Molex Connected Enterprise Solutions

Onsite Installation and Testing Pocket Guide

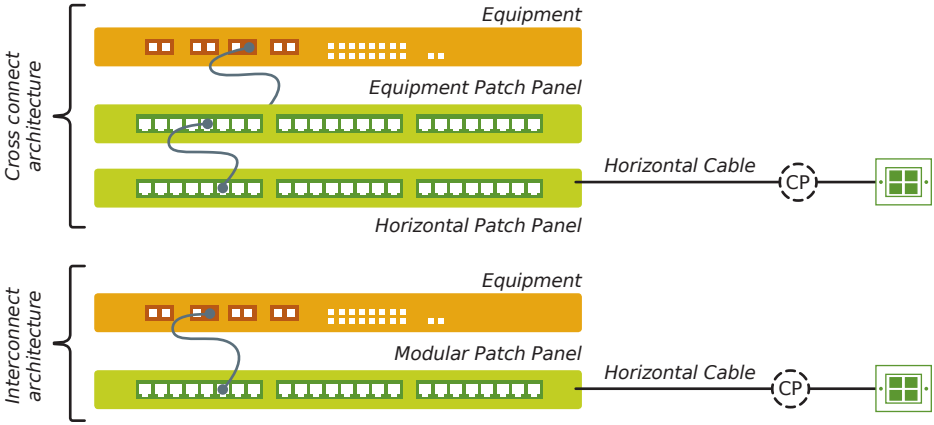
molex

Structured cabling architectures and design considerations

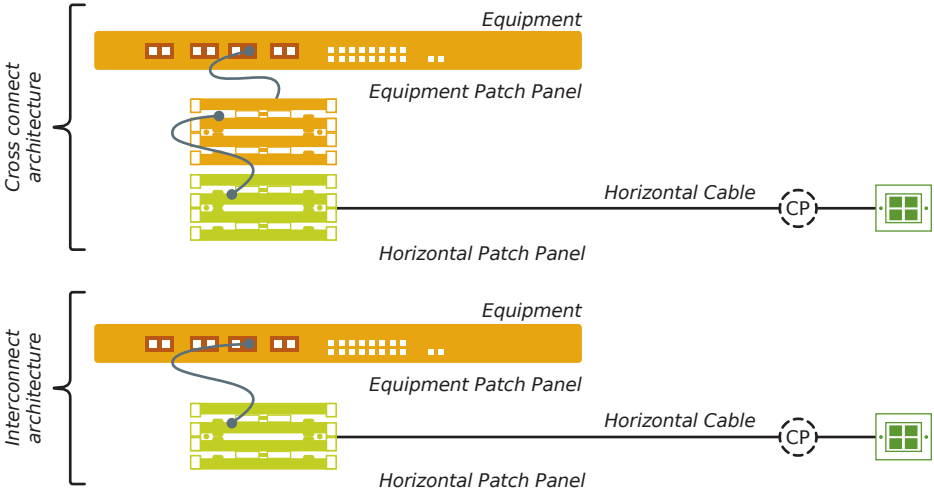
There are two basic architectures for structured cabling systems – Crossconnect and Interconnect.

In a Crossconnect architecture, an additional connection point is added between the horizontal panel and the active equipment, usually a switch.

Often known as the equipment panel or equipment connection point. The switch is then hard wired to the equipment panel, then all moves and changes are performed between the horizontal panel and the equipment panel.



The following illustration shows the same as the above, but using 110 connection blocks. PDS solutions are usually wall mounted. Active equipment is housed in a freestanding cabinet/rack. Equipment cables from cabinet to wall mounted system side blocks deliver active services for Cross connect to horizontal side blocks.



In an Interconnect environment, the patch cord between the equipment (usually a switch) and the patch panel will be stranded cable and will match the performance level of the infrastructure. The horizontal cable between the patch panel and the work area outlet will have solid conductors. The patch cord between the work area outlet and the device at a desktop will have stranded conductors, and should also match the performance level of the infrastructure.

Switch/equipment to patch panel

- Use stranded conductor in patch/ equipment cord for routing flexibility

Patch panel to work area outlet

- Use solid conductor cable in the permanent link

Work area outlet to device

- Use stranded conductor in patch cord for routing flexibility

In a Cross connect environment, the link between the equipment and the patch panel will be solid core cable assemblies. The link between the equipment patch panel and the horizontal patch panel will have stranded patch cords. The horizontal cable between the patch panel and the work area outlet will have solid conductors and the patch cord between the work area outlet and the device at a desktop will have stranded conductor.

Switch/equipment to patch panel

- Use solid conductor in this cable assembly

Switch/equipment patch panel to horizontal patch panel

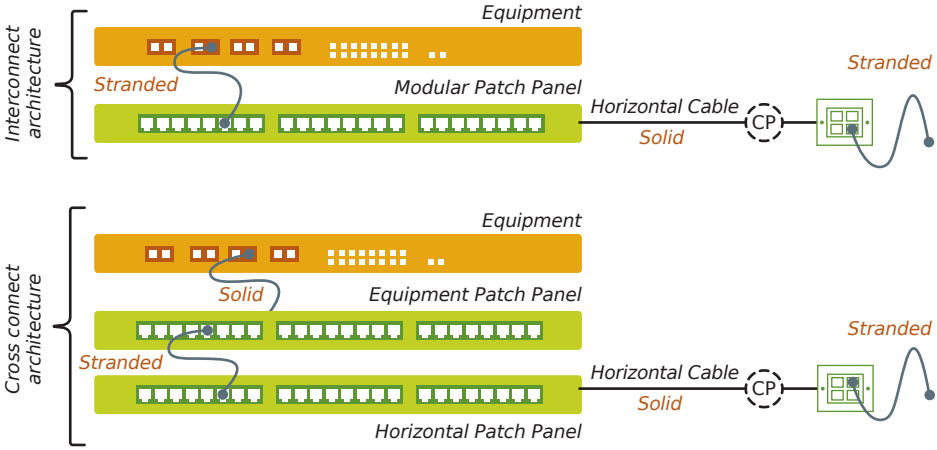
- Use stranded conductor in patch/ equipment cord for routing flexibility

Horizontal patch panel to work area outlet

- Use solid conductor cable in the permanent link

Work area outlet to device

- Use stranded conductor in patch cord for routing flexibility



Open office cabling

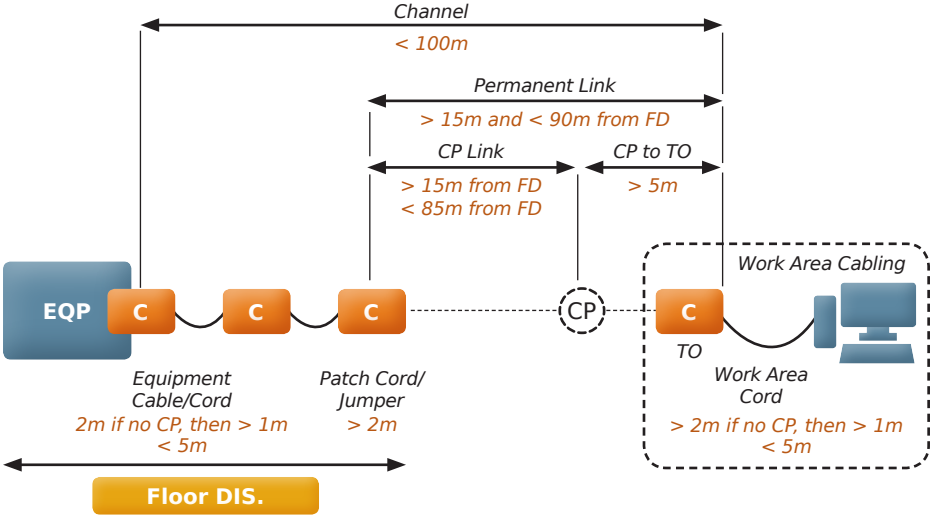
Open office cabling was designed to solve a practical problem rather than a technical one. There are two solutions on open offices, a MUTO, Multi-User Telecommunications Outlet (or MUTOA, Multi-User Telecommunications Outlet Assembly), which can accommodate up to 12 users in one central connection point. It is often used in locations core centers where teams are located together.

The other is Consolidation Point architecture. These are often used where the cabling infrastructure needs to be changed a lot. This is a portion of cabling from the TR to the CP that is permanent and never moved. The portion from the CP to the outlet is moved many times. This is often used in development labs where the benches are often moved depending on the location where the project is being worked on.

EuroClasses

From 1st July 2017 all data and telecommunications cable must be ranked in terms of its reaction to fire performance, by its EuroClass.

There are seven EuroClasses for flame spread and heat release as shown in the table below.



EuroClass	Reaction to Fire Standards	Additional Parameters		
		Smoke production	Flaming droplets	Acidity
Aca	Gross heat of combustion EN ISO 1716	None		
B1ca	Heat Release EN 50399 Flame spread EN 50399 and EN 60332-1-2	s1a, s1b, s2, s3 EN 50399 EN 61034-2	d0, d1, d2 EN 50399 EN 60754-2	a1, a2, a3 EN 50399 EN 60754-2
B2ca				
Cca				
Dca	Heat Release EN 50399 Flame spread EN 50399 and EN 60332-1-2			
Eca	Flame spread EN 60332-1-2	None		
Fca		None		

Installations best practices – copper

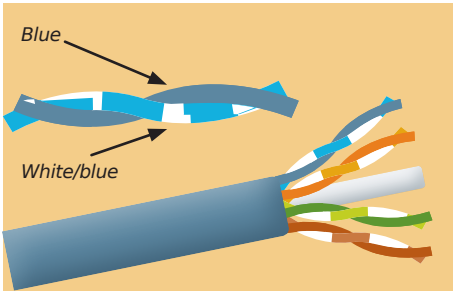
De-Rating Factors as per ANSI/TIA 568-C.2

Copper cable performance is affected due to heat which changes the resistance of the Copper. ANSI/TIA 568-C.2 has provided the table below outlining the de-rating requirements for both screened and unscreened cables. As can be seen, screened cables have a lower de-rating factor and will perform better in hotter environments. ISO/IEC 11801 also lists de-rating factors in Table 21 – Horizontal link length equations (not shown in this document).

4-Pair colour standard

The wires within a cable are all colour coded in pairs. These pairs were named tip and ring with one predominately coloured, whilst the other is predominately white. Other combinations of the colour markings can include the white ring conductor having a coloured strip to match the tip conductor colour, or each the tip and ring conductors have a colour strip their paired cabled. The colours and associated pairs are shown below:

- Pairs are colour-coded
- Each pair has a Tip conductor and Ring conductor
- Pair 1 is designated T1 & R1, or A & B, or + & -
- Cables conform to the following colour standard:
    - T1 White Blue and R1 Blue
    - T2 White Orange and R2 Orange
    - T3 White Green and R3 Green
    - T4 White Brown and R4 Brown



Temperature °C (°F)	Maximum Horizontal Unscreened Cable Length (M)	Maximum Horizontal Screened Cable Length (M)	De-Rating (Unscreened) Length (M)	De-Rating (Screened) Length (M)
20 (68)	90.0	90.0	0.0	0.0
27 (77)	89.0	89.5	1.0	0.5
30 (86)	87.0	88.5	3.0	1.5
35 (95)	85.5	87.7	4.5	2.3
40 (104)	84.0	87.0	6.0	3.0
45 (113)	81.7	86.5	8.3	3.5
50 (122)	79.5	85.5	10.5	4.5
55 (131)	77.2	84.7	12.8	5.3
60 (140)	75.0	84.0	15.0	6.0

Table G.2 – Maximum horizontal screened cable length de-rating factor for different temperatures (ANSI/TIA 568-C.2). Note: This table assumes that the channel includes 10 meters of Patch and Equipment cords at 20°C. ISO/IEC 11801 lists de-rating factors in Table 21 – Horizontal link length equations (not shown on this slide).

Termination sequence – standard RJ45

Shown below are the two globally accepted termination sequences 568A and 568B. Essentially both sequences are the same with the exception being pairs 2 and 3 (Orange and Green) are transposed. There is no performance difference between the two sequences.

Cabling under false floor

Running cables under a false floor has become common place in new buildings, where the floor system has be designed as part of the building. This allows for a more flexible cabling system, access post installations are easier, and fewer services run under the floor. It is often a dedicated area for cabling. However, the disadvantages are that it is initially more expensive, the noise of people's movement is increased, and is better if installed and designed during the building's construction, as the floors can be level.

Advantages

- Clean
- Easy access (no ladder as with ceiling installation)
- Available space is greater

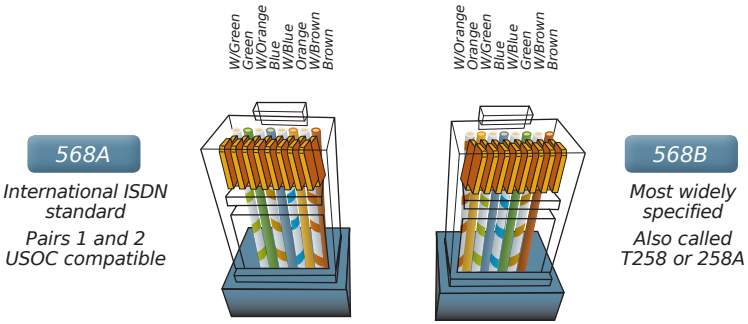
Disadvantages

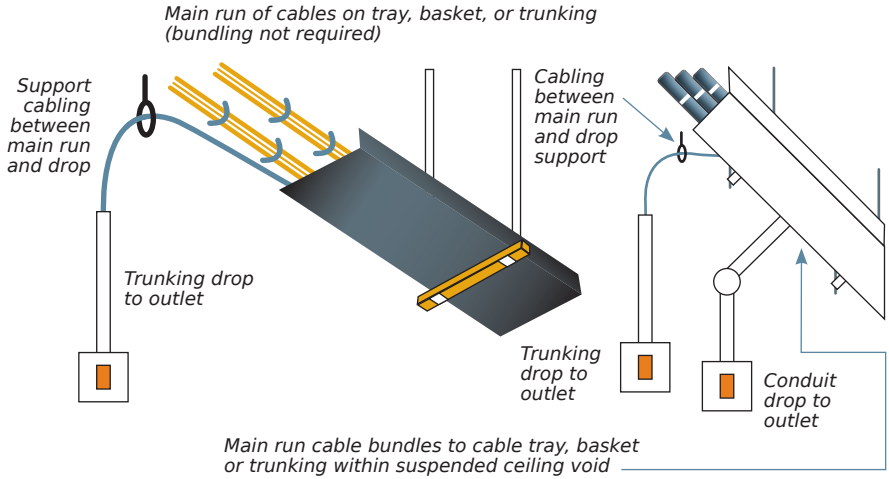
- Expensive (false floor)
- Ambient noise increases
- Needs to be considered at design stage to have floors level

Cabling in suspended ceiling area

Cables in trays and supported cabling on catenaries, should be laid in random order, but kept neat. This assists in the mitigation of Alien Crosstalk. Cables should be secured to the containment at every change of direction, and the supported weight of the chosen containment must be considered. Do not lay cables directly onto the ceiling support system, cabling should always have a dedicated pathway.

- Most common and cost-effective pathways for running cable
- Cable must be supported at every change of direction
- Do not lay cables directly onto the ceiling support system as cabling should have a dedicated pathway
- Support cabling by using cable trays or catenary cables
- Do not over-fill catenaries or support stands
- Maximum of 24 cables per catenary strand





Basket or tray above suspended ceiling

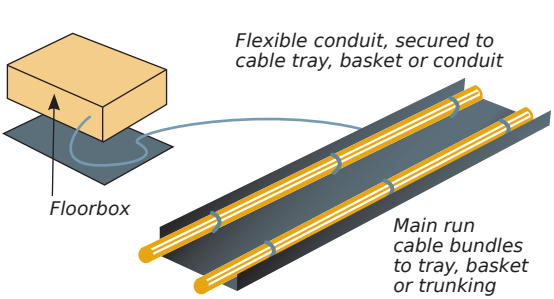
The diagram above shows cables run on a basket, or tray. Do not overfill the cable tray, and ensure the cable is supported as it comes off the tray. Make sure there are no sharp edges, which could damage the cable sheath. Any cables with damaged sheaths should be replaced, as exposing the pairs massively reduces the potential performance, and is more susceptible to external influences such as E M I or Alien Crosstalk (ANEXT).

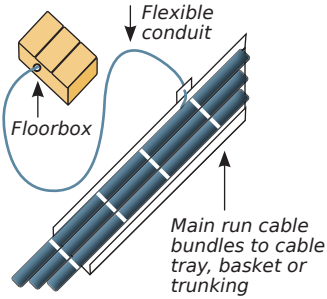
Cabling in floor void

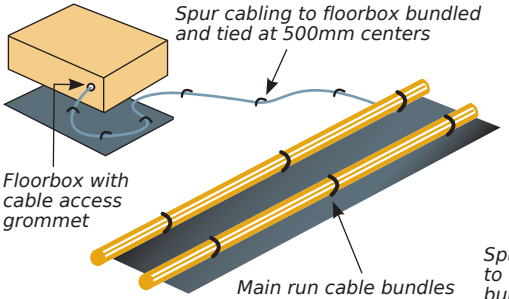
The diagram below shows cables run on a cable tray or basket under a false floor. The cables should be secured at every change of direction. It is advisable to protect the cables servicing specific floor boxes from damage, and flexible conduit is an ideal solution for this. If flexible conduit is not used, the cables should be secured to the floor.

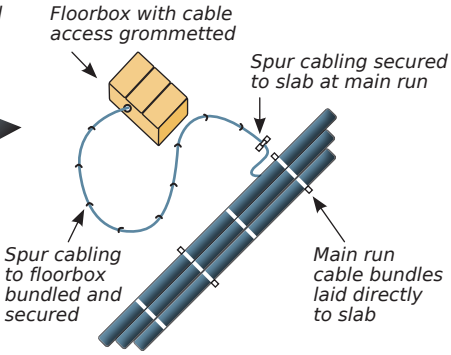
The cables are depicted on matting, and sit on a dedicated pathway, marked on the concrete floor, the cables can be loose laid, but should be secured at every change of direction.

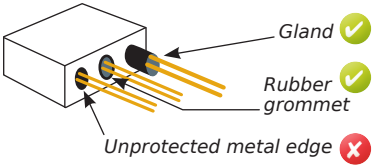
Using floor boxes or GOP boxes, it is crucial to protect the cables entering the floor box from damage. It is not acceptable to have the bare metal from the knockout exposed. There should always be a rubber grommet or a gland.











Surface trunking

Surface trunking offers some key advantages over the other two options. Less pre-design thought needs to go into the building, outlets can be anywhere around the perimeter of a room, outlets can be at desk level for easy access, and there are many shapes and sizes available. The disadvantages are that space is at a premium, and the same containment is often used for power. So, the length of cable that can be run in unshielded conduit is limited.

Advantages

- Easier to retrofit into a building
- Outlets can be at desk level
- Less pre-design required
- Many options available
- Reasonably cost effective

Disadvantages

- Space is at a premium
- Shared with power cables

Two compartment trunking is better than 3 compartments, but 3 compartments are still more common. This is because of legacy designs. It is important when installing surface trunking to consider the bend radii limitations of the cable being installed and use the correct hardware to limit how tight the cables can be bent inside the trunking. You must use containment that is deep enough to limit damage and crimping. This is especially important when installing Cat 6A cables.

Containment types

There are many options for containing cables on a cable run. The purpose of the containment is to give cabling a dedicated marked pathway, which can be documented.

Cable pathways should always run parallel or perpendicular to walls. Basket is a commonly used form of containment in both ceiling voids, and under floors, to mark a pathway from cabling and offers a level of protection. Cable trays are similar to basket in terms of the way it is installed, and where it can be used, however it can offer more protection especially when a lid is used.

It is important to consult the manufacturer for weight limits of basket systems. Metal cable basket should always be grounded. When installing in a ceiling void allow 200mm (8in) clearance above the tray, as per ANSI/TIA-569-D standard. Under raised floors allow 50mm (2in) clearance

above the side of the basket.

- When using basket as a pathway, always consult manufacturer's specifications for installation requirements and load capacity
- Metal support systems must always be bonded together and grounded
- When installing metal basket trays in the ceiling void, allow 200mm (8in)* clearance above the tray. In the US there should be 18 inches of clearance below a sprinkler head
- Under raised flooring, allow 50mm (2in) clearance above the basket/tray side rails
- Allow additional space if tray has a lid for removal and re-installation
- Note: Metallic pathways under 1m (3 ft.) in length (e.g., wall and floor sleeves, J-hooks) are not required to be bonded

* As per the latest ANSI/TIA-569-D, the minimum access headroom above cable trays is reduced from 300 mm (12 in) to 200 mm (8 in).

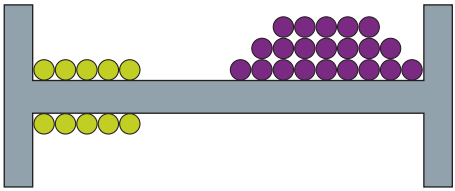
The below shows a infrastructure cabling that are supported at the change of direction, and there is protection when the cables go from horizontal to vertical. There are no sharp edges. The cables once installed will be supported vertically.

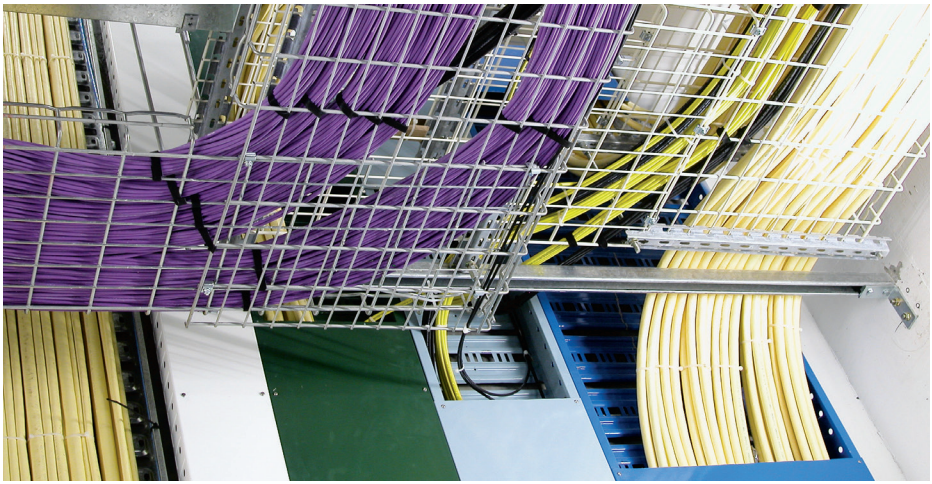
The cables supported vertically should be secured every 500mm (20in) on basket or tray, and every 1,500mm (60in) in closed containment. The cables should always be free from any tension.

Cable tray

Laying cables in a tray or basket is a great way of defining cable routes and protecting cables in ceiling voids, or under false floors. The cables should be run in bundles and secured to the tray or basket. The bundles should not be taller than the containment and should not be stacked more than 3 bundles high. The bundles should contain no more than 96 cables for Cat 5E, 48 cables for Cat 6, and 24 cables for Cat 6A. It is better if you can separate Fiber cables from Copper cables.

- Start laying cables to the side of the tray
- Separate Fiber from Copper
- Tie Fiber to underside of tray if practical





Heat dissipation of pathways

Heat dissipation of cables carrying power is influenced by many pathway characteristics. Table 1 shows the relative heat dissipation effectiveness of various pathway types, depending on cable quantity and bundling state.

According to ANSI/TIA-569-D-2, pathways can be characterized for thermal performance based on several attributes, such as:

- Shape
- Material
- Coatings
- Thickness
- Channels providing cable separation
- Contact area between pathway and ambient air
- Contact area between cables and pathways
- Ability to control number of cables
- Installation factors
- Design factors

Installation of patch panels

When terminating on patch panels, you must support the cables onto the cable support bars (cable managers) provided with every Molex patch panel and dress the cables to the sides of the cabinet.

The cables must be supported on the sides of the cabinet. Using cable basket is ideal for this. Vertical cable management rules apply.

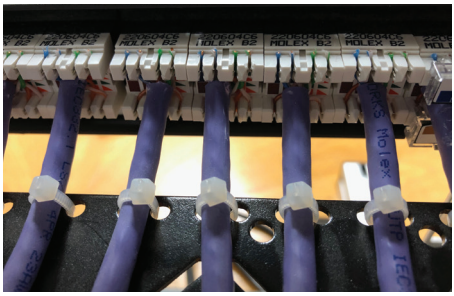
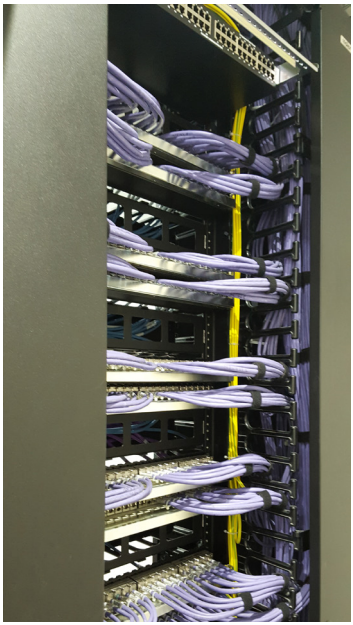


Table: ANSI/TIA-569-D-2
Heat dissipation effectiveness of pathways (excluding cable trays).

Pathway Type	Cable Routing	Cable Quantity			
		1-37	38-61	62-91	> 91
Non-continuous	Bundled	High	High	High	N/A
	Unbundled	High	High	High	N/A
Conduit (metallic and non-metallic)	Bundled	Low	Low	Low	Low
	Unbundled	Medium	Low	Low	Low
Sealed conduit	Bundled	Low	Low	Low	Low
	Unbundled	Low	Low	Low	Low

Patch panel presentation

Present all cables to the center of the DataGate panel. Retain cables to the cable management bar using nylon cable ties which should easily rotate with your fingers.



Installing horizontal cables

J-hooks are a cost-effective way of supporting cables in a roof void. Care should be taken when using J-hooks, but if installed correctly, they offer a very versatile way of distributing cables. Ensure all hooks are secured to the building fabric. Ideally, J-hooks should be spaced at 1m. Allow clearance of 75mm (2.95 in) above the suspended ceiling. Be sure to not install too many cables onto a J-hook. Consult the manufacturers guidelines to be sure.

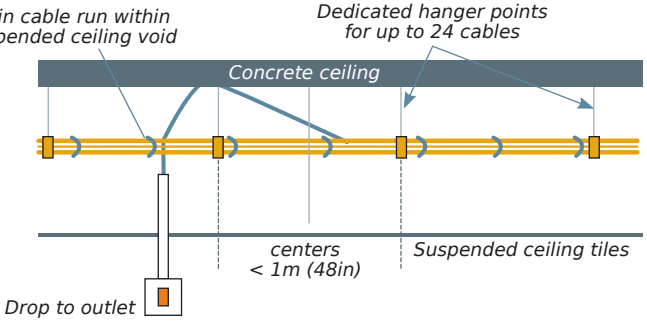
- When using J-hooks in the pathway, ensure they are properly supported
- Space J-hooks or similar support systems 1m (48 in) apart
- Allow clearance of 75mm (3 in) above suspended ceilings
- Don’t install more than 2 bundles of UTP cables per 50mm (2 in) hook
- Never use bridle rings

Cabling support

This picture below depicts how J-hooks are installed in a ceiling void. Note how the cable exits the main run to get to the WAO. Be sure to not damage individual cables and support them.

Containment – loose cables

Loose laying of cables is common practice under false floors, as it is cost effective. However, the cables must have a dedicated path. This is usually formed by matting, but could be just two lines painted on the floor. These pathways must run parallel or perpendicular to walls. Be aware of sharp concrete. The cables when loose laid have little, or no protection.



Installing in conduits

Conduit will be used in underground situations, for example a Campus backbone. Strategically placed access points (Pits) are needed to ensure correct install of cable with limited stress. Pulling cable through flexible conduit over extended distances may cause damage to the cable jacket. The corrugated profile adds more resistance to the pull. Flexible conduit is often used to protect cables coming from the main cable run to the point of termination, for example from the main under floor cable run to a floor box.

- Conduit comes in several types and sizes including rigid metal, PVC and Fiberglass conduit, or flexible PVC conduit
- Molex advises against using flexible conduit of extended length because it has potential for abrasion to jacket
- Can be used for short lengths, e.g.: pathway between permanent duct and modular furnishing when physical elements/obstructions require its use, provides physical barrier between power & communications cable
- Use conduit in environments where the cable needs protection from incidental damage, visual exposure is a consideration, access by unauthorized individuals is possible, or building/safety codes require it
- Not suitable for dynamic environments requiring frequent relocations
- Maximum straight length without access should not exceed 30m (98ft)
- For conduits with an internal diameter more than 50mm (2 in), the inside bend radius shall be at least 10 times the internal diameter. If there is a reverse (U shaped) bend in the section, a pull box shall be installed
- No more than two 90° bends between each pull box – a third bend is allowed if the run is less than 10m (32ft) Pull boxes should be readily accessible and should be installed in straight sections of conduit and not used in place of a bend
- Conduits extending from a distributor room shall not serve more than three equipment outlet boxes

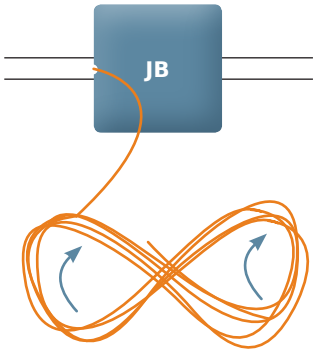
Pulling boxes for horizontal cables

Sometimes pulling boxes are required in a conduit run to avoid excessive tension been exerted on the cable. If this is the case, then the cable should be drawn through the pulling point as shown, and then pulled again. Conduit should be loaded with a pulling rope. It is worth loading the conduit with a spare pulling rope before pulling the cable in case there are more cables to be run in the future.

- The cable should be monitored and fed from the feeding end to eliminate slack, reduce strain on the cable, and prevent the cable snagging
- If cable is being pulled in stages to a location part way to its final destination, the cable stack should be piled in a figure-8 pattern at the pulling junction so that the stack can be flipped over and easily fed for the rest of the pull without any knots, twists or kinks.

1. Lay cable on floor in a figure-8 pattern.

2. Turn figure-8 cable 360° (upside down), before continuing pull to opposite direction (may require 2 people).



Containment Fill

Standards recommend the pathway be designed to accommodate 50% growth. A work area must have at least 2 cables, therefore 10 work areas have at least 20 cables, therefore the cable pathway should be designed to be able to hold at least 30 cables.

- Standards recommend a pathway allow 50% growth from initial installation
- Cable trays shall be planned with an initial fill ratio of 25%
- The maximum fill ratio of any cable tray shall be 50%. It should be noted that a fill ratio of 50% for 4-pair and similar size cables will physically fill the tray in its entirety due to spaces between cables and random placement

Example: If a design calls for 2 cables for the WA and the pathway feeds 10 WA's, the pathway should accommodate 30 cables.

- 2 Cables X 10 WAs = 20 Cables
- 20 Cables + 50% growth = 30 Cables

However, it is recommended that containment should have a maximum fill at time of install of 40% and should never have more than 60% fill. The picture shows containment with 60% fill.

- Pathway fill capacity can be found in manufacturer's specifications
- Pathways should not exceed 40% fill on initial installation and should never exceed 60% fill capacity

Whenever new cabling is installed, the old redundant cabling should always be removed. Cables should never lie directly onto the ceiling support system. Cable pathways should always be independently supported by the building structure.

Installing in pathways

When adding new cabling to a pathway, abandoned cables should be removed as best practice and normally is mandated in local building code. Check local requirements with regard to disposal of the removed cabling. Cables are never allowed to lie directly on the ceiling grid system or rest on the tiles in a suspended ceiling. Pathways must be independently supported by the building structure.

The support wires for a suspended ceiling should not be used to support pathways or cables, instead use independent support rods or cables connected to the building structure to support the pathways.

Areas above ceilings

- Inaccessible ceiling areas, such as lock-in type ceiling tiles, drywall or plaster, should not be used as distribution pathways
- Planning – The design shall provide a suitable means and method for supporting cables. Cable shall not be laid directly on the ceiling tile or rails
- Clearance – A minimum of 75mm (3 in) clear vertical space shall be available above the ceiling tiles for the cabling and pathway

Access floor systems

- Some access floor systems may also be used for air handling. Low profile access floor systems are not recommended for air handling
- There are two types of access floor systems: 1) standard height floors and 2) low profile floors
- Each of these types can have any one or a combination of support structures including stringered systems, free standing systems, cornerlock systems and integral systems

Don't forget to allow for slack at both ends of the cable. There must be at least 3m (10ft) of slack in the telecom room. Leave at least 300mm (12in) at the work area outlet to allow for any moves, adds, or changes.

Protection from damage

- All cables should be concealed where possible. Sharp or rough edges should be avoided. Cuts to metal tray and basket should be protected using grommet strip or split conduit. Holes through walls should be sleeved. Holes through floors should be free from sharp edges or suitably edged.
- All cabling should be concealed wherever possible; otherwise, they should not move or be subject to damage
- Sharp or rough edges should be avoided (Smooth with a file where required)
- Cuts to metal tray and trunking should be protected with a grommet strip or split conduit if necessary
- Holes through walls should be clean and sleeved
- Holes through raised floor tiles should be clean and, if necessary, framed with plastic trunking

Protection from damage / painted cable

Because the probability of performance issues within the extended warranty period would be significantly higher, Molex reserve the right to consider paint application to the cable to void their warranty. Unpredictable interactions between paint and cabling may affect the long-term performance of the cabling system.

There are 3 main areas of concerns:

- **Performance** – The outer jacket of an indoor cable is porous and is not impermeable to liquids. Regardless of its type, paint may contaminate the cable and alter both the materials and performance of the balanced twisted pair cable. As a result, the cable's mechanical and electrical properties may be affected over time
- **Safety** – Paint can change the property of the outer jacket of a balanced twisted pair cable, and the smoke and flame performance of a cable that was contaminated by paint may be changed and degraded. This is a serious safety concern.
- **Identification** – Paint can clearly hide the marking and identification of the cable, which can then lead to all sorts of confusion when the time comes to identify a particular link. Paint can also act as a material that will glue individual cables to each other.

Power source separation

Local standards on separation rulings for safety, etc. must apply in all cases. Maintain greater separation where practical to reduce electrical interference to data traffic. This gives added insurance for integrity of data. When power and comms finally meet, maintain all separation requirements of local electrical safety codes.

Recommended separation from power wiring

This standard specifies requirements for telecommunications pathways and spaces in commercial and multi-tenant buildings, access provider spaces, and service provider spaces, where entrance rooms, distributor rooms, enclosures, racks, cabinets and other telecommunications facilities, and infrastructure is located. Pathway locations include areas above the ceiling, access and cellular floor systems, cable

support systems, underfloor duct and insert systems, perimeter and surface mount pathways, and utility columns.

To reduce noise coupling in electrically conductive telecommunications cables from sources such as electrical power wiring, radio frequency (RF) sources, large motors and generators, induction heaters, and arc welders, the following additional precautions should be considered:

a) increased physical separation;

b) electrical branch circuit line, neutral, & grounding conductors should be maintained close together (e.g., twisted, sheathed, taped, or bundled together) for minimizing inductive coupling into telecommunications cabling;

c) use of surge protectors in branch circuits that can further limit the propagation of electrical surges. Follow guidelines in ANSI/IEEE 1100; and

d) use of fully enclosed, grounded metallic raceway or grounded conduit or use of cable installed close to a grounded metallic surface that will also limit inductive noise coupling. Refer to ANSI/TIA-607-B and ANSI/IEEE 1100.

Higher the current and voltage levels, the higher frequencies of the noise sources, and the closer the cabling is routed to the noise sources. Then greater the probability of data transmission errors, and higher the E rating (from the "mice" classification – TIA TSB-185). Separation from power sources – EN 50174-2:2018

EN 50174-2:2018 clause 6 of the standard, covers segregation of Data cabling with Power supply cabling. As noted on this section, the requirements from this Standard will depend on upon several factors.

Segregation requirements exist to counter, or minimise the risk of electromagnetic interference between a defined group of power cables and data cables.

The construction of the Power supply cable

- The quantity and type of electrical circuits provided by the Power supply cables
- The presence of dividers between the Data cables and Power supply cables (i.e., a physical divider within a common pathway system, which has at least the same electromagnetic performance as the pathway)
- Future expansion of both the Power cable and Data cables shall be taken into account when determining the separation requirement and the selection of pathways to be used in providing the required separation.

Additional items to be considered.

Power cables and others shall not be installed within the same bundle, or in the same compartment of a pathway, or pathway system as data cables. Unless physical separation is maintained. Should power cables (other than single core cables operating at voltages > 600v) pass through a fire barrier, it is then possible to reduce the separation requirements with the following conditions:

- The total distance over which the reduction in the separation occurs is not greater than the thickness of the fire segregation barrier + 0.5m on either side
- The Data and Power cables are enclosed in separate trunking or conduit
- Local regulations concerning fire barriers are complied with Table 10 of EN 50174-2:2018 addresses separation requirements between Data cables and specific EMI sources.

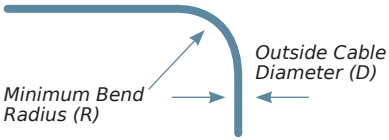
Source of disturbance	Minimum separation (mm)
Fluorescent lamps	130[a]
Neon lamps	130[a]
Mercury vapour lamps	130[a]
High-Intensity discharge lamps	130[a]
Arc Welders	800[a]
Frequency Induction Heating	1,000[a]
Hospital/Airport/Military Equipment	b
Radio-transmitter	b
Television transmitter	B
Radar	B

[a] The minimum separations may be reduced provided that appropriate cable management systems are used or product suppliers guarantees are provided.
[b] Where products suppliers guarantees do not exist, analysis shall be performed regarding possible disturbances, i.e. frequencey range, harmonics, transients, bursts, transmitted power, etc

EN 50174-2:2018 Table 10 – Separation requirements between Data cables and specific EMI sources.

Copper cable handling – bend radius & pull tension

Do not exceed the cable manufacturer's specified cable pulling tension. ANSI/TIA-568-0.D recommended maximum pulling tension for 4-pair balanced twisted pair cable should not exceed 25 lbs (110 N). 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.



The bend radius is the minimum a cable can bend without any risk to damaging it or reducing its expected lifetime.

	Minimum Bend Radius	Notes	Pulling Tension
ANSI/TIA-568-0.D Horizontal and Backbone	4 x D Always follow the vendor's guidelines	The minimum inside bend radius, under no-load or load, for a 4-pair balanced twisted-pair cable shall be four times the cable diameter.	The pulling tension for a 4-pair balanced twisted-Pair cable shall not exceed 110 N (25 pound-foce) during installation.
ANSI/TIA-568-0.D Patch Cord	1 x D Always follow the vendor's guidelines	The minimum inside bend radius for a 4-pair balanced twisted-pair cord cable shall be one times the cord cable diameter.	N/A

Reels and boxes

When pulling cables from reels or boxes, the cable should run freely. If the cable becomes snagged, then un-snag the cable before continuing to pull. The cable jacket should not be crimped at any time.

A single person should not control more than 6 boxes/reels of cable as it becomes too heavy to manage. This frame (on the picture) should have 3 people controlling the running of the reels.

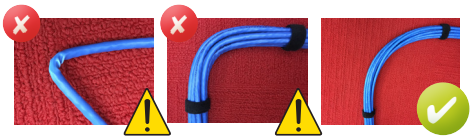
Cable entry and exit

Maintain major cable pathways to common access areas, e.g. above corridors & general office space. All changes in direction, vertical and horizontal, must be made with sweeping 90° bends and be well supported. Run cables parallel and perpendicular to building line and corridors with minimum crossover.

Cable Installation

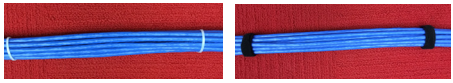
When installing cables, it is important to avoid kinking and stretching. The cables should be supported where necessary particularly at the change of direction. Maintain the recommended bend radius at all times.

- Avoid kinks in the cable during pull
- Do not stretch the cable
- Support cable at all points, particularly at any change of direction
- Maintain recommended bend radius



The use of nylon ties is ok as long as care is taken not to over-tighten. The cable tie should turn around the cables easily and should not deform the shape of the jacket. It is more difficult to over-tighten hook and loop tape.

- *Use nylon cable ties with care*
- *Closed tie should rotate freely*
- *No deformation of cable jacket*
- *Use hook and loop (velcro) ties for neatness and flexibility instead*
- *Support cables at every change of direction when on tray or basket*



Fire stopping

The purpose of a fire stopping system, is to prevent and contain the spread of fire, through the use of architecturally designed & rated fire barriers, in order to protect the structure and inhabitants. Be aware of the local codes relating to cable installation, and the environment you are working in. Alternative routes may prove to be a better solution in the long run. Material and time can be saved without compromising safety if fire stopping is considered at an early stage of design or construction.

You are responsible to provide the proper fire stopping for the cabling installation.

There are 2 broad categories of firestops:

1. Mechanical: Pre-manufactured elastomeric components shaped to fit around standard cables, tubes and conduits.

2. Non-mechanical: These come in a variety of forms that have the advantage of adapting to irregular openings and off-center penetrating items (i.e. cementitious materials, intumescent sheets, intumescent wrap strips, silicone foam and pre-manufactured pillows).

Consult the local codes and ensure who is responsibility for providing the fire protection, which is based on these principles:

- Prevention
- Detection
- Suppression
- Containment

A penetration that is left open or improperly sealed may allow flames, toxic gases and smoke to travel throughout a building firestop should be used or maintained for all penetrations of cable, wires and pathways.

Rack and cabinet layout

It is important to think about the rack layout when installing systems into cabinets. This will allow for best use of patch cords and make the administering of the system easier through its lifecycle.

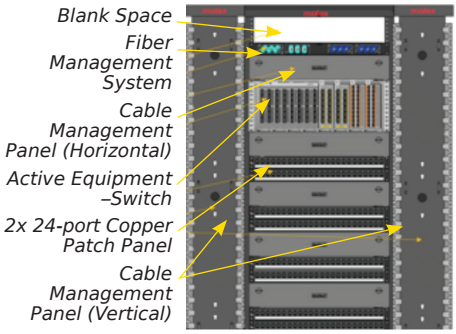
Recommended component placement

- Molex recommends that you place Fiber patch panels at or near the top of the rack to protect the terminations from potential harm
- Molex recommends Fiber out of harm's way
- Install a rack mounted storage unit (such as the Fiber Management System), as well as any splice trays used, to protect and contain slack Fiber strands. For planned future expansion, strategically leave spaces (Rack Units)
- Fiber Crossconnects are not generally re-configured on a regular basis
- Fiber is used mainly in backbone applications / Once in place there should be no need for changes
- Also, the Fiber panel couplers should be above eye level as a safety requirement

Install copper-based patch panels with a cable management ring run above and below every two horizontal rows of patch panel ports.

- Horizontal cable management is mandatory. Support of the patch cables with the use of the extensive range of offering from Molex will lead to a reasonably neat and manageable Crossconnect
- Ideally a row of modular jacks should have direct access to patch cord management
- The patch cord should not have to cross another bank of modular jacks to gain access to the cable management
- In extreme cases Molex will allow limited use of cable management if real estate in the rack becomes a premium
- Molex will allow 3 RU of modular jacks with cable management above and below in these extreme cases
- Locate vertical cable management ring runs on either side of the rack in the position directly below the horizontal ring run
- Vertical pathways are needed to ensure neat and managed vertical runs of patch cords

The Fiber panel is situated at the top of the rack, above eye level. The switch is below, because it allows for easy access by both the Fiber backbone and the Copper horizontal. Each 48-port panel, or 2 units of 24 port panels, should have a horizontal cable management bar in place.



Category	Maximum pair un-twist
3	75mm (3”)
5E	13mm (0.5”)
6	6mm (0.3”)
6A	6mm (0.3”)

Maximum pair un-twist for twisted-pair cable termination

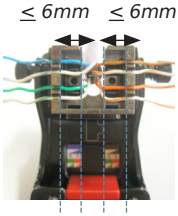
The following pages will cover cable preparation and termination. This table is a reminder on the maximum allowed pair un-twist for twisted-pair cable termination. In all cases, the length of pair untwist shall always be minimized.

Modular plug terminated link

This new link model allows for “limited cases”, where there may be a need to terminate horizontal cables with a plug that is directly plugged to a device. This page is showing some examples. It is important to remember that this new link model is not for the connection of Data/Voice devices, this should still be achieved via the standard Permanent Link with Patch Cords.

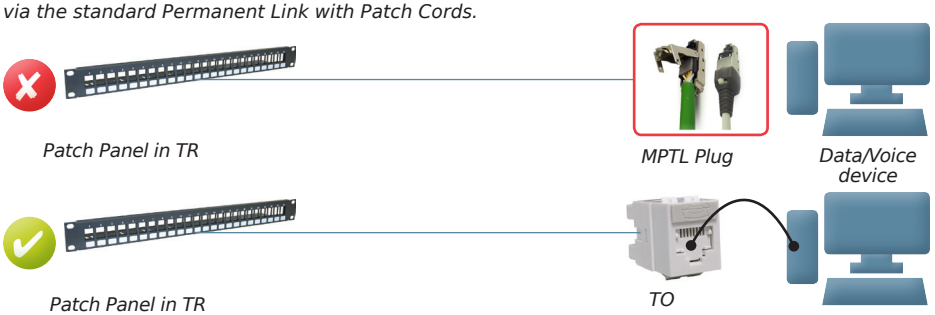
ANSI/TIA-568-2.D link model – Modular Plug Terminated Link (MPTL)

This new link model allows for “limited cases” where there may be a need to terminate horizontal cables with a plug that is directly plugged to a device. Below is an example of the new link model.



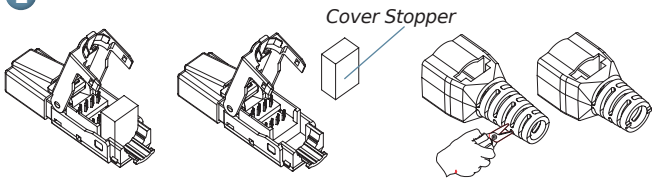
Example of a Cat 6A cable terminated with the Molex Connected Enterprise Solutions 4-pair termination tool.

This new link model is not for the connection of Data/Voice devices, this should still be achieved via the standard Permanent Link with Patch Cords.



Here is the termination process for the Molex Connected Enterprise Solutions MPTL.

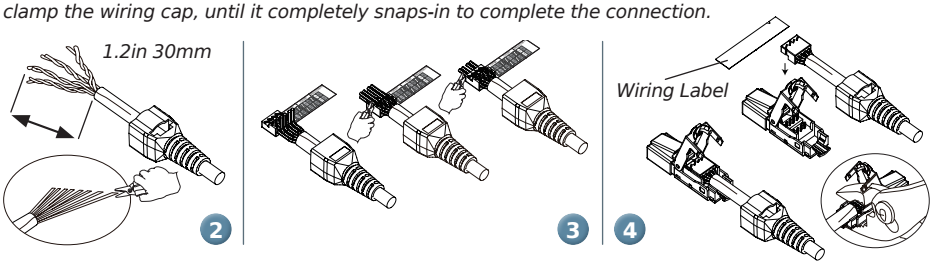
1

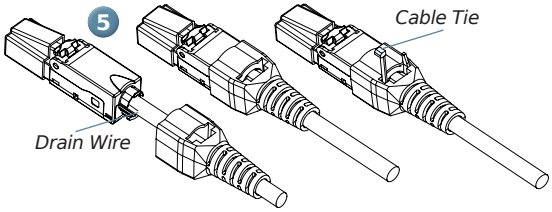


1 *To start with, remove the cover stopper before installation. Then, cut the end of the boot to fit your cable OD.*

Jack Pin designations 87 54 63 12	TIA/EIA T568A	TIA/EIA T568A	Industrial
	White/Green Green	White/Orange Orange	Yellow Orange
	White/Orange Orange	White/Green Green	White Blue
	Blue White/Blue	Blue White/Blue	N/A
	White/Brown Brown	6mm (0.3”)	N/A

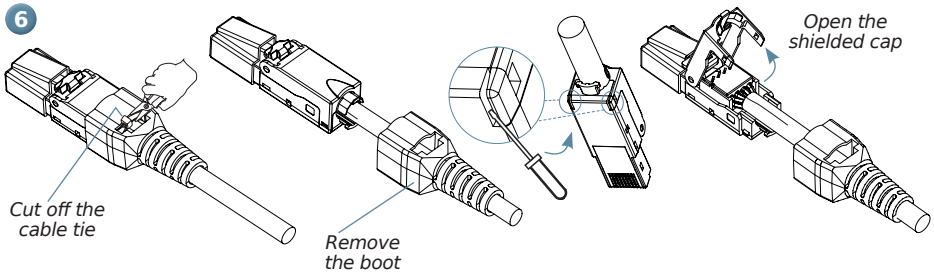
2 *Insert the cable into the strain relief boot and strip off 30mm of cable jacket, and fold back the drain wire.* 3 *Then, fan out all of the four twisted pairs, following the colour-coding label and position each conductor into proper slots on wiring cap. Trim the conductors’ end.* 4 *Remove the wiring label before placing the wiring cap on the plug, and then place the wiring cap onto the plug. Use pliers to clamp the wiring cap, until it completely snaps-in to complete the connection.*





5 *Close the plug cover and make sure the drain wire is in proper contact with the grounding clip on the plug. Pull back the strain relief boot to cover the plug, and lock the final assembly, using the supplied cable tie to secure the grounding contact.*

6 *Should you need to unload your cable, cut off the cable tie and remove the boot. Then, using a flat screw driver, pry gently on the plug cover, one side first, and the other, to open it.*



PowerCat 6 and PowerCat 6A terminations

With Copper terminations (PowerCat 6 and PowerCat 6A), there are two different types of terminations will be covered: one with the Molex 4-pair termination tool, and the other with a standard 110-type punch down tool. Both Shielded and Unshielded types will also be covered.

The Molex DataGate Jacks, Keystone Jacks and ModClip Jacks come either shielded or unshielded. The retainer cap is applied after the termination to hold the terminated wires in place.

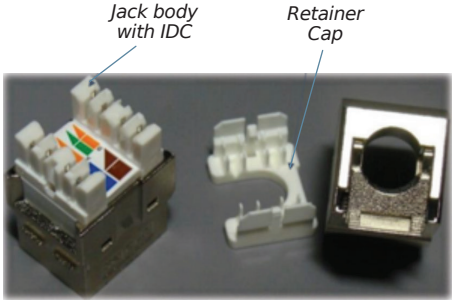
In the shielded jack, a rear housing is added to shield the IDC from noise and to maintain ground continuity.

Part Numbers	PowerCat Jacks
KSJ-00024-xx	C5E DataGate
KSJ-00018-xx	C6 DataGate
KSJ-00032-xx	C5E Keystone
KSJ-00033-xx	C6 Keystone
MMC-00013 / 19-xx	C5E ModClip
MMC-00010-xx	C6 ModClip
KSJ-00091-xx	C6A Keystone*
KSJ-00088	C6A Keystone **

** Not available in the United States – Please consult a Molex Connected Enterprise Solutions representative to check for the correct P/N in the U.S.*

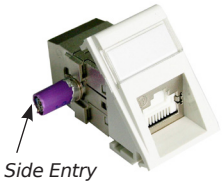
*** Available ONLY in the United States – Please consult a Molex Connected Enterprise Solutions representative to check for the correct P/N OUTSIDE the U.S.*

Part Numbers	PowerCat Shielded Datagate jacks
KSJ-00062-xx	C6A DataGate
KSJ-00073-0x	C6A Side Entry DataGate

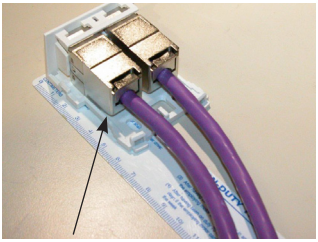


PowerCat 6A – DataGate cable entry options

The DataGate jacks, Category 6 as well as Category 6A, allow for both straight-in and side entry into the jack.



Side Entry



Straight-in Entry

4-Pair Termination Tool features

Molex 4-Pair Termination Tool is designed for use with its DataGate and Keystone Jacks. The tool features a high carbon steel frame, fitted with ergonomic, comfortable handles cable colour code and jack position guides on the Frame, making lacing the wires quick and easy. Changing of the Termination Heads is achieved with the Allen Key provided. Molex highly recommends using this tool for high-quality terminations.

- Designed for Molex DataGate and Keystone Jacks (straight-in only) *
- High carbon steel frame fitted with ergonomic, comfortable handles
- Cable colour code and jack position guides are present on the Frame, making lacing the wires easy
- Quick, easy changing of the Termination Heads with the Allen Key provided
- Molex recommends using this tool for high-quality terminations

*** Not compatible with every jack – Please consult a Molex Connected Enterprise Solutions representative to check for compatibility.**

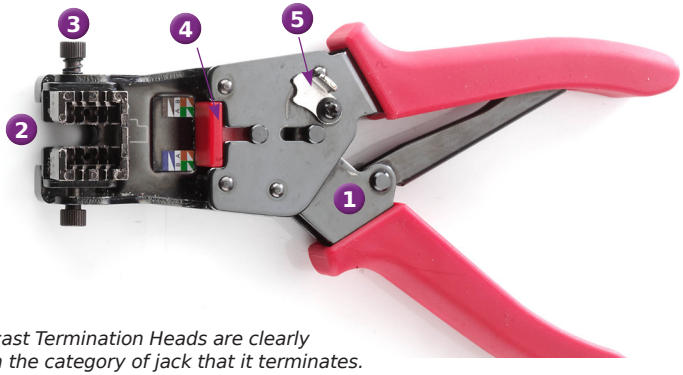
- Reduces installation time compared with a single wire tool
- Accurately seats, cleanly terminates, and neatly trims wires in with one squeeze of the handles

DataGate jack 4-Pair Termination Tool

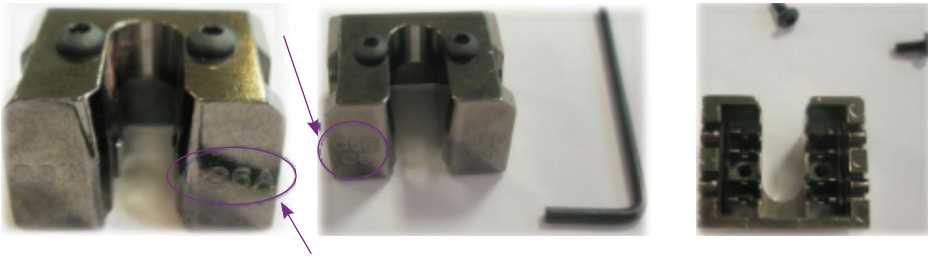
The 4-pair termination tool is comprised of the 5 components shown that are referred to in this module.

1. Tool Frame
2. Termination Head
3. Termination Head Pivot
4. Jack Pusher
5. Handle Latch

Robust die cast Termination Heads are clearly marked with the category of jack that it terminates.

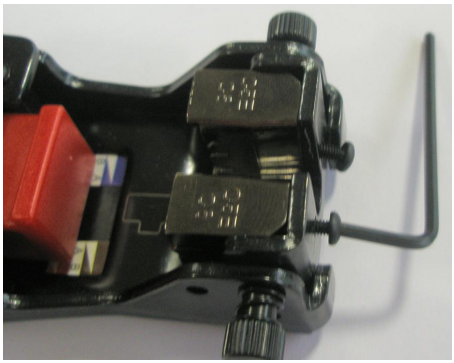


Robust die cast Termination Heads are clearly marked with the category of jack that it terminates.



To change the Termination Head – Remove the 2 M2.5x8 screws on top with the Allen key provided. Position the Termination Head as shown. Re-install the 2 Termination Head screws.

- *Remove the 2 M2.5x8 screws on top with the Allen key provided*
- *Position the Termination Head as shown*
- *Re-install the 2 Termination Head screws*



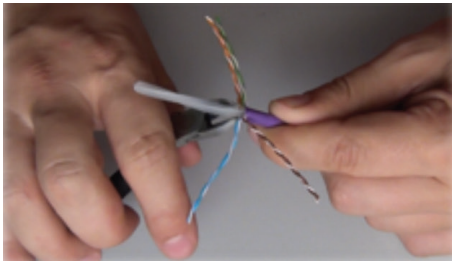
In the following sections, each termination type is broken down into Tool Preparation, Cable Preparation, Termination, and Finishing.

DataGate jack terminations – tool preparation – 110 type punch down termination.

Remove the cutting blade from the rear of the tool. Insert the tool's cutting blade, ensuring the cutting edge is on the side of the tool labeled "CUT". Set the impact adjustment knob to the LOW position. This can be adjusted later.

F/UTP cable preparation

Score and remove approximately 50mm (2 in) of the cable's outer jacket, ensuring not to nick the pairs inside the jacket. Cut away the nylon rip-cord and center separator.



To lace the IDC, Position wire pairs based on your chosen wire map. Ensure wires are straight with no more than 10mm (0.4in) visible between the jacket and IDC termination point. For maximum performance, minimize pair untwist and the change in cable geometry.

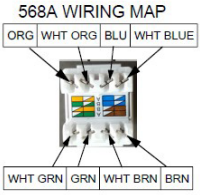
UTP category 6A cable preparation & jack termination – option #1 P/N KSJ-00091-xx

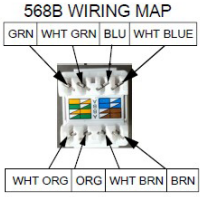
Strip off 50mm (1.97 in) of cable sheath from the one end and then, remove the foil wrap from each pair.

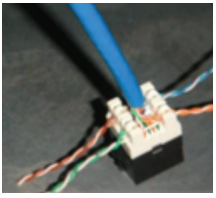
Caution: the Molex C6A cable shown here is unshielded. It does not include a drain wire or braid. The foils provide anext protection. Do not connect any of the foils to ground. This cable does not require grounding or bonding.

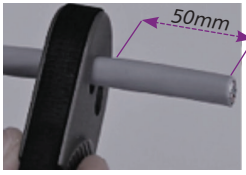
Note: if located IN United States, these instructions do not apply.

Insert wires into IDC's according to the desired wiring configuration (T568B/ T568A). Terminate the cable with a 110 Termination tool ensuring the cable sheath is maintained to the base of the IDC towers and allowing a maximum untwist of 6mm and trim the wires flush with the IDC towers.

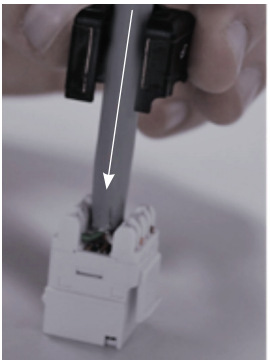






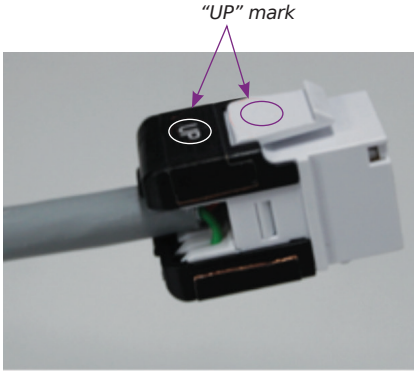


Important: to achieve optimum alien crosstalk prevention, place the IDC cap over the IDC towers. Align the “UP” mark on the cap with the “UP” mark on the jack latch. Snap the cap into place to ensure fully seated.



U/UTP category 6A cable preparation and jack termination: Option #2A - Keystone Jack P/N KSJ-00088

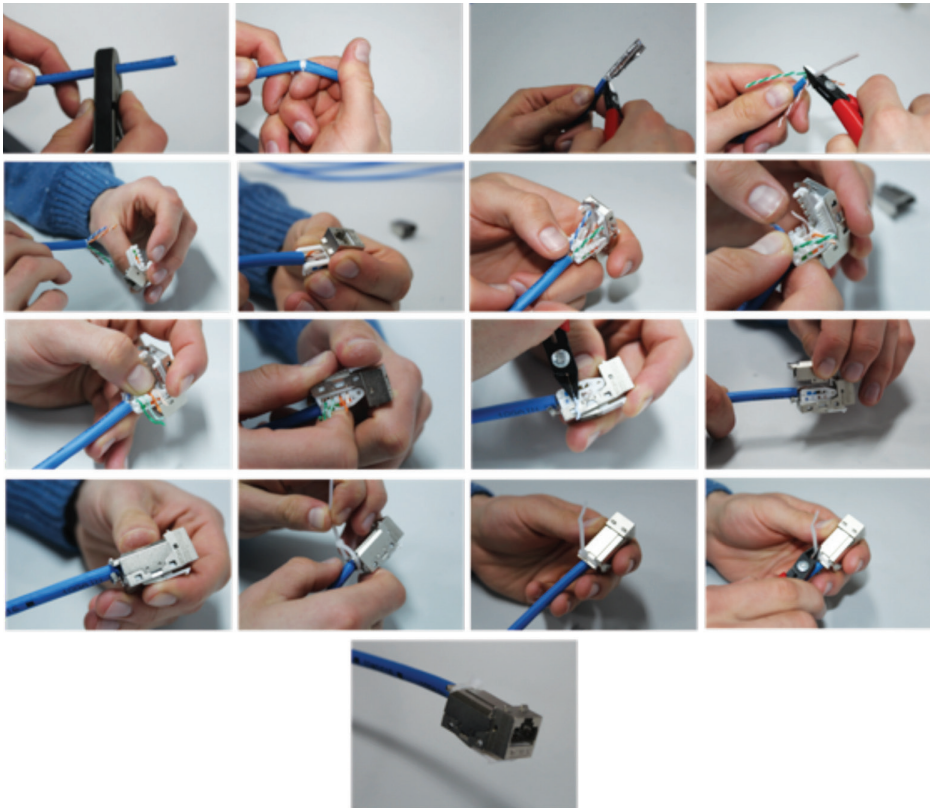
- The termination of this Category 6A U/UTP cable is similar to the Category 6 U/UTP cable
- However, the isolation wrap (conductive discontinuous wrap) should be fully removed on both ends of the cable with cable clippers



Caution: the Molex C6A cable shown here is unshielded. It does not include a drain wire or braid. The foils provide anext protection. Do not connect any of the foils to ground. This cable does not require grounding or bonding.

Note: if located OUTSIDE United States, these instructions do not apply.

Please go to “U/UTP category 6A cable preparation and jack termination – Option #1”.



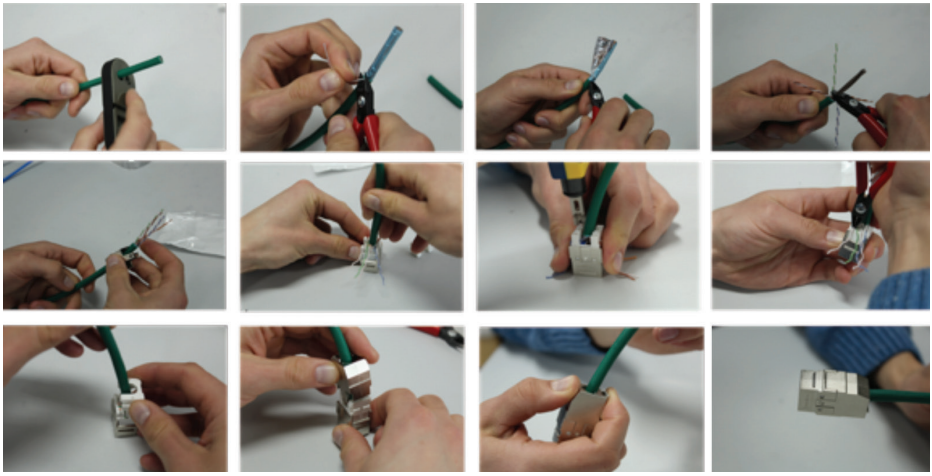
U/UTP category 6A cable preparation and jack termination: Option #2B – DataGate jack P/N KSJ-00062-0x

- The termination of this Category 6A U/UTP cable is similar to the Category 6 U/UTP cable
- However, the isolation wrap (conductive discontinuous wrap) should be fully removed on both ends of the cable with cable clippers

Caution: the Molex C6A cable shown here is unshielded. It does not include a drain wire or braid. The foils provide anext protection. Do not connect any of the foils to ground. This cable does not require grounding or bonding.

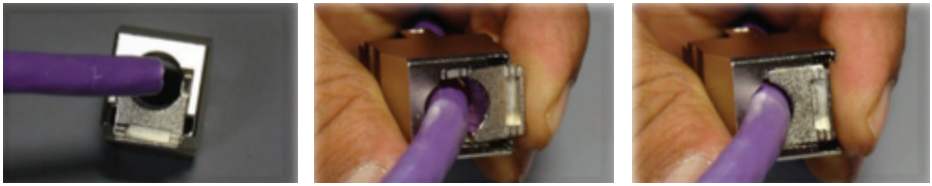
Note: if located outside United States, these instructions do not apply.

Please go to “U/UTP category 6A cable preparation and jack termination – option #1”.



U/FTP cable preparation

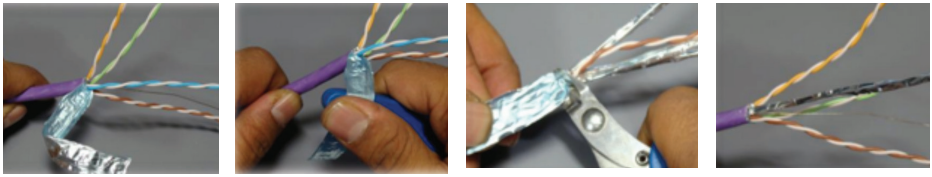
Open the spring-loaded cable clamp in the rear housing and slide over the cable. Close the cable clamp to restrict movement of the rear housing along the cable.



Score and remove approximately 76mm (3in) of outer jacket of the cable, ensuring you do not damage the foils inside.

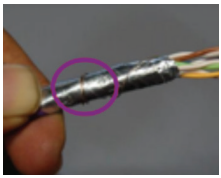
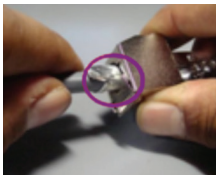
Peel back foils of three pairs (orange, green and brown) and cut each at the cable jacket.

Peel back and straighten the fourth foil.

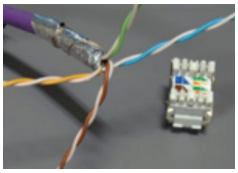
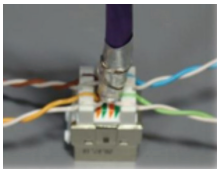


Spiral the foil around the cable jacket, ensuring its blue side is facing inward and its shiny, conductive side is facing outward.

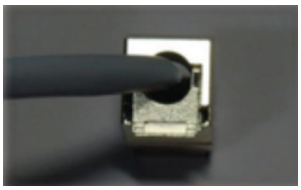
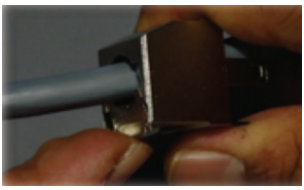
Wrap the drain wire in the opposite direction as the foil. Knot the drain wire 25mm (1 inch) from the end of the jacket. Clamp the rear housing on the foil to hold it in place.

Position wire pairs based on your chosen wire map. Ensure wires are straight with no more than 10mm (0.4in) visible between the jacket and IDC termination point.

Wrap the drain wire in the opposite direction as the foil. Knot the drain wire 25mm (1 inch) from the end of the jacket. Clamp the rear housing on the foil to hold it in place.

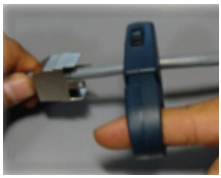
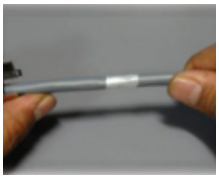



Ensure that none of the internal twisted pairs are visible or exposed outside of the rear can (or cap).

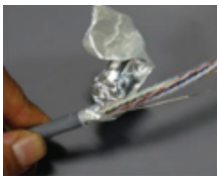
Open the spring-loaded cable clamp in the rear housing and slide over the cable. Close the cable clamp to restrict movement of the rear housing along the cable.

F/UTP cable preparation

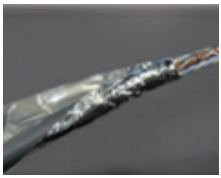
Score and remove approximately 76mm (3in) of outer jacket of the cable, ensuring you do not damage the foils inside.

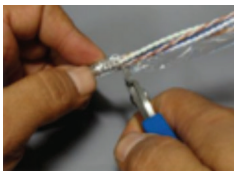
Cut the nylon rip-cord without damaging the foil or wire pairs. Peel back and wrap the foil, shiny, conductive side facing outward, around the jacket of the cable.

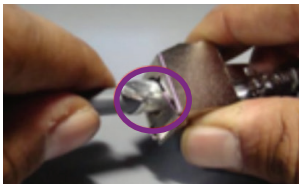
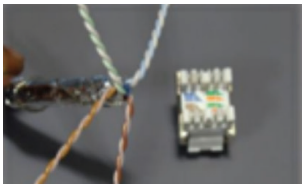
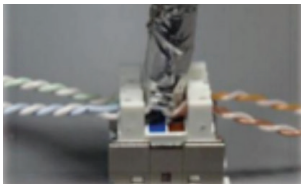
Wind the drain wire around the remaining foil and knot the wire 13mm (0.5 inch) from the end of the jacket.




Cut the polythene wrap around the wire pairs without damaging any wires. Cut the blue plastic cross spline separator at the edge of the jacket without damaging any wires.

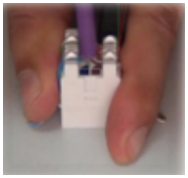
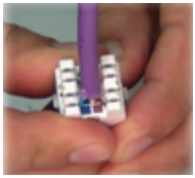
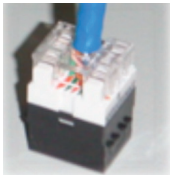



Clamp rear housing on foil to hold it in place. Position wire pairs based on wire map. Ensure wires are straight with less than 10mm (0.4in) visible between jacket & IDC termination point.

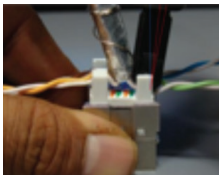
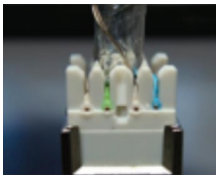
U/UTP termination with 110 tool / punch down wires

Hold the 110 tool at an angle no more than 15˚ to ensure the wire is cut flush and is fully seated in the IDC. Slide the retainer cap over the IDC housing and press until the retainer cap locks in place. Always use a retainer cap to relieve strain, thereby retaining the wires in the IDC.

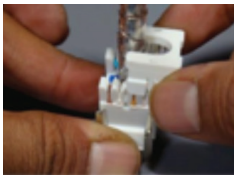
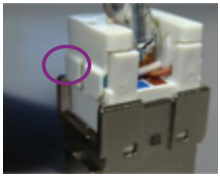




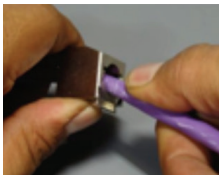
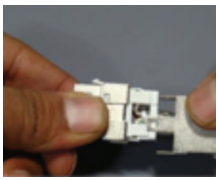
Ensure that none of the internal twisted pairs are visible or exposed outside of the rear can (or cap).

Hold the 110 tool at an angle no more than 10-15˚ to ensure the wire is cut flush and is fully seated in the IDC.

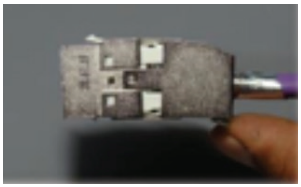
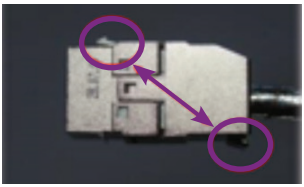
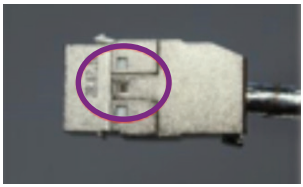
Slide the retainer cap over IDC housing and press until the retainer cap locks in place. Always use the retainer cap that relieves strain thereby retaining the wires in the IDC.

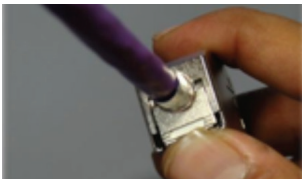



Release the cable clamp from the rear housing by pressing the cable against it. As some of these clips are stiff and cable pressure point/damage could be a result, the use of a small flat screw driver, if you have no thumb nail, works well in the slot. Slide the rear housing over the foil and over the jack.

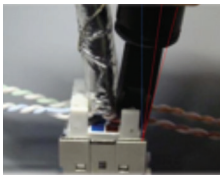
Press the latches on the rear housing to lock onto the jack body. Ensure proper polarity is maintained between cable clamp and tab on the jack body and that the rear housing snaps to jack body.

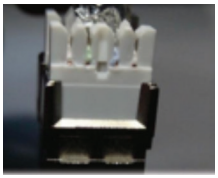




Ensure the drain wire and foil are in contact with cable clamp. Press the clamp until closed, ensuring continuity is maintained with the foil, drain wire, and the metallic jack body. Trim any excess foil. The entire termination should take less than 3 minutes.

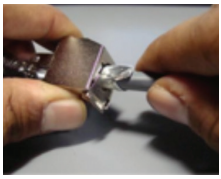
Ensure that none of the internal twisted pairs are visible or exposed outside of the rear can (or cap).

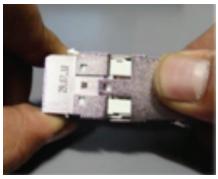




Hold the 110 tool at an angle no more than 15˚ to ensure the wire is cut flush and is fully seated in the IDC.

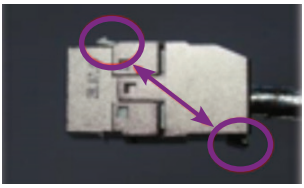
Slide the retainer cap over the IDC housing and press until the retainer cap locks in place. Always use the retainer cap that relieves strain thereby retaining the wires in the IDC.

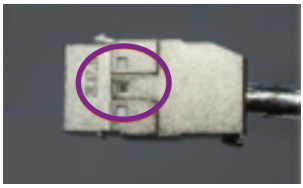




Release the cable clamp from the rear housing by pressing the cable against it. Slide the rear housing over the foil and over the jack.

Press the latches on the rear housing to lock onto the jack body. Ensure proper polarity is maintained between cable clamp and tab on the jack body and that the rear housing snaps to jack body.

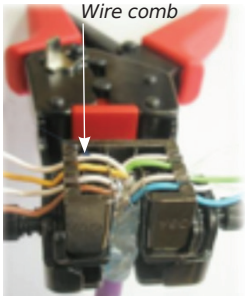




Ensure the drain wire and foil are in contact with the cable clamp. Press the clamp until closed, ensuring continuity is maintained with the foil, drain wire, and the metallic jack body. Trim any excess foil. The Entire termination should take less than 3 minutes.

Ensure that none of the internal twisted pairs are visible or exposed outside of the rear can (or cap).

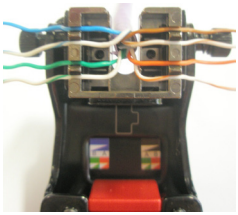
Termination with the Molex 4-Pair Tool – lacing the IDC

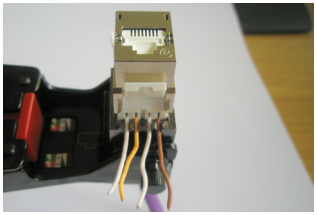


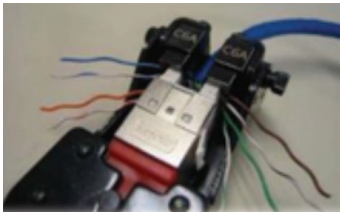
Pivot the Termination Head 90° counter-clockwise until it locks in place so that the wire comb grooves face out from the tool. Place the cable end in the slot of the Termination Head, positioning the end of the cable jacket (or shield) at bottom of wire comb. For shielded cable, do not trim the drain wire; instead, straighten and keep it free from the 4 pairs to be terminated.

It is recommended to keep the foil and drain wire clear of the multipair tool while terminating, again the blue pair foil works as it is at the open portion of the tool.

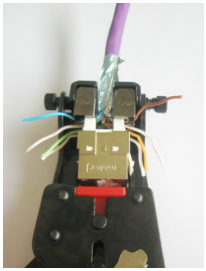
Untwist and lace all wires into comb grooves of the Termination Head following the colour-coding shown on the tool frame (left). Individual wires must be completely straightened inside the Lacing Head. Place the jack over the wires (center). For shielded jacks, remove the can around the jack before terminating. Ensure that the jack is free of any icon labels before placing in the tool. While holding the jack against the wires, pivot the Termination Head anti-clockwise 90°to meet the red pusher (right).

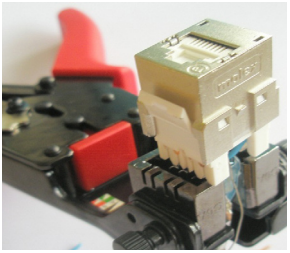




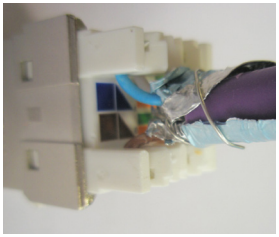


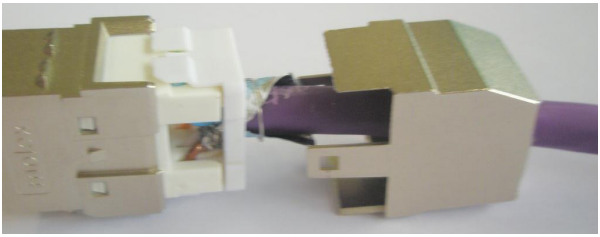
Clamp the tool handles until the wires are seated in the jack and the excess wire is cut, which indicates the stroke is complete. This tool does not have a full-cycle ratchet action, so it is important for the operator to fully close the tool. Excess wire may need to be pulled off. Release the handles to open the tool. Remove the terminated jack by pivoting the Termination Head 90°clockwise and pulling the jack out of the Termination Head.





Visually inspect the terminated jack, ensuring wires are cleanly cut and fully seated to the bottom of the slots in the jack. For shielded terminations, wrap foil and drain wire around the cable sheath. Ensure wires are not exposed more than 10mm (0.4in) from jacket to IDC. Snap-in the retainer cap. For shielded terminations, ensure proper polarity is maintained between the cable clamp and tab on jack body and that the rear housing snaps to jack body.





Take frequent breaks upon prolonged, repetitive use. Only use on our DataGate and our Keystone jacks in field installations of structured cabling. This tool is not intended for high-volume factory production use. The tool's rubber handles do not protect against electrical shock. Replace the Termination Head when the tool is no longer capable of fully inserting and cutting the cable.

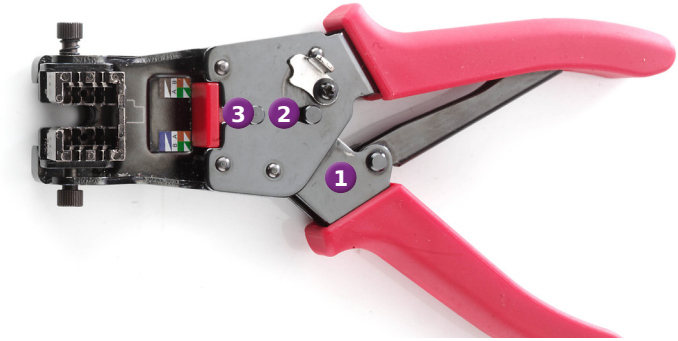
Do not disassemble or repair the tool, which voids the Molex Connected Enterprise Solutions warranty and will not maintain the required tight tolerances.

Termination with the Molex 4-pair tool – maintenance

When the tool is not in use, keep the handles closed and store in a dry, clean place. Clean and lubricate the tool regularly to maximize service life and for trouble-free terminations. Remove contaminants with a clean brush. Protect all pins, pivot points, and bearing surfaces with a thin coat of 30 weight oil at all the oil points every 5,000 crimps or every 3 months. Keep oil away from the Wire Lacing Head & colour code labels, which may affect the electrical characteristics of the termination or cause colour code labels to fall off.

The Molex Connected Enterprise Solutions 4-Pair Termination Tool is made of long-lasting materials that also provide a comfortable feel and precision termination of 23 or 24-gauge solid conductors. Its UTP Termination Head accommodates U/UTP cable while its Cat 6A Termination Head accommodates F/UTP and U/FTP cables.

- Accommodates 23-24 AWG solid conductors
- UTP termination head accommodates U/UTP cable
- Cat 6A termination head accommodates F/UTP and U/FTP cable



Field testers and testing – copper

Testing of the network to standards is required for Molex Warranty Applications.

Testing is performed to specific categories or class of link and results are compared to industry standards to provide pass/fail indication.

Factors that affect the integrity and performance of the installed copper cable

- Severe cable bends, poorly installed connectors or outlets

Testing is to be conducted using a tester of at least level III and Current generation from the manufacturers on this page.

- Testers need to be calibrated annually or as recommended by the tester OEM
- Tester is to have the latest firmware before installations are tested for warranty purposes

Molex will continue to accept test results from a tester which is under a valid calibration, even if this model in particular has been discontinued and not supported any more by the tester manufacturer – test reports showing a note such as "Calibration Due" or similar, will be rejected.

Molex Connected Enterprise Solutions only accepts permanent link test reports for warranty purposes, regardless of architecture.

Additionally, end users should require Channel test reports for any CrossConnect channel to confirm that other components of the channel are functioning properly.

Brands accepted by Molex perform similar functions, and save measurements in a proprietary format allowing ease of audit and sorting.

- A tester is automatically dropped if the manufacturer no longer provides support for that tester.

Below are some examples (subject to change without notice).

If you wish to use a tester model not shown which is able to meet the testing requirements, please contact ces.support@molex.com with the tester details to obtain clarification of its acceptance. This must be done before proceeding with the testing.

Fluke
DSX-600 (Copper only)
Versiv DSX-5000
Versiv DSX-8000

Ideal
Lan Tek II Series
(discontinued with product support until March 2022)

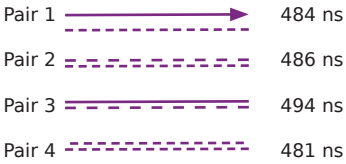
VIAVI Solutions
(Formerly JDSU)
Certifier 10G
Certifier 40G

Softing
WireXpert 4500

Nominal Velocity of Propagation (NVP)

NVP is the ratio of the speed at which electrical energy travels in a pair of conductors relative to the speed of light, given as a %. Each pair will have a different travel time due to the difference in the twist ratios between them, which varies the path length for each pair.

Note: The NVP setting affects the length measurement and NO other Parameter.



The NVP is used in calculation of the length of the link under test. As the NVP varies between cable type and manufacturer, Molex cables have the NVP printed on the jacket for ease of identification for testing.

- The NVP of the cable can vary by manufacturer by up to 2%
- The NVP setting affects the length measurement only and NO other test parameter
- The table on the next page gives an indication of the additional inaccuracy created on a maximum length with the incorrect setting for NVP

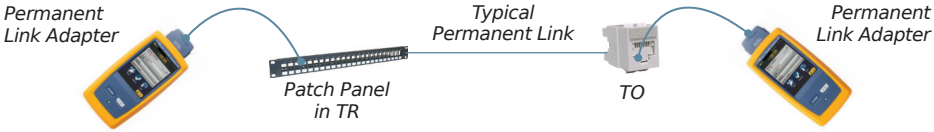
Some tester software's can re-certify results (RC) with adjusted NVP without affecting the results. Note that Molex does not accept RC (re-certified) test results for certification. Should you need to use this function please ensure you provide the original results with the (RC) results.

NVP	Report Length	
	(m)	(ft)
60	75.9	249
61	77.2	253
62	78.4	257
63	79.7	261
64	81.0	266
65	82.2	270
66	83.5	274
67	84.8	278
68	86.0	282
69	87.3	286
70	88.5	290
71	89.9	295
72	91.1	299
73	92.4	303
74	93.6	307
75	94.9	311
76	96.2	316
77	97.4	320
78	98.7	324

Never use tone probe testers to tone out cables!

The tip of the probe causes damage to the DataGate jack combs on the gate, as well as the pin contacts in the jack. You may use a single line tester instead.

Permanent Link testing only looks at cable and modular jacks each end, the PL Leads are factored out. Permanent Link tests are used to confirm the link as they are a permanent fixture within the building and the required test for a 25yr Molex Warranty. Channel Link testing involves cable, modular jacks and the patch cords at each end and is a good way of testing a link if a requirement to include the patch cords exist. We will cover the tester setup requirements later in this module.

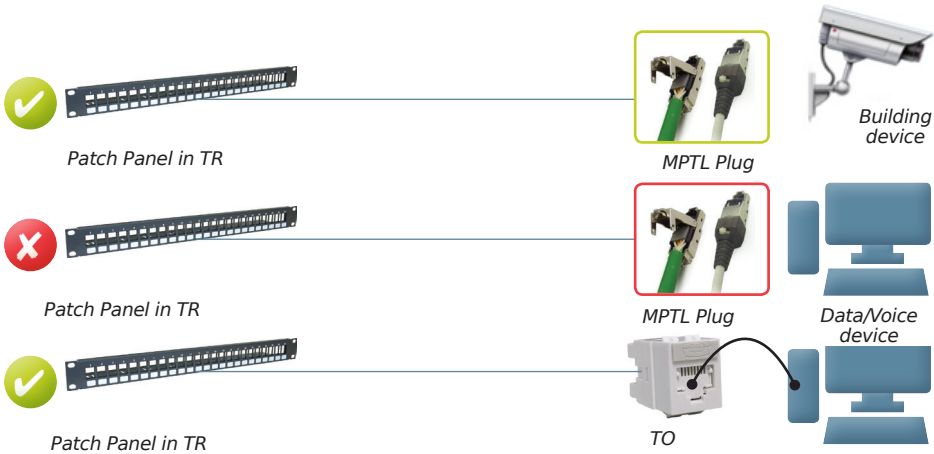


During the testing of the copper link, the tester induces various forms of noise and measures their results:

- Permanent Link Test is the industry standard for testing installations and the required test for a 25 year Molex Warranty
- The permanent link is the installed cable between the patch panel and work area outlet
- Permanent Link Leads, designed for the tester in use, are to be used to complete the testing
- Test the link to the required standard as per the project specification for your region
- Channel Link Test is used to confirm the channel performance and is useful for diagnostic works
- The channel is completed once the equipment is installed and patching is completed using Molex manufactured patch cords
- End Users should require Channel test reports for any Crossconnect channel to confirm all components of the channel are functioning properly
- Channel tests may also be used for diagnostic works against application concerns
- Channel Test Heads and 2m Molex patch cords should be used to complete the testing
- Test the channel to the required standard as per the project specification or your region

Copper testing – Modular Plug Terminated Link

The latest ANSI/TIA-568-2.D standard now includes a new link called a Modular Plug Terminated Link (MPTL). This has been due to limited cases where there may be a need to terminate horizontal cables with a plug that is directly plugged into a device. Note this is not an acceptable connection for Data/Voice devices as shown above. We will cover the tester setup requirements later in this module.



This new link model allows for "limited cases" where there may be a need to terminate horizontal cables with a plug that is directly plugged to a device. Below is an example of the new link model.

This new link model is not for the connection of Data/Voice devices, this should still be achieved via the standard Permanent Link with Patch Cords.

How to test the new Modular Plug Terminated Link?

This new link model requires a new test limit (MPTL) and the combination of a Permanent Link Adaptor and a Patch Cord Adaptor. This allows the result to contain the performance of the final plug connection at the far end.

- This new link model requires a new test limit (MPTL) and the combination of a Permanent Link Adaptor and a Patch Cord Adaptor. This allows the result to contain the performance of the final plug connection at the far end. The configuration for the MPTL testing is shown on the right
- The use of a Patch Cord Adaptor (PCA) on the far end helps to verify the performance of the field terminated plug. A channel adaptor will not include the mated **next** of the plug and jack in the measurement
- **Note:** The PCA being used, needs to correspond to the category of cable being tested. They are NOT backward compatible, therefore a Cat 6A PCA cannot be used on Cat 6 link

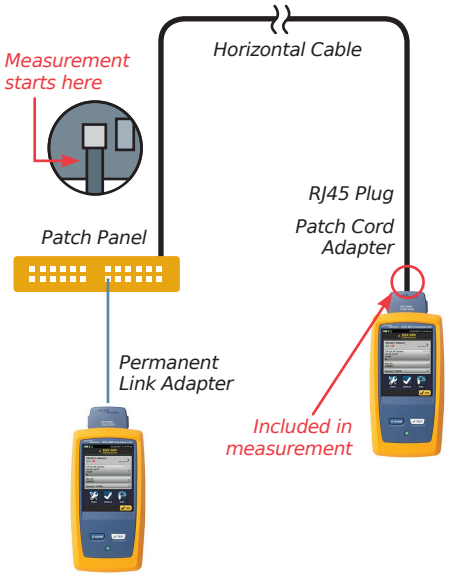
Under previous standards, the testing of a field terminated plug was by using the Modified Single Connector Permanent Link.

It has since been identified the test was not completely testing the performance of the field terminated plug.

Under ANSI/TIA-568.2-D, the Modular Plug Terminate Link (MPTL) was introduced to provide suitable testing of the field terminated plug. This is achieved through the use of a Patch Cord Adapter which tests the field installed modular plug. As such the previous Modified Single Connector Permanent Link is no longer accepted for warranty applications on field terminated plugs.

Please note: The Patch Cord Adapters are not backwards compatible, and you will need the correct Category Patch Cord Adapters for the installation you are testing.

To complete the tester setup for other categories, use the correct cable type/ category and the correct category MPTL test parameter and Patch Cord Adapters.



TEST LIMIT	TEST LIMIT
Limit Groups	TIA
Last used	TIA Cat 6A MPTL
TIA	TIA Cat 6 MPTL
ISO	TIA Cat 5e MPTL

Installation best practices – fiber optic

This sections looks at installation practices that are specific to Fiber Optic. Please keep in mind that many of the Copper installation practices also apply to Fiber.

As a start, the table below shows the minimum bend radius and pulling tensions for Fiber Optic cables. Do not exceed the cable manufacturer's specified cable pulling tension.

Cable type and installation details ANSI/TIA-568-0.D	Minimum Bend Radius – No tensile load (once installed)	Minimum Bend Radius – Max tensile load (during installation)	Pulling tension
Inside plant cable with 2 or 4 Fibres installed in Cabling Subsystems 1 (See Module 02 of this traning course)	**10 x D** Always follow the vendor's guidelines	**20 x D** Always follow the vendor's guidelines	220 N (50 pound-force)
Inside plant cable with more than 4 Fibres	**10 x D** Always follow the vendor's guidelines	**20 x D** Always follow the vendor's guidelines	As per vendor's guidelines
Inside/Outdoor cable with up to 12 Fibres	**10 x D** Always follow the vendor's guidelines	**20 x D** Always follow the vendor's guidelines	1335 N (300 pound-force)
Inside/Outdoor cable with more than 12 Fibres	**10 x D** Always follow the vendor's guidelines	**20 x D** Always follow the vendor's guidelines	2670 N (600 pound-force)
Outside plant cable	**10 x D** Always follow the vendor's guidelines	**20 x D** Always follow the vendor's guidelines	2670 N (600 pound-force)
Drop cable installed by pulling	**10 x D** Always follow the vendor's guidelines	**20 x D** Always follow the vendor's guidelines	1335 N (300 pound-force)
Drop cable installed by directly burying, trenching or blowing into ducts	**10 x D** Always follow the vendor's guidelines	**20 x D** Always follow the vendor's guidelines	440 N (100 pound-force)

Cable types

Always select the appropriate cable for the type of environment in which it will be installed. Install only loose tube cables in an outside (direct burial) environment. Tight buffer "distribution" style cables, meeting the appropriate standards and building codes, are suitable for intrabuilding backbone installations. Also, loose tube cables, especially multi-Fiber per tube, must be terminated using a breakout kit when splicing and pigtails are not used.

Always select the appropriate cable for the type of environment in which it will be installed.

- Interbuilding backbones usually experience the most severe conditions, depending on where they are installed
- Temperature fluctuations and water intrusion, at a minimum, can adversely affect the cable
- Install only loose tube cables in an outside (direct burial) environment

- Tight buffer “distribution” style cables, meeting the appropriate standards and building codes are suitable for intrabuilding backbone installations

When splicing and pigtails are not used, loose tube cables, especially multi-fiber per tube, can only be terminated using a breakout kit for any Molex Connected Enterprise Solutions warranty.

- A breakout kit routes individual bare Fibers into protective “breakouts” that allow the Fiber to then be connectorized
- Breakout kits allow for loose tube cables to be field terminated forgoing expensive fusion or mechanical splices

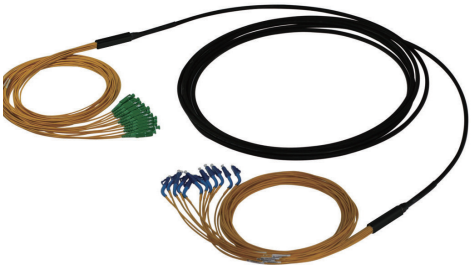
Fiber optic termination – Pigtail Splicing

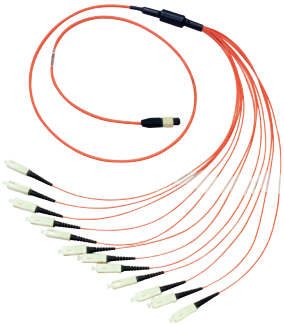
Pigtail Splicing is nowadays one of the most popular way to make Fiber Optic connections. A pigtail is an optical Fiber cable, usually a simplex 900µm Fiber cable with a factory terminated connector on one end and unterminated at the other end.

- The unterminated end is then spliced (fusion or mechanical) to the installed cable
- The slack Fiber and splice is then stored in the splice tray (see picture on the right)
- The terminated end is then mated to the corresponding adapter/coupling
- Pigtail splicing has its advantages: no field terminations are needed and they can be done quickly
- However, splicing equipment is costly, additional hardware is required, and splices introduce additional loss to the cable system
- When loose tube Fiber cable is to be used, recommends splicing as a solution
- Molex provides a complete solution which includes cassettes, splice protectors and pigtails

Fiber Optic termination – pre-connectorized cables

Pre-connectorized cables are Fiber Optic cables with factory installed connectors at one or both ends. These include simplex pigtails, duplex patch cords, or multi-Fiber cables for horizontal or backbone installations. Pigtails and patch cords are available in standard lengths (usually one meter increments) and are easily installed. Installing these cables requires more planning and additional equipment, such as pulling eyes, to protect Fibers during installation.





Fiber optic termination – modlink plug and play Fiber optic solution

ModLink is an ideal solution for mission critical applications such as Data Centers and Storage Area Networks, where fast installation is paramount and where moves, adds and changes are frequent or managed in-house.

The benefits of ModLink Fiber Optic solution are - no field termination and no splicing, resulting in 80% reduction in installation time. Rapid deployment is suitable for Data Center environment. **Note:** ModLink assemblies are Factory terminated and tested, but it is required to test these assemblies on arrival at the site to detect damage in transit. Test after install to ensure the assembly is not damaged during install. Confirm the type of cable assemblies prior to install to avoid rework.

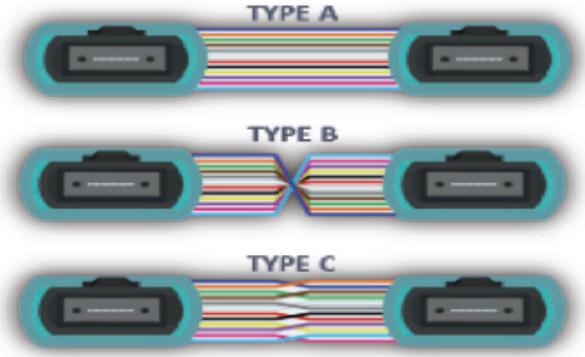
Identify Type of Connector (FEMALE / MALE), Orientation (Key Up / Key Down) and Polarity (Type-A, Type-B, Type-C) and of ModLink Cable assemblies before install – avoid rework.

The ModLink Fiber Optic cable assembly requires proper maintenance. So, lengths of cable assemblies are very important. Short cable assemblies may prevent proper connectivity and longer cable assemblies require space to manage the slack lengths. Pre-configured ModLink Fiber Panels are designed to accommodate up to 5 meters (16ft) of cable, per individual cable. Panels that house ModLink Cassettes may not have this advantage.

Fiber optic termination – direct field termination

The Molex G2 Xpress connector is a direct connection device. Study this guide to understand its benefits. Instructions are included in the kit and are explained in the following pages.

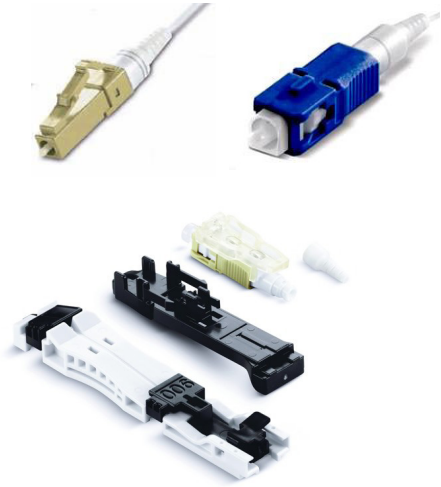
Along with splicing, field termination is a popular method of terminating fiber optic cables.



With improvements in connector technology, it is the most cost-effective method used to terminate cables Field installed connectors can be either epoxy or epoxy-less style.

The G2 Xpress connector is a pre-polished, non-epoxy direct fiber connector:

- Assembles in less than 2 minutes
- No polishing or adhesive
- Low tooling investment
- Fiber stripping tool
- Fiber cleaver tool
- Fiber cleaning kit for stripping (lint free wipes and alcohol)
- Available in both SC and LC connections
- Available for both Multimode and Singlemode Fiber
- Suitable for 250µm or 900µm with 900µm tubing for the 250µm Fiber
- Contains Index Matching Gel to provide an air tight connection
- Re-usable

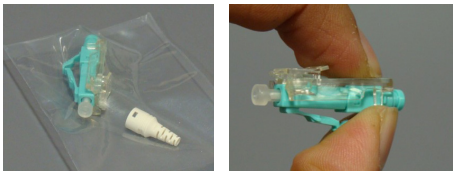


Assembly tooling

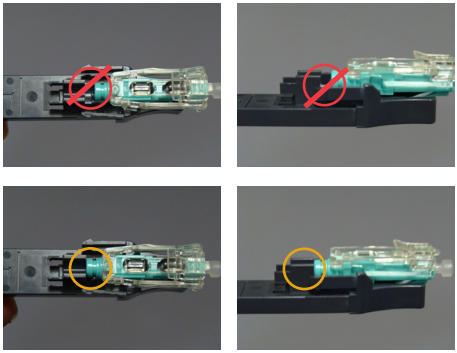
Fiber optic termination – direct field termination: Xpress G2 OM3-LC connector example

Here are the components of the G2 Xpress connector: 1 x connector body with plastic edge, and 1 x connector boot.

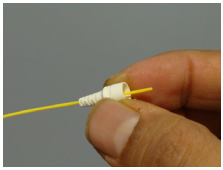
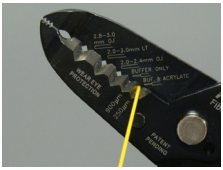
Depress the plastic wedge onto the connector body to ensure it is fixed securely.



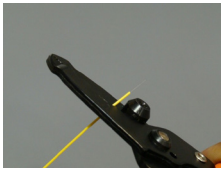
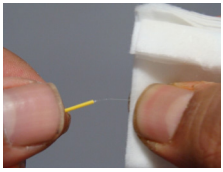
Ensure there is no gap between the connector groove and the "U" bridge on the Assemble Guide jig. Ensure the connector is positioned correctly as shown.



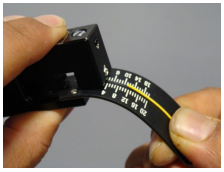
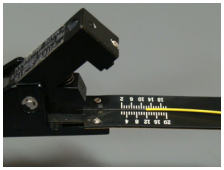
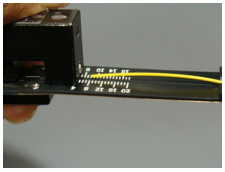
Insert Fiber through the connector boot as shown. Then, remove the buffer and acrylic overcoat on the Fiber with a good Fiber Optic stripper.

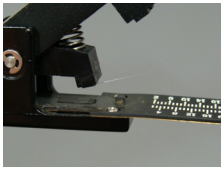
Insert Fiber through the connector boot as shown. Then, remove the buffer and acrylic overcoat on the Fiber with a good Fiber Optic stripper.

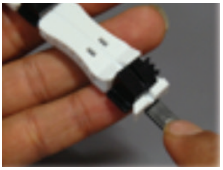
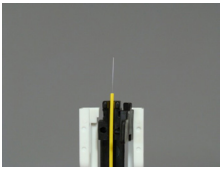
Remove 30-35mm (1.18 -1.37in) of coating in short portions, without damaging the optical Fiber strand. Clean exposed Fiber strand with an alcohol swab for any residue.

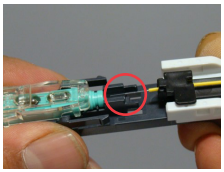
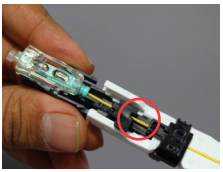
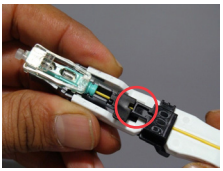
A Fitel S-315 Cleaver is convenient and cleaves the Fiber well. Cleave 9-11 mm (0.35-0.43in) of the optical Fiber from the buffer end.



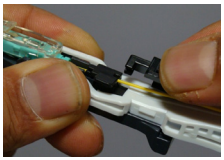
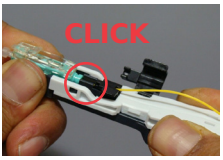

Dispose of the cleaved optical Fiber safely. Avoid accidents while handling the optical Fiber

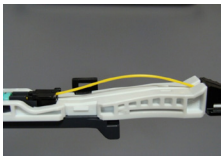
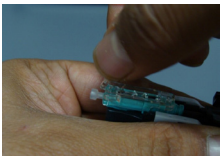



Ensure that the guide is not extending out of the Fiber Holder. Place the cleaved optical Fiber in the Fiber Holder's front cover.

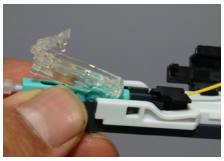
Place the Fiber Holder onto the Assembly Guide jig and ensure the exposed Fiber is within the "U" bridge and positioned to enter the connector. Slide the Fiber Holder on the Assembly Guide jig. Notice that the front cover is being pushed towards and is stopped by the middle cover.

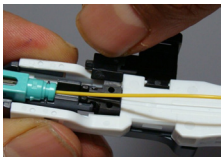



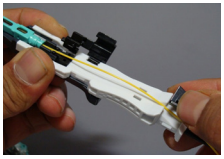



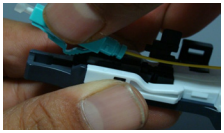
Open the midle cover without disturbing the assembly. Slide the Fiber Holder further until a 'click' is heard. The optical Fiber will arch, which is normal. Lift the lever on the plastic wedge atop the connector.

Gradually press the sides of the plastic wedge to displace the wedge, but do not disturb the connector. Lift open the front cover of the Fiber holder. Then lift open the back cover of the holder. Lift the Fiber connector from the Assembly Guide jig

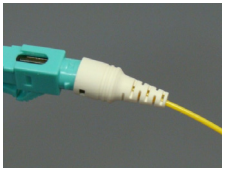








Finally, slide the Boot onto the connector and lock securely. Your Xpress G2 LC connector termination is now complete.



Cleaning a fiber optic

Cleaning of Fiber connections is critical and Molex has a range of connector cleaners that covers SC, LC and MPO/MTP® connectors. A cleaning process has been outlined in the following pages.

Connector cleaning tools:

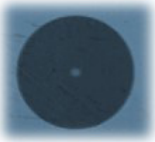
- LC connector cleaning
- SC connector cleaning
- MPO/MTP® connector cleaning
- The cleaning process on the following pages are **Important**

Cleaning is a critical step. This is a 3-step process: Step 1: Inspect the Fiber connectors for damage and dirt. Step 2: Clean the Fiber connectors if required. Step 3: Re-inspect the Fibers that have been cleaned and repeat if necessary. We will look at each of these in more detail.

Before any testing of a fiber optic solution can commence, there are up to 3 steps that need to be completed:

- Step 1: Inspect the Fiber Connectors for damage, dirt or any other foreign residue that will impact the throughput of the signal
- This inspection is completed using a Video Scope
- Ensure you have the correct adaptor for the connector type (SC, LC, MPO/MTP®)
- Best practice is to use a Video Scope with the capacity to analyze the connector
- This should also create a report you can add to your records
- If the inspection shows a clean connector, **do not clean**, connect the Fiber as required for testing
- Cleaning a clean connector could introduce dirt

Chips are present on the end face of the connector



Residue left from cleaning with Alcohol

Residue left after touching the connector end face

Residue left from wiping on a shirt

Clean connector

- Above is a sample test report using the Fluke Networks® FiberInspector™ Video Scope connected to a DSX-5000 tester

Step 2 is only required if step 1 identifies a failed or dirty connector, for any reason, during inspection.

Step 2: Clean the Fiber connector if it is found to be dirty or has any other foreign residue on it. If the connector is chipped or cracked, the connector must be replaced. Below are samples of inspected connectors:

Cleaning the Fiber connector can be undertaken in a number of ways. Following are examples of the 3 main methods for cleaning Fiber connectors that Molex recommends. Method 3 is the preferred method unless a deep clean is required.

Method 1: the first method is a wet clean

- This is a good method the remove dry residue or stubborn dirt
- Beware this method may leave a film behind which would require a second clean with an alternative method (Method 2)

Using a lint-free wipe which is dampened with Alcohol

Using a pre-packaged Alcohol wipe

Method 2: the second method is a dry wipe using a lint-free wipe

- This is good to remove residue and light dirt

Only dry wipe

Do not use either Method 1 or Method 2 for ModLink MPO/ MTP® Products.

Method 3: the third method is a dry clean similar to method 2 utilizing a cleaning tool sometimes called a "one click" cleaner. This is the preferred cleaning method by Molex for the following reasons:

- Tools are available in a variety of configurations, SC; LC; MPO/MTP®
- Adaptors on the tip retain the connector for cleaning
- Removal of the adaptor allows cleaning of Fiber ports or connectors in a through adaptor installed in a Fiber tray
- Enabling the cleaning of installed connectors reduces the risk of damage to the Fiber and connector with opening the tray for cleaning
- Below are examples of the cleaning tools for SC and LC connectors.
- These are suitable for cleaning the Angle Polished Connector (APC) version of SC and LC connectors

Cleaning tools with connectors located in the tip adaptor for cleaning Molex part numbers for the cleaners are:
SC Connector cleaner AFR-00429
LC Connector cleaner AFR-00428

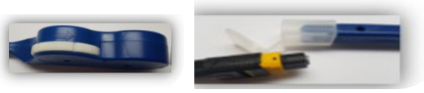
Cleaning tools with adaptor removed and the tip in a through adaptor for cleaning internal connector or a Fiber port requiring cleaning

Method 3: continued for the cleaning of MPO/MTP® connectors

- As previously mentioned, any chipped or cracked connectors must be replaced
- Below are samples of inspected MPO/MTP® connectors. Due to the width of the MPO/MTP® connector, the cleaning process is a more pronounced 'wipe' of the connector
- If a wet clean is required, the wiping cloth in the tip could be moistened with Alcohol then insert the connector for a wet clean
- Then you may need to do a standard dry clean to remove any residue

Molex uses MPO/MTP® APC connectors as standard which requires additional considerations when cleaning

- **Note:** the directional arrow on the cleaner body which indicates the direction of operation for cleaning the connector
- Also note the resulting direction of rotation of the cleaning tip as shown
- As the face of the APC connector is angled, it is important to clean in the correct direction as shown below

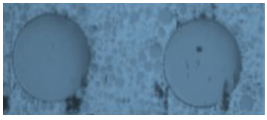


To ensure correct cleaning, our cleaner and adaptor are leveled for correct alignment as shown above.

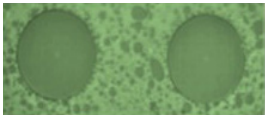
This may not be the case with all MPO/MTP™ cleaners.

Step 3: re-inspect the fiber connectors that have been cleaned, and repeat cleaning if required, until connector is clean

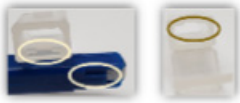
- Now you can conduct the testing of the Fiber Optic Solution



Dirty MPO/MTP® connector



Clean MPO/MTP® connector



Cleaning tool with connector located in the tip adaptor for cleaning Molex part number for the cleaner is MPO/MTP® Connector cleaner AFR-00427

Cleaning tool with adaptor removed and the tip in a through adaptor for cleaning internal connector or a Fiber port requiring cleaning

Field testers and testing – fiber optic

Testing of the network to standards is required for Molex Warranty Applications.

Testing is performed to specific categories or class of link and results are compared to industry standards to provide pass/fail indication.

Factors that affect the integrity and performance of the installed fiber optic cable:

- Severe cable bends, poorly installed connectors or presence of dirt on the face of the connector
- The attenuation measurement result should always be less than the **loss budget** or link attenuation allowance, which is dependent on the cable length, number of terminations and number of splices, if any

An Optical Loss Test set (OLTS) can measure the optical attenuation quite accurately. Testing with an OLTS and verifying the cable length and polarity add up to tier 1 testing as specified in the standard. Tier 1 is the required test for Molex Connected Enterprise Solutions warranty applications.

- The optional Tier 2 includes the Tier 1 testing plus an OTDR trace
- Testers need to be calibrated annually or as recommended by the tester OEM
- Tester is to have the latest firmware before installations are tested for warranty purposes

Molex will continue to accept test results from a tester which is under a valid calibration, even if this model in particular has been discontinued and not supported any more by the tester manufacturer – Test reports showing a note such as "Calibration Due" or similar, will be rejected.

Brands accepted by Molex connected enterprise solutions perform similar functions, and save measurements in a proprietary format allowing ease of audit and sorting:

- A tester is automatically dropped if the manufacturer no longer provides support for that tester
- Below are some examples (subject to change without notice)

If you wish to use a tester model not shown which is able to meet the testing requirements, please contact ces.support@molex.com with the tester details to obtain clarification of its acceptance. This must be done before proceeding with the testing.

Fluke
DSX-600 (Copper only)
Versiv DSX-5000
Versiv DSX-8000

Ideal
Lan Tek II Series
(discontinued with product support until March 2022)

VIAVI Solutions
(Formerly JDSU)
Certifier 10G
Certifier 40G

Softing
WireXpert 4500

Caring for the tester and leads is important. Your tester is a valuable asset that needs to be cared for to ensure reliable performance:

- Your tester is a valuable asset that needs to be cared for to ensure reliable performance
- Store the tester in a secure manner
- Keep the tester clean
- Ensure your inspection scope is stored securely
- Ensure the test leads are stored correctly with dust caps installed
- Ensure the test leads are not pinched, kinked or stressed while being stored

The maintenance of the tester kit is just as important as caring for the kit. Always ensure your tester is kept in calibration. Ensure your tester is fully charged for testing (Low battery charge can create incorrect test results). Ensure your test leads are in good working order. And finally, inspect your leads for damaged connectors, cable kinks.

TSB-4979 / Encircled Flux (EF) conditions for multimode fiber testing

TIA has released TSB-4979, “Practical Considerations for Implementation of Encircled Flux Launch Conditions in the Field”, or EF for short. That was developed for components used in 10/40/100G networks. EF measurements became important when tenths of a dB could mean the difference between PASS and FAIL in high speed transmissions over Multimode Fiber. The objective here is to control the launch to eliminate the uncertainty in Multimode Fiber Testing.

- The test leads required for Multimode Fiber testing are required to be Encircled Flux Test Reference Cords used for the output on the tester
- EF was developed to keep up with components used in high speed networks (e.g. 10/40/100 GbE)
- Since high speed transmissions over Multimode Fiber has become a reality, EF measurements became important where tenths of a dB could mean the difference between PASS and FAIL
- Also, with the introduction of low loss Fiber Optic components such as LC/MPO cassettes, loss budgets are becoming all the time smaller
- More Consultants and End-Users are now beginning to specify loss budgets based on component performance, not standards (i.e. 0.3dB per pair of mated connectors instead of 0.75dB)

TIA/TSB-4979 describes 2 implementation methods for field test equipment to meet standard encircled flux launch conditions:

- The “universal controller” method can be used with any light source from any test supplier
- The “matched controller” method is a light source and launch cord combination (the launch cord could include a controlling device) that together meet encircled flux requirements
- Additionally, TSB-4929 reviews the advantages and drawbacks of each implementation method
- Finally, it also provides uncertainty of measurements and best practices advice

Molex Requires Multimode Field Tests to be performed with the Encircled Flux Launch Condition as defined in TIA/TSB-4979

- **Ensure TRCs (Test Reference Cords) are of good quality**
- **For MM TRCs : <0.10dB and for SM TRCs : <0.20dB**
- **Make sure they are Cleaned and Inspected prior to testing**
- **Never pull on the boot of a connector**

When testing OLTS over Multimode Fiber, you can use the OM3 test reference cords to test OM4 and OM5. Once the referencing of the TRCs is complete, only the link is measured. When OTDR testing, the Test Reference Cords are replaced with Launch and Tail cords as outlined above. Please read carefully and make sure you understand these points:

Link Loss Budget

Understanding how to calculate the link loss budget can become critical when you are testing a 10G/40G/100G installation.

Designers will usually review Link Loss Budget calculations to insure they are specifying the correct Fiber Optic Solution.

- As previously mentioned, Optical Fiber Links have power loss or attenuation
- Different standards list different Attenuation of the Optical Fiber cable
- Standards have reviewed the loss budget for mated pair connectors and expanded the connector types
- **Reference Connector – Connector on a TRC which has been tested as part of the TRC**
- **Non-Reference Connector – Embedded Connector on pre-terminated pigtails or Fiber cables**
- Consideration needs to be taken into account for the number of splices, if any, that are in the link

Understanding how to calculate the Link Loss Budget can become critical when you are testing a 10G/40G/100G installation.

The following equation is used to estimate the attenuation or link loss (calculated loss budget):

Loss (dB) = Cable Attenuation + Connector Attenuation + Splice Attenuation

Cable attenuation – Multimode Fiber cable

The table below shows the cable attenuation for Multimode Fiber cable:

Fiber Structure (µm)	ISO/IEC 11801-2017			AS/NZS ISO/IEC 14763-3-2014			TIA-568.3-D (REF Grade)			Bandwidth (MHz/km)			
	Name	Cable IL dB/km		Name	Cable IL dB/km		Name	Cable IL dB/km		Overfilled Launch		Effective Modal Bandwidth	
		850nm	1,300mn		850nm	1,300mn		850nm	1,300mn	850nm	1,300mn	850nm	953nm
62.5	OM1	3.5	1.5	OM1	3.5	1.5	OM1	3.5	1.5	200	500	N/A	N/A
50	OM2	3.5	1.5	OM2	3.5	1.5	OM2	3.5	1.5	500	500	N/A	N/A
50	OM3	3.5	1.5	OM3	3.5	1.5	OM3	3.5	1.5	1,500	500	2,000	N/A
50	OM4	3.5	1.5	OM4	3.5	1.5	OM4	3.5	1.5	3,500	500	4,700	N/A
50	OM5	3.5	1.5	OM5	3.5	1.5	OM5	3.5	1.5	3,500	500	4,700	2470

The table below shows the cable attenuation for Singlemode Fiber cable:

Fiber Structure (µm)	ISO/IEC 11801-2017			AS/NZS ISO/IEC 14763-3-2014			TIA-568.3-D ISP (REF Grade)			TIA-568.3-D OSP (REF Grade)		
	Cable IL dB/km			Cable IL dB/km			Cable IL dB/km			Cable IL dB/km		
	1,310 mn	1,383 mn	1,500 mn	1,310 mn	1,383 mn	1,500 mn	1,310 mn	1,383 mn	1,500 mn	1,310 mn	1,383 mn	1,500 mn
9 (OS1)	1	N/A	1	1	N/A	1	1	N/A	1	0.5	N/A	0.5
9 (OS2)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

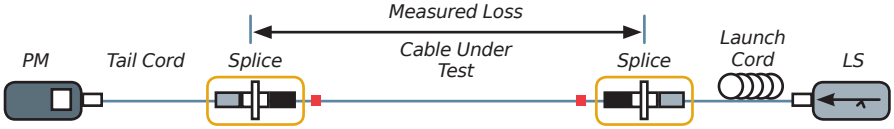
Connector and splice attenuation

The following table shows the attenuation allowance for connectors and splices for both Multimode and Singlemode Fiber cable solutions. As there are differences between standards, the table lists the differences:

Component by Standard	Attenuation Loss at the different Wavelengths			
	Multimode		Singlemode	
AS/NZS ISO/IEC 14763-3-2014 and ISO/IEC 11801-2017	850nm	1,300mn	1,310mn	1,550mn
Mated Ref to Ref connector	0.10 dB	0.10 dB	0.20 dB	0.20 dB
Mated Ref to Non-Ref connector	0.50 dB	0.50 dB	0.75 dB	0.75 dB
Mated Non-Ref to Non-Ref connector	0.75 dB	0.75 dB	0.75 dB	0.75 dB
Mated MPO connector	0.75 dB	0.75 dB	0.75 dB	0.75 dB
Splices	0.30 dB	0.30 dB	0.30 dB	0.30 dB
TIA-568.3-D IPS and OSP (REF Grade)	850nm	1,300mn	1,310mn	1,550mn
Mated Ref to Ref connector	0.10 dB	0.10 dB	0.20 dB	0.20 dB
Mated Ref to Non-Ref connector	0.30 dB	0.30 dB	0.50 dB	0.50 dB
Mated Non-Ref to Non-Ref connector	0.75 dB	0.75 dB	0.75 dB	0.75 dB
Mated MPO connector	0.75 dB	0.75 dB	0.75 dB	0.75 dB
Splices	0.30 dB	0.30 dB	0.30 dB	0.30 dB

Comparing measured results against a design Link Loss Budget

Here is an example of a 135m installed link being tested at 850nm. The mated connections shown represent a Ref to Non-Ref mated connection. This example shows the different loss budgets calculated at 850nm over a 50µm Fiber with the different standards. This is the traditional format of splicing pigtails to the installed Fiber cable.



Under ISO/IEC 14763-3:2014 at a wavelength of 1,300nm:
Loss Budget = Connector Loss + Cable Loss + Splice Loss
Connector Loss = 2 x 0.5 dB per mated connector
Cable Loss = (Length in km) 0.135 x 1.5 dB/km
Splice Loss = 2 x 0.3 dB

Total = (2 x 0.5) + (0.135 x 1.5) + (2 x 0.3) = 1.8 dB

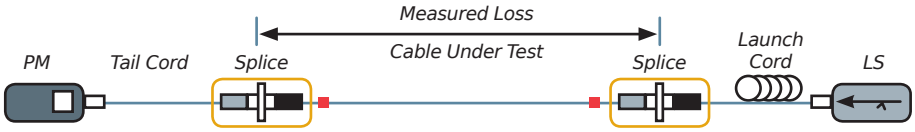
Reading on Tester is 1.35 dB which is within budget

Under TIA 568.3-D ISP (Ref Grade) at a wavelength of 1,300nm:
Loss Budget = Connector Loss + Cable Loss + Splice Loss
Connector Loss = 2 x 0.3 dB per mated connector
Cable Loss = (Length in km) 0.135 x 1.5 dB/km
Splice Loss = 2 x 0.3 dB

Total = (2 x 0.3) + (0.135 x 1.5) + (2 x 0.3) = 1.4 dB

Reading on Tester is 1.35 dB which is within budget

Below is another example of a 135m installed link being tested at 1,300nm. The mated connections shown represent a Ref to Non-Ref mated connection. This example shows the different loss budgets calculated at 850nm over a 50µm Fiber with the different standards. This is the traditional format of splicing pigtails to the installed Fiber cable.



Under ISO/IEC 14763-3:2014 at a wavelength of 850nm:
Loss Budget = Connector Loss + Cable Loss + Splice Loss
Connector Loss = 2 x 0.5 dB per mated connector
Cable Loss = (Length in km) 0.135 x 3.5 dB/km
Splice Loss = 2 x 0.3 dB

Total = (2 x 0.5) + (0.135 x 3.5) + (2 x 0.3) = 2.07 dB

Reading on Tester is 1.35 dB which is within budget

Under TIA 568.3-D ISP (Ref Grade) at a wavelength of 850nm:
Loss Budget = Connector Loss + Cable Loss + Splice Loss
Connector Loss = 2 x 0.3 dB per mated connector
Cable Loss = (Length in km) 0.135 x 3.0 dB/km
Splice Loss = 2 x 0.3 dB

Total = (2 x 0.3) + (0.135 x 3.0) + (2 x 0.3) = 1.61 dB

Reading on Tester is 1.35 dB which is within budget

Standards approach against a MPO/MTP® design Link Loss Budget

This example below shows the different loss budgets calculated at 850nm and 1,300nm over a 50µm Fiber using the MPO testing setup. This is the latest MPO/MTP® trunk cable to ModLink® cassettes for pre-terminated installations or within a Data Center.

- 145m installed link being tested at 850nm and 1,300nm

The **mated** connections shown now represent the MPO Module

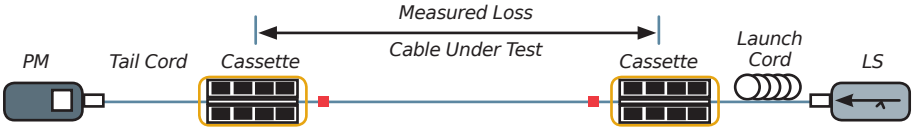
This Loss Budget is now under the 2.6Db at 850nm for 10GBASE-SR on OM3 up to 150m Molex custom limit approach

When using the Fluke CertiFiberPro OLTS system it is possible to create a custom test limit, which is required to test the Molex MPO Cassettes.

- The loss for the Molex MPO cassette is 0.5dB as per the datasheet
- The MPO trunk is pre-terminated, no splices should be listed
- Test is based on ISO/IEC 14763-3:2014

Molex custom approach against a MPO/MTP® design Link Loss Budget

This example shows the different loss budgets calculated at 850nm and 1,300nm over a 50µm Fiber using the Molex MPO Custom test setup. This is the latest MPO/MTP® trunk cable to Modlink® cassettes for pre-terminated installations or within a Data Center.



Under ISO/IEC 14763-3:2014 at a wavelength of 850nm:
Loss Budget = Connector Loss + Cable Loss
Connector Loss = 2 x 0.75 dB per mated connector
Cable Loss = (Length in km) 0.145 x 3.5 dB/km

Total = (2 x 0.75) + (0.145 x 3.5) = 2.01 dB

Under ISO/IEC 14763-3:2014 at a wavelength of 1,300nm:
Loss Budget = Connector Loss + Cable Loss
Connector Loss = 2 x 0.75 dB per mated connector
Cable Loss = (Length in km) 0.145 x 1.5 dB/km

Total = (2 x 0.75) + (0.145 x 1.5) = 1.72 dB

This loss budget is now under the 2.6dB at 850nm for 10GBASE-SR on OM3 up to 150m

- 145m installed link being tested at 850nm and 1,300nm
- The mated connections shown now represent the MPO Module
- Molex MPO Cassettes have a loss of no more than 0.5dB

This Loss Budget is now under the 2.6Db at 850nm for 10GBASE-SR on OM3 up to 150m

Standards approach

Now you know that the common approach against an MPO/MTP® design link loss budget is not accepted by Molex. The standards approach is the one that is explained on this page, and on the following one.

- The standards indicate that the MPO cassette containing LC and MPO/MTP® connectors is treated as one adapter
- 1-Jumper Reference Method, and the LC and MTP® are the two “mating” connectors
- The key word here is “mating”!
- When using the Fluke CertiFiberPro OLTS system it is possible to create a test limit, based on ISO/IEC 14763-3:2014, which treats the cassette as a single loss MPO Module
- The loss for the MPO is 0.75dB as per the standards
- As the MPO trunk is pre-terminated, no splices should be listed

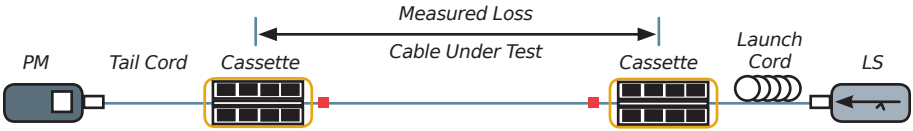
Fiber testing

In preparation for testing the installation, you need to follow these steps:

- All forms of OLTS testers are temperature sensitive
- Turn on the tester and allow about 10-15 minutes for the tester electronics to settle in the environment they are to be used in for testing
- Ensure the tester is fully charged and calibrated
- Ensure you have the correct test leads (Multimode and/or Singlemode with the correct connector to suit the installation)
- Set up the tester for the testing to be completed (process is discussed later in this manual)
- Complete the Set Reference for the test leads (process is discussed later in this manual)
- Check the reference regularly, especially if environment temperature changes

Permanent link test settings for fiber testing

As has been shown, there are different standards which have different attenuation levels for some cable and connectors. Ensure you use the test limit as required for your location or as specified in the project documentation.



Under Molex MPO ISO 14763-3 at a wavelength of 850nm:
Loss Budget = Connector Loss + Cable Loss
Connector Loss = 2 x 0.5 dB per mated connector
Cable Loss = (Length in km) 0.145 x 3.5 dB/km

Total = (2 x 0.5) + (0.145 x 3.5) = 1.51 dB

Under Molex MPO ISO 14763-3 at a wavelength of 1,300nm:
Loss Budget = Connector Loss + Cable Loss
Connector Loss = 2 x 0.5 dB per mated connector
Cable Loss = (Length in km) 0.145 x 1.5 dB/km

Total = (2 x 0.5) + (0.145 x 1.5) = 1.22 dB

This loss budget is now under the 2.6dB at 850nm for 10GBASE-SR on OM3 up to 150m

Key take aways

- What is being measured in a fiber channel varies greatly depending on the reference method selected. This is why it is extremely important to understand why the 1-jumper method is preferred and what the difference is compared to the 3-jumper method
- The 1-jumper reference takes into account the loss of the connections at both ends of the link – this is the preferred method from the Standards
- If it is not possible to use the 1-jumper reference method due to limitations of the test equipment (i.e. the tester does not support native MPO adapters), the 3-jumper reference method is the next best option
- This is required when the fiber type of the TRCs does not match the fiber type of the link (i.e. testing MPO links with an LC interface on the tester)
- **But: because the 3-jumper method references out both connectors, it does not provide an accurate indication of the quality at either end of the fiber link**
- **The 3-jumper reference method has a higher level of uncertainty than the 1-jumper method, which becomes critical for shorter links**
- As a rule of thumb, a 1-jumper reference has a test uncertainty of +/- 0.1dB and a 3-jumper reference has a test uncertainty of +/- 0.2dB
- With the 1-jumper method, a 2.1dB 350-meter link therefore has an uncertainty of about 4.7%, while a shorter 0.8dB 50-meter link has an uncertainly of about 12.5%. Using the 3-jumper method, the same 350-meter link that now measures 1.6dB has an uncertainty of about 12.5%. For the 50-meter link that measures 0.6dB, the uncertainty is now going up to 33%
- **If your OLTS does not have native MPO ports, it will have either LC or SC ports. As a result, connecting an MPO connector directly into the tester is not possible. To test MPO connections, an additional break-out/fan-out cable (also called "Hydra" cable) must be added between the MPO connector and the TRCs that connect to the tester port. TIA-568.3-D with a 3-jumper Reference IS REQUIRED in this instance**
- **Molex will accept the 3-jumper method under the conditions explained above, but you must be prepared to explain the justification for using this if requested**

Optical test report checklist

Here are some common faults you may encounter with suggested solutions:

If a fail or reporting a gain	Check the following
Failing in one direction only	Connector attached to light source
Failing in both directions	Both connector faces, excessive bends in cable or poor splice
Passes at lower wavelength but fails at higher wavelength	Check cable for excessive bends as longer wavelengths are more sensitive to bends
A negative loss or 'gain'	Check correct reference method and levels. Re-certify the reference
All cores in the cable show a fail	Look for excessive bends in the cable, check test leads for dirt/ contamination. Check reference and re-certify the reference
If still failing	Use an OTDR to locate the source of the issue and rectify

Requirements for Warranties

The full requirements list is extensive, some of the key points are highlighted below ensure the following:

1. Your company is eligible to apply for a Warranty at the time of installation
2. The installation conforms to regional structured cabling standards and Molex Connected Enterprise Solutions installation guidelines
3. The installation testing was completed within the last 6 months
4. The details of the installation match those entered into the Warranty Application, and Test Results
5. Testing is completed using a tester which is listed on the Molex Connected Enterprise Solutions Approved Testers List. Note that this may be updated at any time and the most recent version can always be found under the "Useful Warranty Information" section on the main CSP Home Page. **The tester MUST also be under valid calibration (as per manufacturer's recommendations)**
6. Test results are in its native format
7. Provided test results do not contain any FAIL or FAIL* results
8. Ensure the tester used has the latest software updates and firmware
9. **All the Copper links are tested to Permanent Link test settings using appropriate adapters**
10. Fiber testing are conducted using an Optical Loss Test Set (OLTS) as per Tier 1 requirement in the standards
11. The correct approved Fiber Optic test "referencing method" is used (1-Jumper Method, unless stated otherwise)
12. Fiber testing is conducted in both direction and at both wavelengths Molex Connected Enterprise Solutions reserve the right to conduct a site inspection if required

Molex reserve the right to abandon Warranty Applications pending input from a Certified Installer for more than 45 days

Molex offers an extended **25 Year System Performance and Application Assurance Warranty** and a 25-Year Product Warranty for channels conforming to applicable standards as details on our published Warranty Statements.

These Warranties are **not** a site warranty, but a channel warranty for those channels detailed in the application.

Warranty Type - 25 Year System Performance & Application Assurance

Warranty Coverage

Molex warrants the following for a period of 25 years from the date of installation:

1. System Performance Warranty

The installed links of the Certified Cabling System will comply with the category of end-to-end performance to which the system is certified.

2. Application Assurance Warranty

The Certified Cabling System will be free from defects which prevent the operation of standards-based applications/protocols over the category of end-to-end performance to which the system is certified. The applications/protocols shall be those recognized by standards bodies IEEE, ANSI, ATM Forum and sanctioned specifically for transmission over the category of cabling standards defined in the published edition of TIA/EIA 568, ISO IEC 11801, EN 50173 and AS/NZ 3080 which is current at the date of installation and which is most recognized by your local industry.

Eligibility

Certified Installers, who are applying for the above Warranty, must meet the criteria below:

1. Have a Business Associate Agreement (BAP) ticket which has been completed (Status = Agreement Valid) within the last 2 years – at the time of installation.
2. Certified in Molex Connected Enterprise Solutions' Data Transport Solutions (DTS) as detailed on the BPP, with a Certified Installer classification of Certified Installer (CI).

Certified Installers may be provided a 25 Year Product Warranty if approved by the associated RSD and the Regional Technical Manager.

Conformance

Certified Installers applying for the above Warranty need to ensure conformance to the following:

1. Must be registered on the Molex Connected Enterprise Solutions Customer Support Portal (CSP) at https://csp.molex.com
2. Must submit a correctly completed Warranty Request https://csp.molex.com/forms/wtyv2en/add
3. Must have acknowledged both Installer Declarations (A & B) within the form
4. Have submitted all accompanying documentation:

   a. Test Results in native format, tested in accordance with the requirements specified in the IEC and ANSI/TIA Standards.

Permanent Link testing is mandatory and prior approval from Molex is required in case Channel test is inevitable. The request shall be made by initiating a Help Desk Support (HDS) ticket on CSP with the reasons/difficulties in conducting Permanent Link test.

   b. Test Results in native format from an "approved" tester as specified in the List of Approved Testers.

If you own a tester other than the ones listed, please submit a Help Desk Support (HDS) ticket on CSP with name and model of the tester, the website from where we download the report viewing software and sample test reports in the native format. Molex Connected Enterprise Solutions may review the information before approving the tester. This activity must be done BEFORE testing the install at the project site.

   c. Test Results for the installed Permanent Links must be less than or equal to its specified maximum length for the applicable Category

   d. Required documents – As-Built document / The As-Built documentation can be uploaded in PDF Standard View format:

   - Location of work area outlets, consolidation points, and Multi User Telecommunications Outlet Assembly (MUTOA) Tele-Communications Room locations
   - Main Copper and Fiber cable routing (include drawings with red lines of cable runs if available)
   - Cabinet layout
   - BOM List

5. Test Result Dates must not be:

   a. Prior to the Installation Date specified within the ticket

   b. Where possible, be within 6 months of the Site Installation Date

   6. Test Results shall:

   a. Match link counts specified in the ticket for each applicable Category

   b. Match the total count specified within the form

   c. NOT contain any FAIL, or FAIL* results

   d. NOT contain duplicate results for a given link

e. NOT contain more than a total of 5% PASS* results

f. NOT contain recertified (RC) results

g. NOT contain multiple results with identical Date & Time Stamp for the same individual tester

h. Have the correct NVP specified as per the Cable specification (NVP is also printed on cable)

7. Testers used must:

a. Be calibrated by the tester manufacturer and in accordance with their recommendations for frequency (usually annually). Testers MUST also be under valid calibration.

b. Have the latest Firmware

c. Be used in conjunction with the correct adapters (also calibrated) according to the tests performed

Note: The above conformance requirements (including As-Built documentation) are mandatory for System Performance and Application Assurance warranties. If not supplied, the warranty request can only be considered for a Product only warranty.

Warranty Type – 25-Year Product Warranty

Warranty Coverage

Molex Connected Enterprise Solutions warrants the following for a period of 25 years from the date of installation:

1. Components

The cabling system installed by a Certified Installer must be comprised entirely of Molex Connected Enterprise Solutions-approved passive connectivity components. This expressly excludes any active equipment, whether in or attached to it, public network interface, and terminal equipment.

2. Installation

The entire cabling system installed by a Certified Installer must have been installed and commissioned by an authorized Molex Connected Enterprise Solutions Certified Installer to the practices specified by Molex Connected Enterprise Solutions and based on the published edition of TIA/EIA 568, ISO/IEC 11801, EN 50173 and AS/NZ 3080 which is current at the date of installation.

Eligibility

Certified Installers, who are applying for the above Warranty, must meet the criteria below:

1. Have a Business Associate Agreement (BAP) ticket which has been completed (Status = Agreement Valid) within the last 2 years – at the time of installation.
2. Certified in Molex Connected Enterprise Solutions' Data Transport Solutions (DTS) as detailed on the BPP, with a Certified Installer classification of Certified Installer (CI). Certified Installers may be provided a 25-Year Product Warranty if approved by the associated RSD and the Regional Technical Manager.

Conformance

Certified Installers applying for the above Warranty need to ensure conformance to the following:

1. Must be registered on the Molex Connected Enterprise Solutions Customer Support Portal (CSP) at https://csp.molex.com
2. Must submit a correctly completed Warranty Request https://csp.molex.com/forms/wtyv2en/add
3. Must have acknowledged both Installer Declarations (A & B) within the form.

The following are not required but highly recommended:

4. Have submitted all accompanying documentation:

   a. Test Results in native format, tested in accordance with the requirements specified in the IEC and ANSI/TIA Standards
   See note 4a above on previous page

   b. Test Results in native format from an "approved" tester as specified in the List of Approved Testers
   See note 4b above on page 3

   c. Test Results for the installed Permanent Links must be less than or equal to its specified maximum length for the applicable Category

   d. Optional As-Built drawings etc.

5. Test Result Dates must not be:

   a. Prior to the Installation Date specified within the ticket

   b. Where possible, be within 6 months of the Site Installation Date

6. Test Results shall:

   a. Match link counts specified in the ticket for each applicable Category

   b. Match the total count specified within the form

   c. NOT contain any FAIL, or FAIL* results

   d. NOT contain duplicate results for a given link

   e. NOT contain more than a total of 5% PASS* results

   f. NOT contain recertified (RC) results

   g. NOT contain multiple results with identical Date & Time Stamp for the same individual tester

   h. Have the correct NVP specified as per the Cable specification (NVP is also printed on cable)

   Testers used must:

   a. Be calibrated by the tester manufacturer and in accordance with their recommendations for frequency (usually annually). Testers MUST also be under valid calibration.

   b. Have the latest Firmware

   c. Be used in conjunction with the correct adapters (also calibrated) according to the tests performed

When processing Warranty Applications, Molex will open the Warranty Application and check:

1. Installer Declaration section
2. Warranty Type selected
3. Site Name
4. Installation Date
5. Channel Certifications Information section:

a. Copper/Fiber counts

b. Cable part number etc.

c. Tester Make & model

d. Tester Calibration Date (to ensure results are reliable)

6. Validate BPP Application (See Eligibility above)
7. Molex reserve the right to abandon Warranty Applications pending input from a Certified Installer for more than 45 days
8. All items listed under the relevant conformance sections above are present

Review related Test Results – Copper:

1. Ensure Cable IDs are not repeated
2. Tested date vs. Installation date vs. Calibration Date
3. If the test report show PASS* percentage greater than 5%
4. If the test report has FAIL / FAIL* results
5. Identical results – Lengths, Cable IDs, Date and Time Stamps, Loss Values
6. Length (Depending on Channel and Permanent Link)
7. Test Limits
8. Ensure the correct adapters have been used (PL adapters only)
9. Frequency Range must be specific to the Category being tested.

10. Tester is a Molex Approved tester
11. If CAT 6A check whether the technician has:
    a. Used correct Adapters (if Fluke)
    b. Enable Shield Test if applicable

Review related Test Results – Fiber Test reports:

1. Ensure Tier 1 Testing was conducted using an Optical Loss Test Set (OLTS). OLTS test results must include:
    a. Date of the test
    b. Test personnel
    c. Description of field-test instrument used (including the source CPR Category for Multimode measurement); manufacturer model number and serial number
    d. Date of the latest field-test instrument calibration
    e. Type and length of test jumpers
    f. Fiber identifier (ID)
    g. Test procedure and method used (TIA-526-14-A, Method B for multi-mode; TIA-526-7, Method A.1 for Single mode) to include launch condition description (for diameter of the mode suppression loop and number of turns)
    h. Link loss result (including direction) and tested wavelengths. Molex insists on tests be conducted in both direction and at both wavelengths for sites seeking warranty
    i. LUT Budget
    j. LUT Length
    k. Polarity
2. Ensure Cable IDs are not repeated
3. Tested date vs. Installation date vs. Calibration Date
4. If the test report show PASS* percentage greater than 5%
5. If the test report has FAIL / FAIL* results
6. Identical results – Lengths, Cable IDs, Date and Time Stamps, Loss Values
7. Test Limit (We don't accept Fiber test report tested using General Fiber custom (fixed loss) test limit)
8. Test Reference Method – This must be set to 1 Jumper when link testing for warranty applications (Adapter Count =2).

Several Permanent Link (PL) test configurations exist as defined by standards. The goal of any PL testing should be such that the contributions made by the tester referencing cables (and adapters) are fully excluded from the measurement results so that the unbiased capability of the PL is quantified.

9. **Molex requires multimode field tests to be performed with the encircled flux launch condition as defined in TIA/TSB-4979**
10. Molex does not accept Fiber test results tested to General Fiber Optic test limit – General Fiber is not a standards-based limit. It is a fixed loss limit test. It is generally only used as the base for a custom test limit where the customer needs to enter their own loss values
11. Reference @850nm and 1,300nm for Multimode and @1,310nm and 1550nm for Singlemode
12. As per the Standards requirements, testing installed optical Fiber cabling for attenuation must be done with an Optical Loss Test Set (OLTS) described in the standards as Tier 1.

Tier 2 testing conducted with an Optical Time Domain Reflectometer (OTDR) is only supplementary to Tier 1

Note: Please refer to Technical Bulletins on the CSP for any specific information. Alternatively, you can send a mail to ces.support@molex.com for assistance.

Approved testers list

List of approved test equipment – copper

All testers of at least Level III and current generation from the following manufacturers are accepted by Molex.

To warrant installations completed by Molex Connected Enterprise Solutions Certified Installers, using end-to-end Molex products in the installed Channel / Permanent Link, the test results to be submitted by the Certified Installers must be in their native formats only. It is mandatory to test all the installed links using the Permanent link test settings on the tester with appropriate adapters.

Molex insists that the test equipment be factory calibrated annually or as recommended by the tester OEMs, and to have the latest firmware before installs are tested for warranty purposes.

The list of test equipment is as follows:

1. Fluke Networks

- DSX Cable Analyzer Series: DSX-600, DSX-5000 and DSX-8000
- DTX 1500 (This product will be supported by Fluke until June 2020)
- DTX 1200 and DTX 1800 (This product will be supported by Fluke until June 2018)

Note: For more information about the listed tester models, please refer the Fluke Networks website www.flukenetworks.com

2. Ideal Industries

- Lantek III Series
- Lantek II Series (This has been discontinued by Ideal Industries and the product support is available until March 2022)

Note: For more information about the listed tester models, please refer the Ideal Networks website www.idealnetworks.net/in/en/index.aspx

3. VIAVI Solutions (formerly JDSU)

- Certifier 10G
- Certifier 40G

Note: For more information about the listed tester models, please refer the Viavi Solutions website www.viavisolutions.com/en-us

4. Softing

- WireXpert 4500

List of approved test equipment – fiber optic

Factors that affect the integrity and performance of the installed Fiber Optic cable may be severe cable bends, poorly installed connectors, or presence of dirt on the face of the connector.

The attenuation measurement result should always be less than the **loss budget** or the link attenuation allowance, and is dependent on the cable length, number of terminations, and number of splices, if any.

An Optical Loss Test Set (OLTS) can measure the optical attenuation quite accurately.

Testing the installed Fiber Optic cabling with an OLTS and verifying the cable length and the polarity add up to **Tier 1** testing as specified in the standard. **Tier 2**, which is optional, includes Tier 1 testing plus an OTDR trace. Tier 1 testing is sufficient for Molex Warranty Certification.The list of test equipment is as follows:

- **For the latest updated list of Approved Testers, please refer to the Molex Connected Enterprise Solutions Approved Testers List, that can be found at https://csp.molex.com**

1. Fluke Networks

- CertiFiber Pro

Test reports from DTX-1800 with MFM2 and EFM2 modules for Multimode and SFM2 modules for Singlemode are still accepted as long the tester and modules used are calibrated. DTX calibration and Service ended on June 30, 2018.

Note: For more information about the listed tester models, please refer the Fluke Networks website www.flukenetworks.com

2. Ideal Industries

- Ideal Industries OC 1

Note: For more information about the listed tester models, please refer the Ideal Networks website www.idealnetworks.net/in/en/index.aspx

3. VIAVI Solutions (formerly JDSU)

- SmartClass Fiber OLTS-85/85P Optical Loss Test Sets

Note: For more information about the listed tester models, please refer the Viavi Solutions website www.viavisolutions.com/en-us

4. EXFO

- MaxTester 940/945 Fiber CertiFiber OLTS (sample reports available)

Note: For more information about the listed tester models, please refer the EXFO website www.exfo.com/en/products/maxtester-940-945-telco-olts

5. Softing

- WireXpert 4500

Note: For more information about the listed tester models, please refer the Softing website itnetworks.softing.com

For the latest updated list of Approved Testers, please refer to the Molex Connected Enterprise Solutions Approved Testers List, that can be found at https://csp.molex.com

Notes

Notes

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