, kinks, etc.)
- Inappropriate use of couplers

- Excessive noise source near cabling under test. Use the impulse noise test to check for noise.
- Wrong test standard selected

When - Return loss gives FAIL, FAIL*, or PASS* result

Possible Causes

- Cable impedance ... not 100 Ω
- Patch cord handling causing changes in impedance
- Excessive amount of cable jammed into outlet box
- Tight service loops in telecommunications closet
- Excessive untwisting of pairs at connector
- Damage to connectors
- Cable impedance not uniform (possible damage)
- Mismatches in cable construction (such as using cable from another manufacturers)
- Water in cable jacket
- Cable compression (tight cable ties, pinches, kinks, etc.)
- Wrong test standard selected
- Defective link interface adapter

When Attenuation (insertion loss) gives FAIL, FAIL*, or PASS* result

Possible Causes

- Cabling is too long
- Poor quality patch cord
- Bad connection
- Wrong cable type in installation
- Wrong test standard selected

When - Characteristic impedance exceeds the limit or an anomaly is detected

Possible Causes

- Bad connection
- Cable compression (tight cable ties, pinches, kinks, etc.)
- Mismatch of cable types
- Water in cable jacket
- Excessive loading at coaxial cable tap
- Incorrect terminator value (coaxial cable)

When - Resistance gives FAIL, FAIL*, or PASS* result

Possible Causes

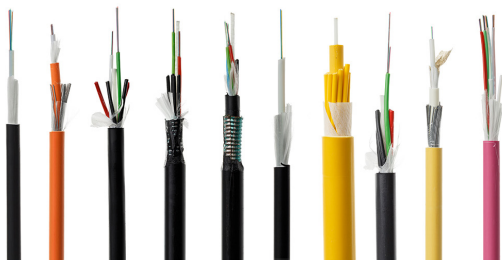
- Cabling is too long
- Bad connection due to oxidized or loose contacts
- Wire gauge is too thin
- Wrong patch cord type used

When - Length gives FAIL result

Possible Causes

- Cable is too long (may need to remove coiled service loops)
- NVP is set incorrectly

8. Optical Fiber Instruction



- **Simplex and zip cord**

Simplex cables are one Fiber, tight-buffered with Kevlar strength members and jacketed for indoor use. The jacket is usually 3mm (1/8 in.) diameter. Zipcord is simply two of these joined with a thin web. It's used mostly for patch cord and backplane applications, but zipcord can also be used for desktop connections.

- **Tight Buffered**

They can contain several tight-buffered fibers bundled under the same jacket with Kevlar strength members and sometimes fiberglass rod reinforcement to stiffen the cable and prevent kinking. These cables are small in size, and used for short, dry conduit runs, riser and plenum applications. The fibers are double buffered and can be directly terminated, but because their fibers are not individually

reinforced, these cables need to be broken out with a "breakout box" or terminated inside a patch panel or junction box.

- **Loose tube cables**

These cables are composed of several fibers together inside a small plastic tube, which are in turn wound around a central strength member and jacketed, providing a small, high Fiber count cable. This type of cable is ideal for outside plant trunking applications, as it can be made with the loose tubes filled with gel or water absorbent powder to prevent harm to the fibers from water. It can be used in conduits, strung overhead or buried directly into the ground. Since the fibers have only a thin buffer coating, they must be carefully handled and protected to prevent damage.

- **Breakout cables**

They are made of several simplex cables bundled together. This is a strong, rugged design, but is larger and more expensive than the distribution cables. It is suitable for conduit runs, riser and plenum applications. Because each Fiber is individually reinforced, this design allows for quick termination to connectors and does not require patch panels or boxes. Breakout cable can be more economic where Fiber count isn't too large and distances too long, because it requires so much less labor to terminate.

- **Armored Cable**

Cable installed by direct burial in areas where rodents are a problem usually have metal armoring between two jackets to prevent rodent penetration. This means the cable is conductive, so it must be grounded properly.

- **Aerial cable**

Aerial cables are for outside installation on poles. They can be lashed to a messenger or another cable (common in CATV) or have metal or aramid strength members to make them self supporting.

Choosing a cable type

Fiber optic "cable" refers to the complete assembly of fibers, strength members and jacket. Fiber optic cables come in lots of different types, depending on the number of fibers and how and where it will be installed. Choose cable carefully as the choice will affect how easy it is to install, splice or terminate and, most important, what it will cost!

What hazards will it face?

- What chemicals will the cables be exposed to?
- What Temperatures will the cables be exposed to?
- What sort of physical stresses will the cable be exposed to?

Choosing a cable - what hazards will it face?

Cable Type	Application	Advantages
Tight Buffer	Premises	Makes rugged patchcords
Distribution	Premises	Small size for lots of fibers, inexpensive
Breskout	Premises	Rugged, easy to terminate. no hardware needed
Loose Tube	Outside Plant	Rugged, gel or dry water-blocking
Armored	Outside Plant	Prevents rodent damage

Cable's job is to protect the fibers from the hazards encountered in an installation. Will the cables be exposed to chemicals or have to withstand a wide temperature range? What about being gnawed on by rodents or other animals? Inside buildings, cables don't have to be so strong to protect the fibers, but they have to meet all fire code provisions. Outside the building, it depends on whether the cable is buried directly, pulled in conduit, strung aerially or whatever.

Most users install lots more fibers than needed, especially adding singlemode Fiber to multimode Fiber cables for campus or backbone applications.

9. Optical Fiber Installation procedures guidelines and practices



Where is Fiber different to standard copper cable when it comes to installing?

From the outside, a Fiber optic cable looks like any electrical multi-conductor cable. However, it is lightweight and flexible compared to metal conductor cable. Typical Fiber cable OD's range from less than 1/8" up to 3/4", depending on Fiber numbers and cable construction. The most common Fiber optic cable jacket materials are polyethylene (all types), PVC, and polyurethane.

The glass Fiber optics in the cable are not "fragile." For instance, they won't shatter if you drop the cable on the floor. These glass fibers are usually well protected by buffer tubes inside the cable itself.

INSTALLATION GENERAL GUIDELINES

In general, Fiber optic cable can be installed with many of the same techniques used with conventional copper cables.

Basic guidelines that can be applied to any type of cable installation are as follows:

- Conduct a thorough site survey prior to cable placement.
- Develop a cable pulling plan.
- Follow proper procedures.
- Do not exceed cable minimum bend radius.
- Do not exceed cable maximum recommended load.
- Leave extra cable
- Document the installation.

Conduct a thorough site survey prior to cable placement.

The purpose of a site survey is to recognize circumstances or locations in need of special attention. For example, physical hazards such as high temperatures or operating machinery should be noted and the cable route planned accordingly. If the Fiber optic cable has metallic components, it should be kept clear of power cables. Additionally, local building code regulations must be considered. If there are questions regarding local building codes or regulations, they should be addressed to the authority having jurisdiction, such as the appropriate building inspector.

Develop a cable pulling plan.

A cable pulling plan should communicate the considerations noted during the site survey to the installation team. This includes the logistics of cable let-off/pulling equipment, the location of intermediate access points, splice locations and the specific responsibilities of each member of the installation team.

Follow proper procedures.

Because fibers are sensitive to moisture, the cable end should be covered with an end cap, heavy tape or equivalent at all times. The let-off reel must never be left unattended during a pull because excess or difficult pulls, center-pull or backfeeding techniques may be employed.

Do not exceed cable minimum bend radius.

Every Fiber cable has an installation minimum bend radius value. During cable placement it is important that the cable not be bent to a smaller radius. After the cable has been installed, and the pulling tension removed, the cable may be bent to a radius no smaller than the long term application bend radius specification.

The minimum bend radii values still apply if the cable is bent more than 90 degrees. It is permissible for Fiber optic cable to be

wrapped or coiled as long as the minimum bend radius constraints are not violated.

Do not exceed cable maximum recommended load.

While Fiber optic cables are typically stronger than copper cables, it is still important that the cable maximum pulling tension not be exceeded during any phase of cable installation. In general, most cables designed for outdoor use have a strength rating of at least 600 lbs. Most Fiber optic cables also have a maximum recommended load value for long term application.

After cable placement is complete the residual tension on the cable should be less than this value. For vertical installations, it is recommended that the cable be clamped at frequent intervals to prevent the cable weight from exceeding the maximum recommended long term load. The clamping intervals should be sufficient to prevent cable movement as well as to provide weight support

Leave extra cable

A common practice is to leave extra cable at the beginning and at the end of the cable run. Also, extra cable should be placed at strategic points such as junction boxes, splice cases and cable vaults.

Extra cable is useful should cable repair or mid-span entry be required.

Document the installation.

Good record keeping is essential.

This will help to ensure that the cable plant is installed correctly and that future trouble shooting and upgrading will be simplified. Dintek Fiber optic cables have a unique lot number shown on the shipping spool. It is important that this number be recorded.

Cable pre- and post- installation test data should be recorded in an orderly and logical fashion.

PULLING CABLES



In order to effectively pull cable without damaging the Fiber the following guidelines

should always be adhered to:

- Properly assess cable for pulling first
- Do not to attach connector prior to pulling
- Prevent moisture getting in
- Keep spacing in duct to below 53%

Properly assess cable for pulling first

Fiber Optic cable has special strength members, usually aramid yarn, for pulling. Fiber optic cable should only be pulled by these strength members unless the cable design allows pulling by the jacket. Any other method may put stress on the fibers and harm them.

Do not to attach connector prior to pulling

As a general rule, it is best to install cable prior to connector attachment. After connectors have been attached, it becomes more difficult to protect the fiber from inadvertent stress. If a pull is to be made entirely in one direction, connectors may be pre-installed on one end, leaving the other end for pulling.

If the cable must be installed with connectors attached, every practical means must be taken to protect the connectorized end from damage or stress. Cushioned enclosures should be used to protect connectors during pulling.

Prevent moisture getting in

The leading end of the cable should be sealed to prevent intrusion of water or other foreign material while pulling.

Keep spacing in duct to below 53%

For ease of cable installation, the area of the cable divided by the area of the duct or conduit should be less than 53% per a single cable. Permissible area to be occupied for 2 cables is 31%, for 3 or more cables it is 40%.

Planning the Run:

Underground Conduits: We recommend that underground conduits, if newly installed, to 50mm or 1.5" to 2". If the run is long, or if you anticipate the possibility of additional future pulls; Then you may want to install a conduit of up to 100mm (or greater). Once the trench is dug, the installation of the conduit is comparably easy and inexpensive. You may also want to consider installing additional conduits for future use.

Conduit Installations General Information:

- Try to design the conduit run with as few bends as possible. If there are too many bends in the run then you may consider installing junction boxes in lieu of bends. Note: There is some controversy on installing junction boxes in lieu of bends.
- Use plastic bushings on conduit ends to

avoid damage to the cable during the pull.

In Buildings: It is not necessary to pull fiber optic cable in innerduct. Innerduct is strictly a personal preference. The following instruction takes into consideration that you will pull the fiber optic cable directly into the ceiling or other space. Plan for straight pulls only (point A to point B). Diagonal pulling across an area will be OK but it would make for a neater and more professional installation to install the cable at an angle that is parallel to a wall.

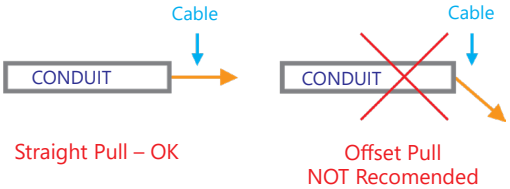
Installing the cable:

Rope Size: We recommend a heavier rope that is anywhere from a 1/4" to 1/2" in thickness. The thickness of the rope should increase with greater pull lengths. Have the pull rope installed before the cable pulling crew arrives for maximum efficiency.

Use a generous amount of cable pulling lubricant on the entire run, especially on the leader (pulling eye & mesh). The person may stop the cable pull from time to time to prepare and apply more lubricant. Use only lubricant that is expressly designed for cable pulling. When working in freezing temperatures, use a lubricant that is designed not to freeze.

Do make every effort to pull cables from a conduit in as straight an angle as possible.

Pulling on an angle can cause damage to the cable.

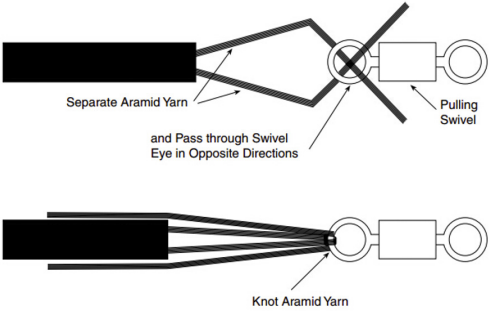


How to Handle Slack: When pulling cable out from a conduit or ceiling, it will become necessary to coil up the cable in preparation to pull it in another direction. Fiber Optic cable has a "memory". That is to say that it holds its contour that it formed while being on a reel. Do not try to re-coil the cable in a circular pattern; Instead use a figure 8 pattern as shown in the illustration. When you are finished pulling out all of the slack, turn the figure 8 cable 360° (upside down) and proceed to setup to pull it in the other direction.



Pulling Procedures

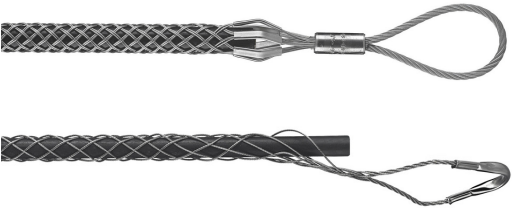
Direct Attachment



With direct attachment, cable strength material is tied directly to the pulling fixture. Conventional cable tools may be used.

Swivel pulling eyes should be used to attach the pulling rope or tape to the cable to prevent cable twisting during the pull.

Indirect Attachment



A popular type of pulling fixture for indirect attachment is the "Kellems Grip" or Cable Sock . The Kellems Grip is usually reliable for

cables of 1/4" diameter or more. Large pulling forces are possible with a Kellems Grip if the grip's diameter and length are properly matched to cable characteristics.

A Kellem Grip should spread pulling forces over a 400mm to 900mm length of cable. For small cables, pre-stretching and taping the Kellems Grip to the cable helps to assure even pulling.

Tensile Loading & Bend Radius

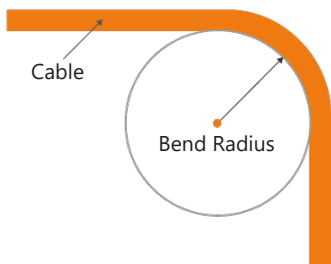
Tensile Loading

The maximum allowable pulling tension on Fiber cable can vary from as low as 50 lbs. force to as much as 800 lbs., depending on the cable construction. The maximum tension for a particular cable should be available from the cable manufacturer, and is often found in the cable specs.

- Whenever possible, the tension of the installation should be monitored.
- If pulling a cable in an outside plant conduit, the use of approved lubricants can help minimize friction.
- If a run is too long, or if several bends are in the conduit, intermediate pull boxes should be used to separate one pull into two or more shorter pulls.
- A cable should not be pulled through more than two 90° bends at one time.
- When running cable vertically, take note of the cable weight. Install cables in a

sequence that applies the least amount of strain on the cable.

Bend Radius



There are two different types of bend radius

- Dynamic bend radius
- Static bend radius
- The short term minimum bend radius, or dynamic bend radius, is the tightest recommended bend while installing cable at the maximum rated tension. It is the larger of the two specified bend radii. Throughout the pull, the minimum bend radius must be strictly followed. If a location exists in the middle of a run where a relatively tight bend is unavoidable, the cable should be hand bend or a pulley can be used.
- The long term bend radius, or static bend radius, is the tightest recommended bend the cable is under a minimum tension. It is

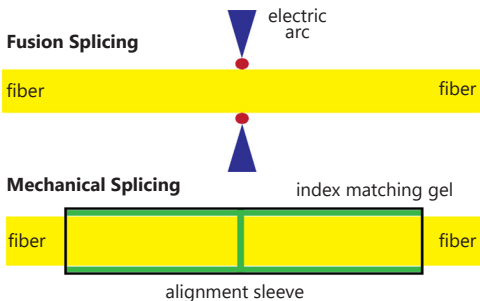
the smaller of the two specified bend radii. After the pull is complete, the cable can be bent more tightly to fit into existing space, but not to exceed the long term minimum bend radius.

- Always follow the manufacturer's guidelines for minimum bend radius and tension. Failure to do so may result in high attenuation (macrobends) and possible damage to the cable and fiber. Guidelines are normally supplied with the cable manufacturer specification sheets. If the bend radius specifications are unknown, the industry de facto standard is to maintain a minimum radius of 20X the diameter of the cable.
- The minimum bend radius must also be adhered to when using service loops. Fiber optic splice trays and patch panels are designed to accommodate the bend radii of the individual fibers, but outside of the hardware, extra care must be taken.

	Short Term (Installation)	Long Term (Installed)
Outside Plant Cable	20x Cable Diameter	15x Cable Diameter
Premise Cable	15x Cable Diameter	10x Cable Diameter

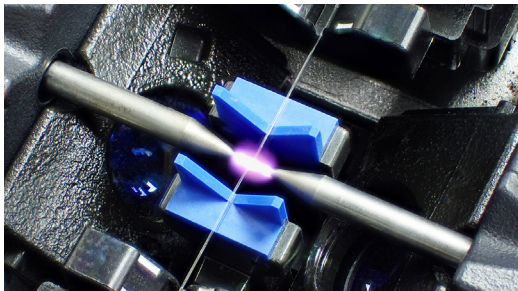
10. Fiber Termination Fusion Splices

There are two types of splices, fusion & mechanical.



Mechanical splices use an alignment fixture to mate the fibers and either a matching gel or epoxy to minimize back reflection. While fusion splicing normally uses active alignment to minimize splice loss, mechanical splicing relies on tight dimensional tolerances in the fibers to minimize loss.

Fusion Splicing Process



Fusion splicing is the act of joining two optical fibers end-to-end using heat. The goal is to fuse the two fibers together in such a way that light passing through the fibers is not scattered or reflected back by the splice, and so that the splice and the region surrounding it are almost as strong as the virgin fiber itself. The source of heat is usually an electric arc, but can also be a laser, or a gas flame, or a tungsten filament through which current is passed.

Splicing Equipment



Online Instructional PDF

Fusion splicers are fully automated machines that do most of the work. The operator uses a high quality cleaver to prepare the fibers and inserts them into the jaws of the splicer. The machine automatically aligns the ends, makes the splice and even gives an estimate of the loss. The operator then places the splice in a holder which also seals it and inserts it in a splice tray.

Fusion splicers can splice one fiber at a time or all the fibers in a ribbon.

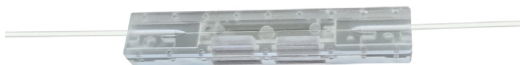
While fusion splicers are expensive, each splice is cheap. So if you are doing lots of splices, fusion splicing is more cost effective.

Mechanical Splicing

Mechanical splices use some mechanical alignment fixture.



Online Instructional PDF



Fusion vs Mechanical ?

Fusion Splicing Advantages

- Lowest loss
 - Lowest back reflection
 - Strongest
 - Faster
 - High capital cost
 - Low per splice cost
- Generally used for OSP Construction

VS

Mechanical Splices Advantages

- Minimal tooling
 - Low capital cost
 - High per splice cost
-
- Mostly used for restoration and MM premises cabling

The cost issue is simple: Fusion has high capital equipment costs but low splice costs, so if you are doing lots of splices, like OSP installation of cables with lots of fibers, fusion is cheap. If you are only doing a few splices, the lower tool costs of mechanical splicing make it cheaper.

11. Fiber Optic Testing

Testing fiber optic cables, connectors and splices is primarily done at the terminated phase on installed cable plants and patchcords. There are 4 ways of testing these cables:

Continuity testing with a visible light source - a LED or incandescent bulb in a fiber tracer or a higher power visible laser in a visual fault locator tells you if the fiber is continuous and if the connections from end to end is correctly set up (e.g. transmitter to receiver). A visual fault locator can also find problems like bending losses and broken fibers.

Visual inspection with a microscope allows checking connector ferrule ends for scratches, cracks, dirt and other contamination. It's always used in termination, but is also a valuable troubleshooting tool.

Insertion loss simulates the way the cable will be used by a transmission system, using a source (LED or Laser) at the same wavelength(s) as the system and optical power meter, with two reference cables. This test is required by all network testing standards.

OTDR testing uses a unique property of fiber - backscatter - to create a "picture" of the fiber and find faults. It's generally used for splice verification and troubleshooting, but some users also test bare fibers in cables on spools before installing it - especially when it's long cables and installation is expensive.

In addition, there are several other parameters that may need testing:

Back reflection testing is very important for singlemode terminations as it can lead to laser instability and high optical background noise in a cable.

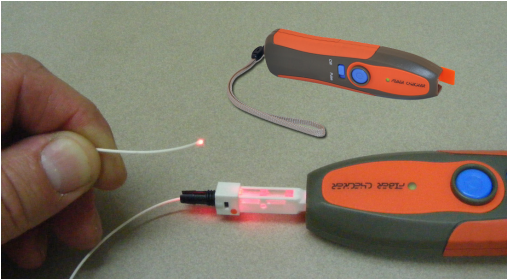
Bandwidth testing is becoming a problem as multimode fibers are used for multi-gigabit networks. Testing can be done in several ways in the factory but options are fewer in the field.

Summary Of Tests

- Continuity testing with visual tracer/fault locator
- Visual inspection with a microscope
- Optical power with a power meter
- Insertion loss with source and meter
- Required by all network and cabling standards to assure network operation
- OTDR testing
- Splice verification
- Finding faults

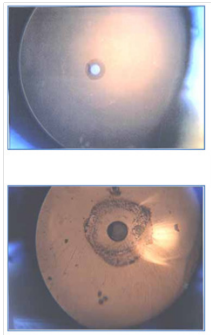
- Testing bare fiber on the reel
- Back Reflection Testing
- Bandwidth Testing

Continuity Testing



Continuity testing is done with a visible light source - a LED or incandescent bulb in a fiber tracer or a higher power visible laser in a visual fault locator.

Connector Visual Inspection



You can visually inspect the polished end of a connector ferrule with a microscope to see that the ferrule is properly polished, there are no cracks in the fiber and that the tip is smooth and free of scratches.

Optical Power Testing

Fiber Optic Power Meters



The power meter is a specialized light meter with adapters to allow connection to the fiber optic connectors on the cables and calibration at the wavelengths used in fiber optic systems.

The power meter needs to be calibrated to be able to measure at appropriate wavelengths (850, 1300, 1310 or 1550 nm.)

12. DINTEK 25yrs Warranty Program

The DINTEK 25yr System Warranty provides the recipient with the security and assurance of knowing that their installed DINTEK system will provide the performance they need to meet their long term networking needs.



Warranty Web Page

The warranty offers a 25-year standards based system performance and application assurance warranty that applies to all certified and registered links in an installation project.

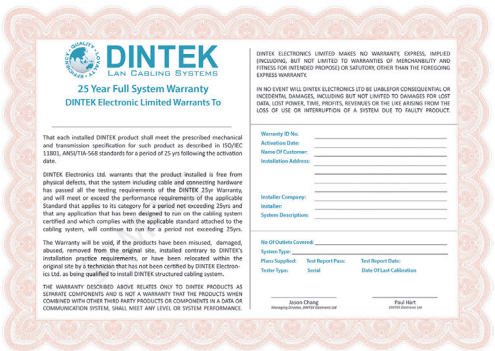
The Warranty states that these links will meet minimum performance requirements as specified in the relevant Commercial Building Telecommunications Cabling Standards (ANSI/TIA 568 and IEC 11801).

With this minimum requirement of performance, the end user is assured that their installed system will support networking applications today and into the future, which have been designed to run on their cabling system.

If any certified links subsequently fail to meet specified performance requirements, the DINTEK warranty covers the repair or replacement of defective components and/or cable and the labor associated with this repair or replacement as per the terms of the warranty.

The requirements of the warranty program include verified compliance with the design, installation, maintenance and operation practices as well as test, labeling and administration procedures as specified in Commercial Building Telecommunications Cabling Standards.

These minimum requirements ensure that all the links will provide the expected performance requirements and also help facilitate easy changes, additions and relocations which will decrease the end users total cost of ownership over time.



The warranty itself is made up of 3 specific components.

1. Product warranty
2. System Performance warranty
3. Application Assurance warranty

1. Product Warranty

The product warranty certifies that our product will continue to work for 25yrs, assuming normal working conditions.

2. System Performance warranty

The System Performance Warranty certifies that the system including cable and connecting hardware that has been tested and has passed all the requirements of the DINTEK Warranty, will meet or exceed the performance requirements of the applicable Standard that applies to its Cat. for a period not exceeding 25yrs.

3. Application Assurance warranty

The Application Assurance Warranty states that any application that has been designed to run on the cabling system certified and which complies with the applicable standard attached to the cabling system, will continue to run for a period not exceeding 25years.



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