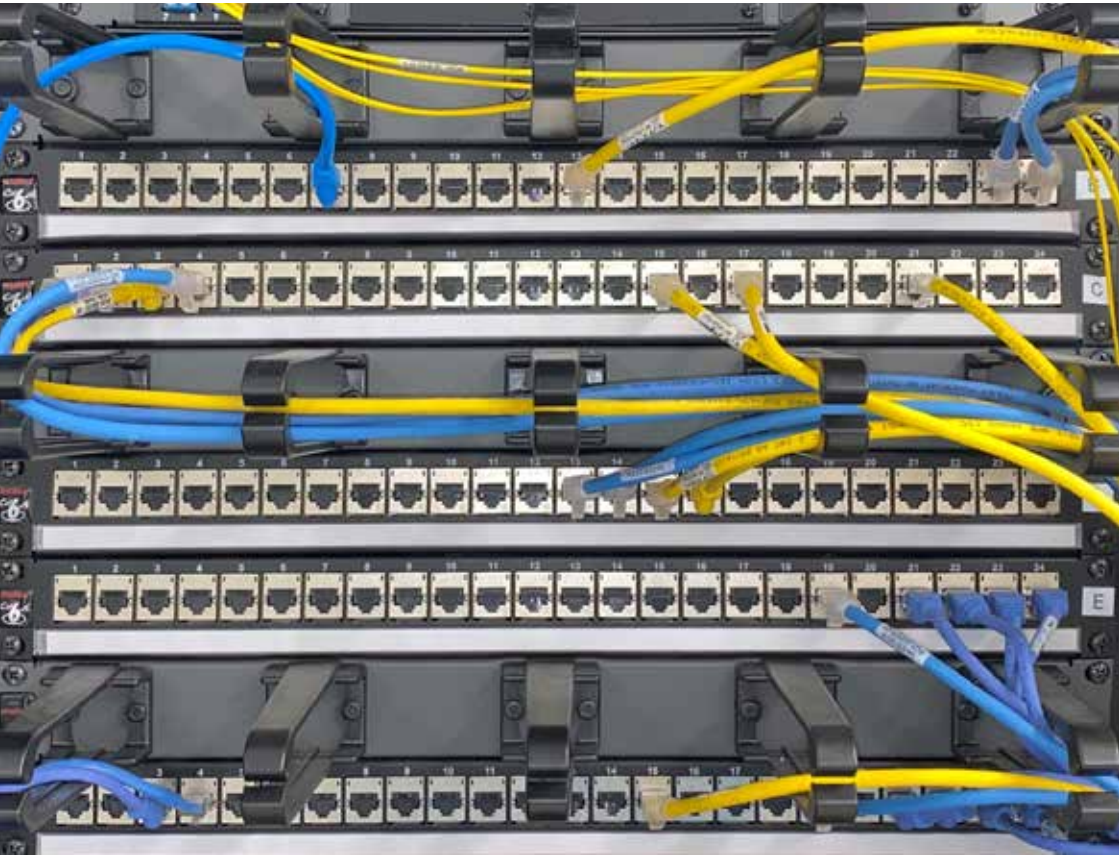
Molex Connected Enterprise Solutions

Onsite Installation and Testing Pocket Guide



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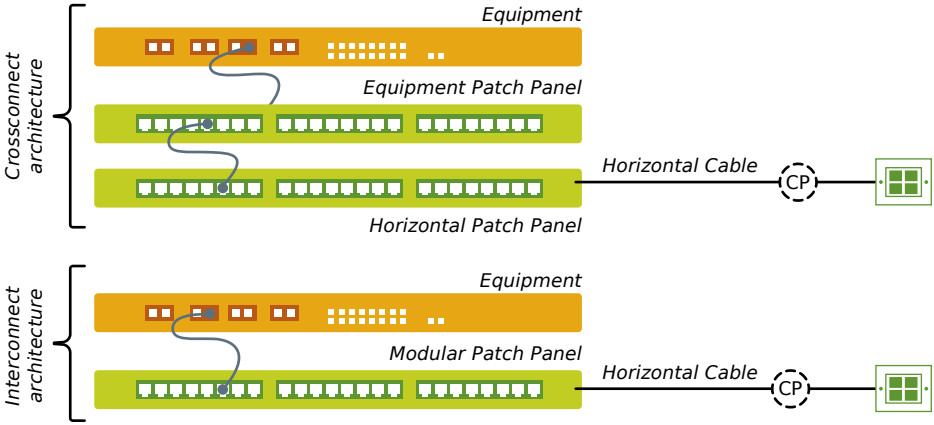
molex

Structured cabling architectures and design considerations

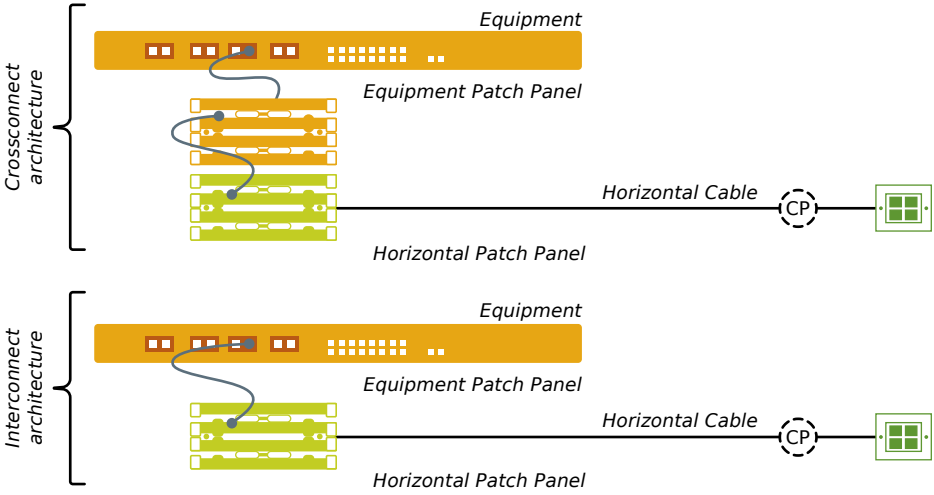
There are two basic architectures for structured cabling systems – Crossconnect and Interconnect.

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 Crossconnect 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 Crossconnect 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

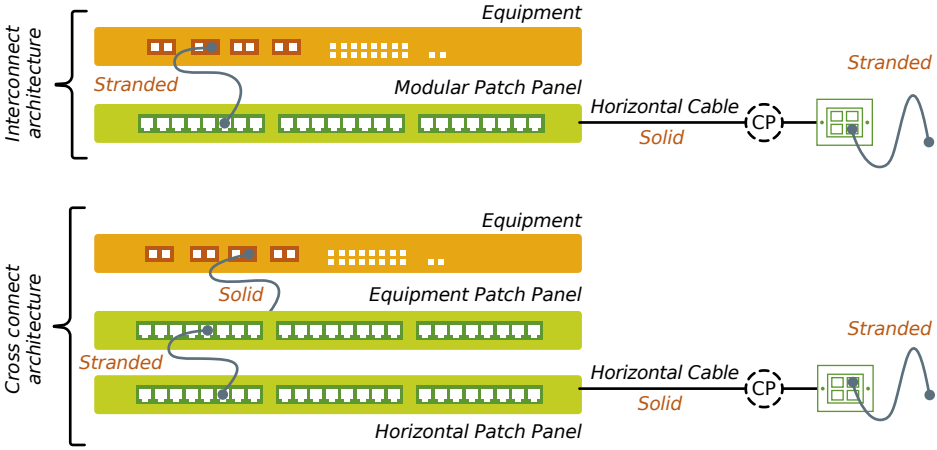
- Use stranded conductor in patch/ equipment cord for routing flexibility

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

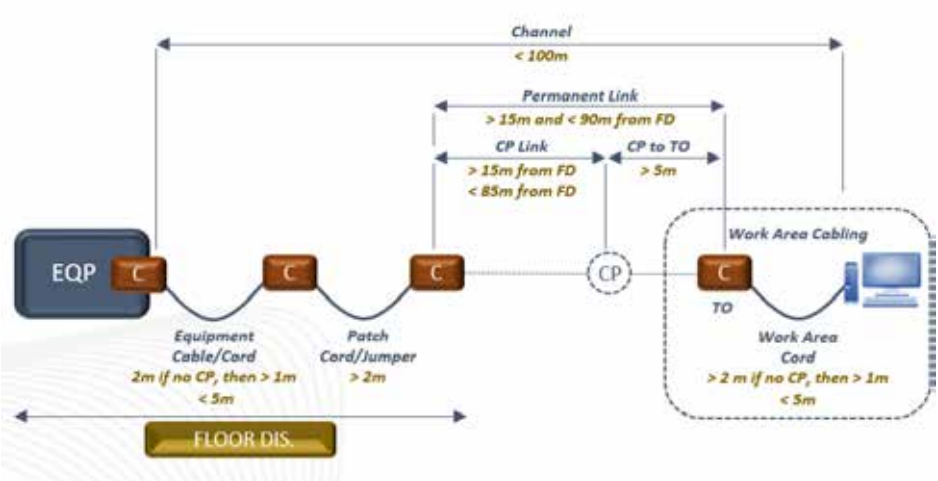
Open office cabling was designed to solve a practical problem rather than a technical one. There are two solutions on open offices, a MUTO, Multi-User Telecommunications Outlet (or MUTOA, Multi-User Telecommunications Outlet Assembly), which can accommodate up to 12 users in one central connection point. 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 568.2-D

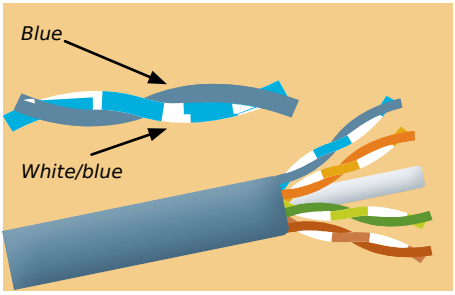
Copper cable performance is affected due to heat which changes the resistance of the copper. ANSI/TIA-568.2-D has provided Table I.2 below outlining the de-rating requirements for both screen and unscreened cables. As can be seen, screened cables have a lower de-rating factor and will perform better in hotter environments. ISO/IEC 11801.1 also lists de-rating requirements in Table 84 - Backbone link length equations.

4-Pair color standard

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

The colors and associated pairs are shown below:

- Pairs are color-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 color 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

ANSI/TIA 568.2-D Table I.2 – Maximum horizontal screened cable length de-rating factor for different temperatures (ANSI/TIA 568.2-D). Note: This table assumes that the channel includes 10 meters of Patch and Equipment cords at 20°C. .

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)	87.5	88.7	2.2	1.3
30 (86)	86.4	88.2	3.6	1.8
35 (95)	84.6	87.3	5.4	2.7
40 (104)	82.8	86.4	7.2	3.6
45 (113)	76.5	85.5	13.5	4.5
50 (122)	73.8	84.6	16.2	5.4
55 (131)	71.1	83.7	18.9	6.3
60 (140)	68.4	82.8	21.6	7.2

Derating as per ISO/IEC 11801-1. Maximum horizontal screened cable length de-rating factor for different temperatures. Note: This table assumes that the channel includes 10 meters of Patch and Equipment cords at 20°C. .

Termination sequence – standard RJ45

Shown on the next page 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 been 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

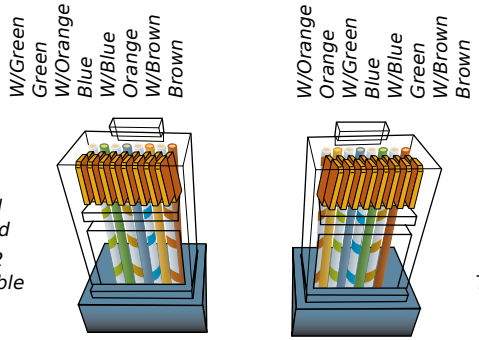
Disadvantages

- 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



568A

International ISDN standard

Pairs 1 and 2 USOC compatible

568B

Most widely specified

Also called T258 or 258A

- Do not over-fill catenaries or support stands
- Maximum of 24 cables per catenary strand

Basket or tray above suspended ceiling

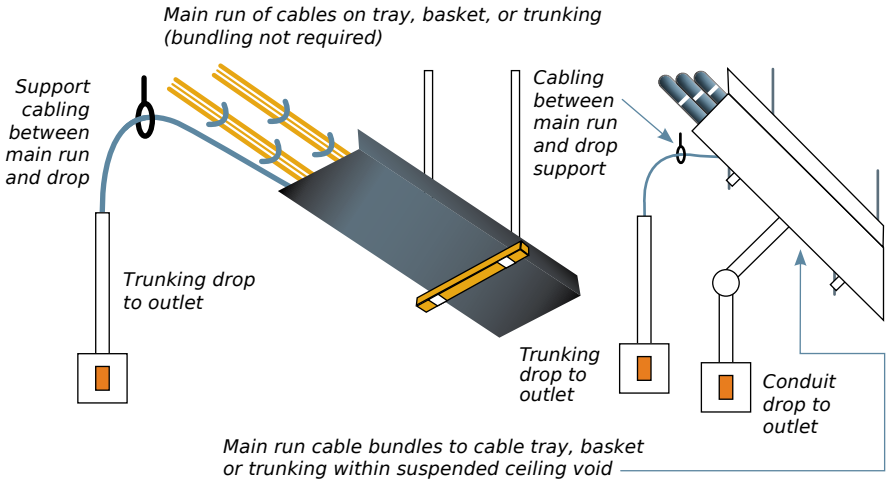
The diagram below shows cables run on a basket, or tray. Do not overfill the cable tray, and ensure the cable is supported as it comes off the tray. Make sure there are no sharp edges, which could damage the cable sheath. Any cables with damaged sheaths should be replaced, as exposing the pairs massively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

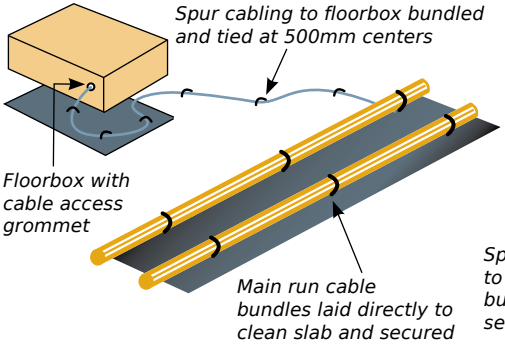
Cabling in floor void

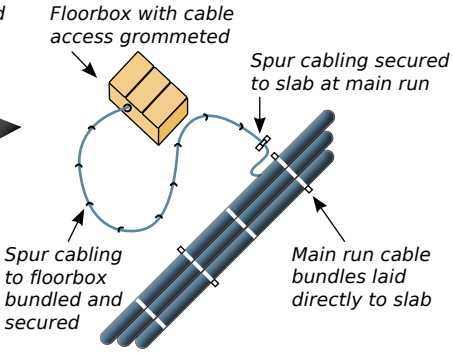
The diagram on the next page shows cables run on a cable tray or basket under a false floor. The cables should be secured at every change of direction. It is advisable to protect the cables servicing specific floor boxes from damage, and flexible conduit is an ideal solution for this. If flexible conduit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

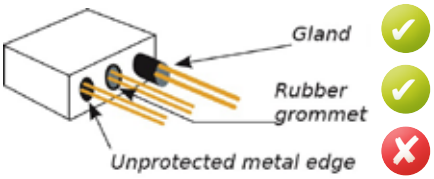
The cables are depicted on matting, and sit on a dedicated pathway, marked on the concrete floor, the cables can be loose laid, but should be secured at every change of direction.

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.

Where an outlet is to be located in the ceiling space or under a floor for connection to building devices, like WAPs, the outlets need to be securely fixed in position.

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

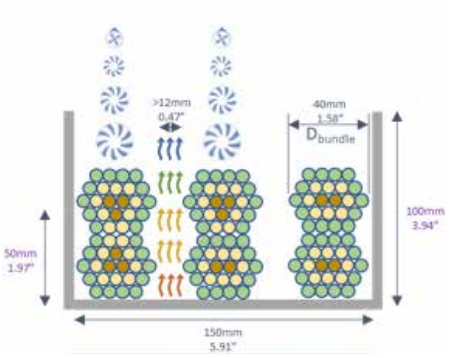
Two compartment trunking is better than 3 compartments, but 3 compartments are still more common. This is because of legacy designs. It is important when installing surface trunking to consider the bend radii limitations of the cable being installed and use the correct hardware to limit how tight the 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. Baskets are 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 baskets in terms of the way they are 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 baskets should



always be grounded. When installing in a ceiling void allow 200mm (8in) clearance above the tray, as per ANSI/TIA-569-E 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

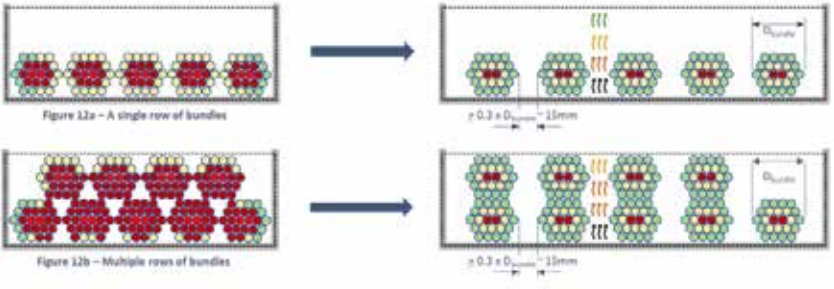
* As per the latest ANSI/TIA-569-E, the minimum access headroom above cable trays is reduced from 300 mm (12 in) to 200 mm (8 in).

The photo above shows infrastructure cabling that is 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 height of the bundles as laid in the containment should not exceed the height of the container, and should not be



stacked higher than the cable tray or the basket's side rail. 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

As per international cabling Standards, cable bundles must not contain more than 24 cables. This is a requirement for the Molex 25-Year System Performance and Application Assurance warranty, if IEEE802.3bt Type 3 and above is to be supported.

Heat dissipation of pathways

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

According to ANSI/TIA-569-E, 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

As per Standards, the following examples are mandated by Molex for Type 3/ Class 5 & above PoE applications.

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.

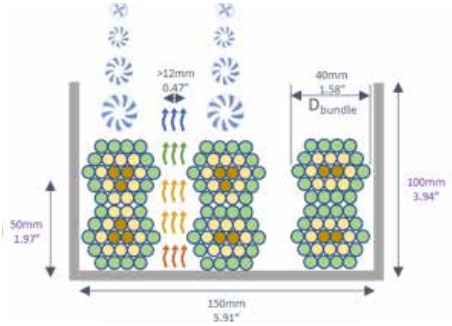


Table: ANSI/TIA-569-E: Heat dissipation effectiveness of pathways (excluding cable trays).

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

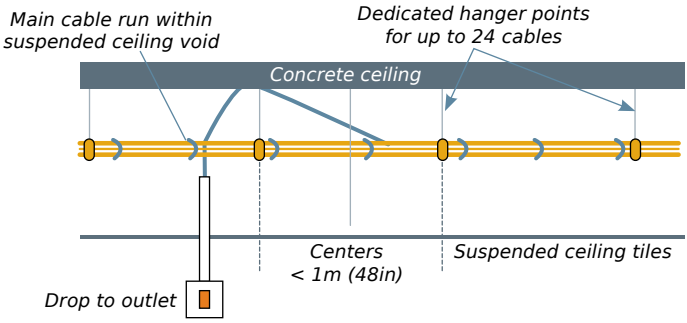
This picture on the next page depicts how J-hooks are installed in a ceiling void. Note how the cable exits the main run to get to the WAO. Be sure to not damage individual cables and support them.

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.

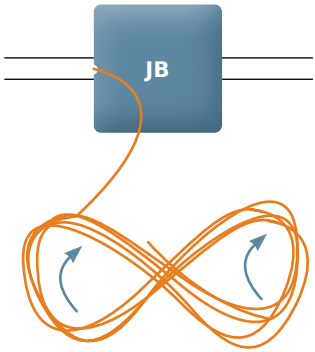
- Conduit comes in several types and sizes including rigid metal, PVC and fiberglass conduit, or flexible PVC conduit
- Molex advises against using flexible conduit of extended length because it has potential for abrasion to jacket
- Can be used for short lengths, e.g.: pathway between permanent duct 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

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).



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.

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.

- 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.

The 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 the 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 minimize 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.

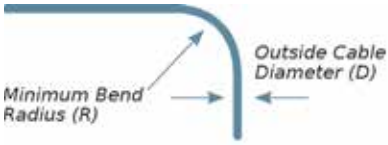
Source of disturbance	Minimum separation (mm)
Fluorescent lamps	130[a]
Neon lamps	130[a]
Mercury vapor lamps	130[a]
High-Intensity discharge lamps	130[a]
Arc Welders	800[a]
Frequency Induction Heating	1,000[a]
Hospital/Airport/Military Equipment	b
Radio-transmitter	b
Television transmitter	B
Radar	B

[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. frequency 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.E 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.E 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-force) during installation.
ANSI/TIA-568-0.E Patch Cord	4 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

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 4 people controlling the running of the reels.

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.

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.

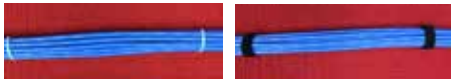
Cable Installation

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 for providing the proper fire stopping for the cabling installation.

Temperature range for installed cables between -20°C and +60°C.

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 putting 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

Blank Space

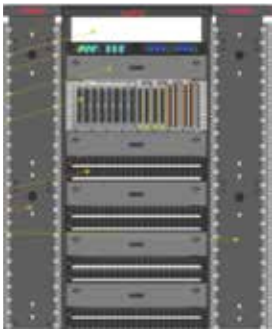
Fiber Management System

Cable Management Panel (Horizontal)

Active Equipment –Switch

2x 24-port Copper Patch Panel

Cable Management Panel (Vertical)



Note: All shielded panels to have individual earth cable to cabinet earth bar.

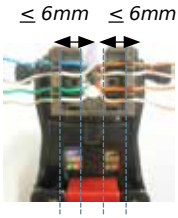
The fiber panel is situated at the top of the rack, above eye level. The switch is below, because it allows for easy access by both the fiber backbone and the copper horizontal. Each 48-port panel, or 2 units of 24 port panels, should have a horizontal cable management bar in place.

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 (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.
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.



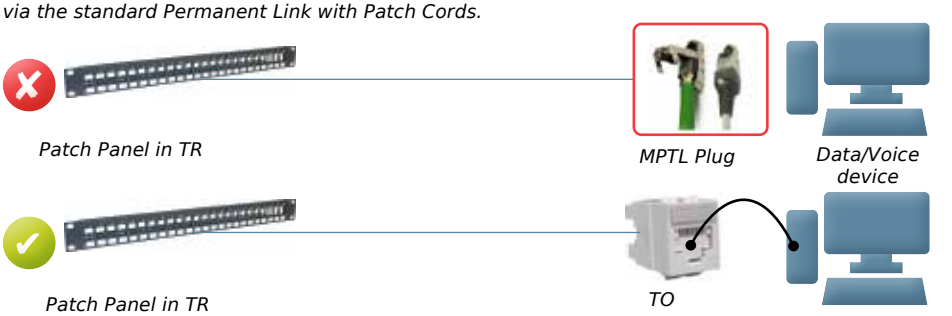
Example of a Cat 6A cable terminated with the Molex Connected Enterprise Solutions 4-pair termination tool.

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

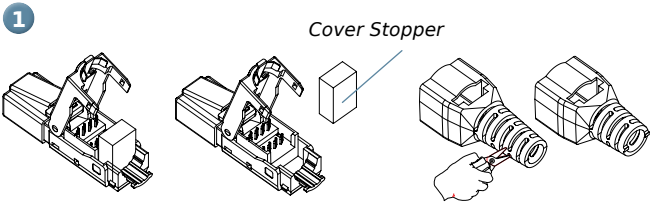
ANSI/TIA-568-2.D and AS/NZS 11801.1 link models – Modular Plug Terminated Link

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. Above 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.



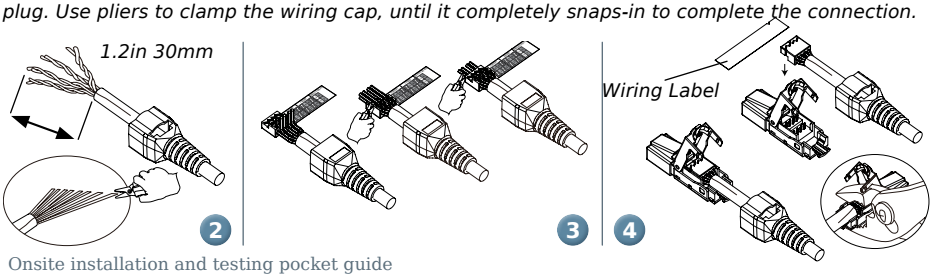
Here is the termination process for the Molex Connected Enterprise Solutions MPTL.

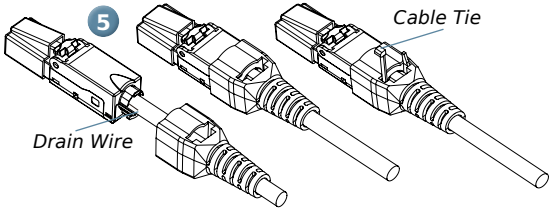


1 *To start with, remove the cover stopper before installation. Then, cut the end of the boot to fit your cable OD.*

Jack Pin designations 87 54 63 12	TIA/EIA T568A	TIA/EIA T568B	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

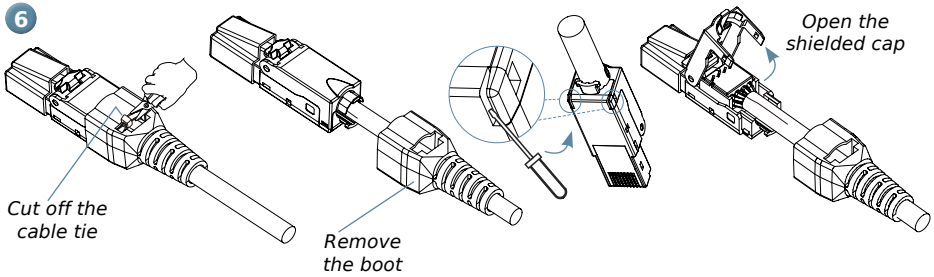
2 *Insert the cable into the strain relief boot and strip off 30mm of cable jacket, and fold back the drain wire.* 3 *Then, fan out all of the four twisted pairs, following the color-coding label and position each conductor into proper slots on wiring cap. Trim the conductors’ end.* 4 *Remove the wiring 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 screwdriver, 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.

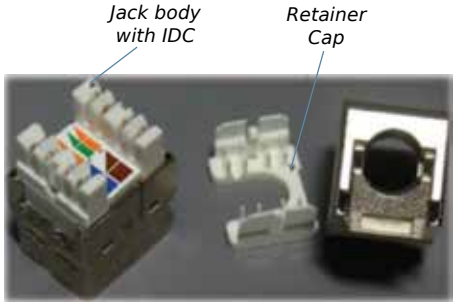
In the shielded jack, a rear housing is added to shield the IDC from noise and to maintain ground continuity.

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.*

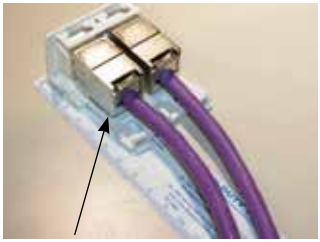
Part Numbers	PowerCat Shielded Datagate jacks
KSJ-00062-xx	C6A DataGate
KSJ-00073-0x	C6A Side Entry DataGate



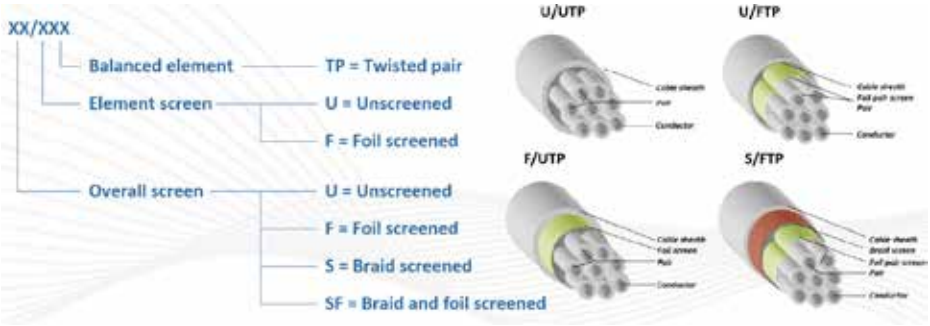
PowerCat 6a – DataGate cable entry options

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



Reminder: Construction of copper cable

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 color 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 color 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.**

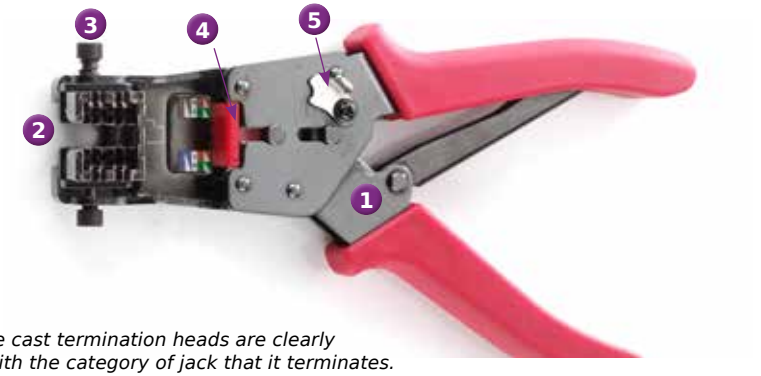
- Reduces installation time compared with a single wire tool
- Accurately seats, cleanly terminates, and neatly trims wires in with one squeeze of the handles

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.

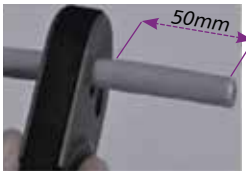
UTP Category 6a cable preparation & jack termination – option #1 P/N KSJ-00091-xx

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 Cat6a 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.

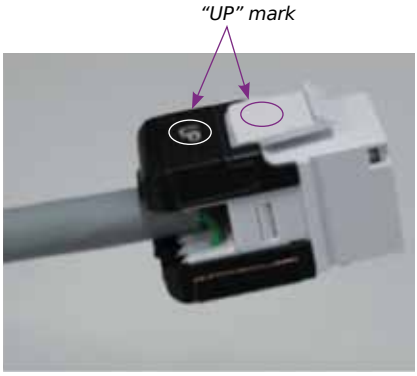
Insert wires into IDC's according to the desired wiring configuration (T568B/ T568A). Terminate the cable with a 110 termination tool ensuring the cable sheath is maintained to the base of the IDC towers and allowing a maximum untwist of 6mm and trim the wires flush with the IDC towers.



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

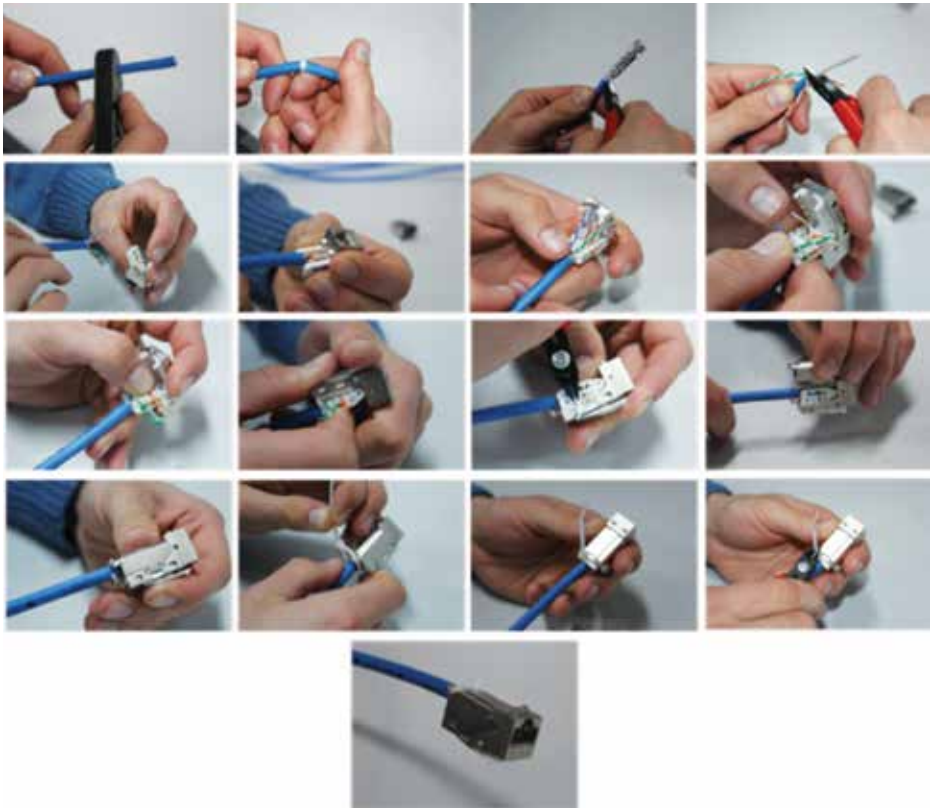
- The termination of this Category 6a U/UTP cable is similar to the Category 6 U/UTP cable
- However, the isolation wrap (conductive discontinuous wrap) should be fully removed on both ends of the cable with cable clippers



Caution: the Molex Cat6a 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”.



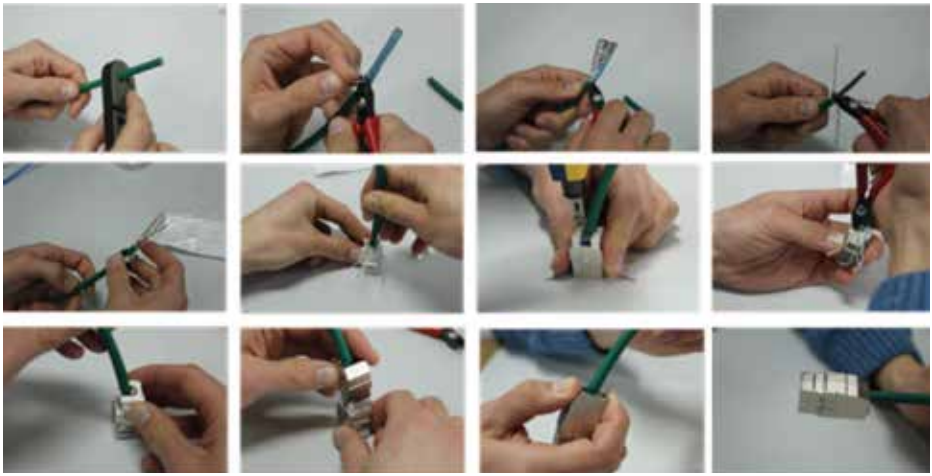
U/UTP Category 6a cable preparation and jack termination: Option #2B – DataGate Jack P/N KSJ-00062-0x

- 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 Cat6a 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".



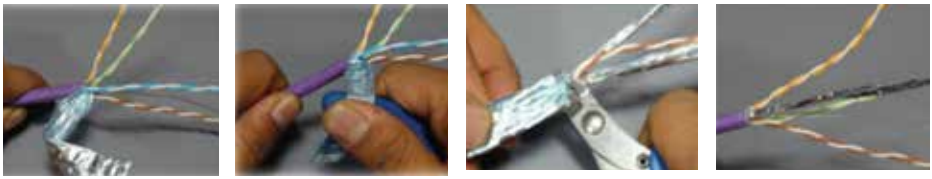
U/FTP cable preparation

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.

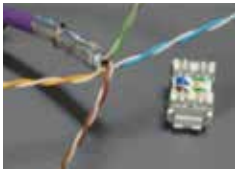
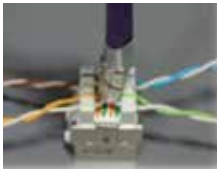
Peel back and straighten the fourth foil.



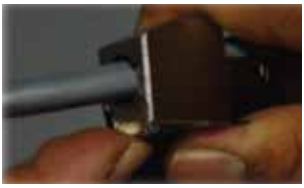
Spiral the foil around the cable jacket, ensuring its blue side is facing inward and its shiny, conductive side is facing outward.

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.

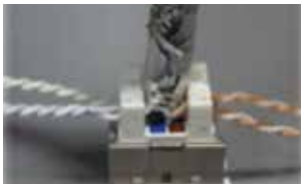

Cut the nylon rip-cord without damaging the foil or wire pairs. Peel back and wrap the foil, shiny, conductive side facing outward, around the jacket of the cable.


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.





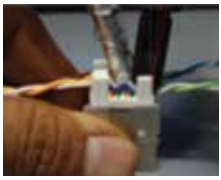
Termination with 110 tool / punch down wires

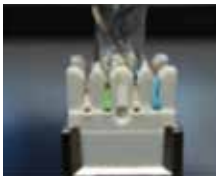
Hold the 110 tool at an angle no more than 15˚ to ensure the wire is cut flush and is fully seated in the IDC. Slide the retainer cap over the IDC housing and press until the retainer cap locks in place. Always use a retainer cap to relieve strain, thereby retaining the wires in the IDC.

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.

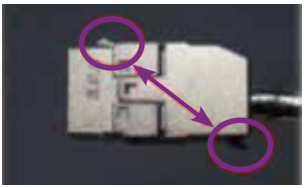
Slide the retainer cap over IDC housing and press until the retainer cap locks in place. Always use the retainer cap that relieves strain thereby retaining the wires in the IDC.

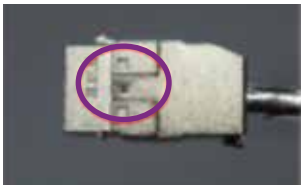




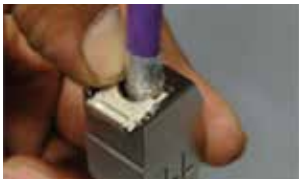
Release the cable clamp from the rear housing by pressing the cable against it. As some of these clips are stiff and cable pressure point/damage could be a result, the use of a small flat screwdriver, if you have no thumb nail, works well in the slot. Slide the rear housing over the foil and over the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





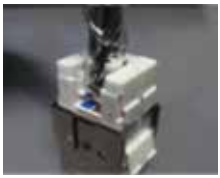
Ensure the drain wire and foil are in contact with cable clamp. Press the clamp until closed, ensuring continuity is maintained with the foil, drain wire, and the metallic jack body. Trim any excess foil. The entire termination should take less than 3 minutes.

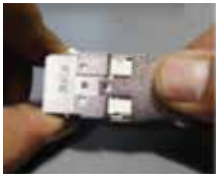


Ensure that none of the internal twisted pairs are visible or exposed outside of the rear can (or cap).

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.

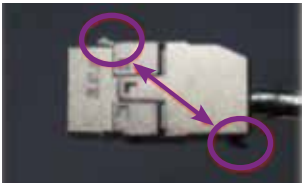
Slide the retainer cap over the IDC housing and press until the retainer cap locks in place.
Always use the retainer cap that relieves strain thereby retaining the wires in the IDC.





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.

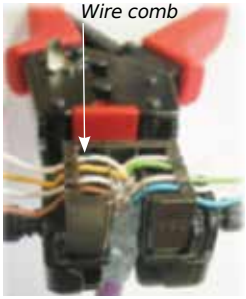
Press the latches on the rear housing to lock onto the jack body. Ensure proper polarity is maintained between cable clamp and tab on the jack body and that the rear housing snaps to jack body.



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

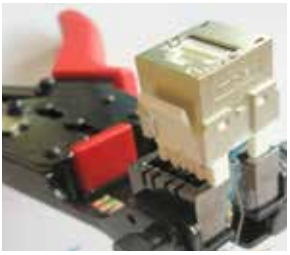


Pivot the termination head 90° counter-clockwise until it locks in place so that the wire comb grooves face out from the tool. Place the cable end in the slot of the termination head, positioning the end of the cable jacket (or shield) at bottom of wire comb. For shielded cable, do not trim the drain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

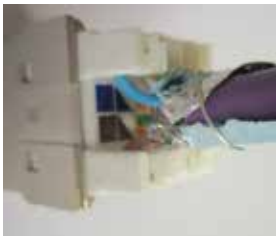
It is recommended to keep the foil and drain wire clear of the multipair tool while terminating, again the blue pair foil works as it is at the open portion of the tool.

Untwist and lace all wires into comb grooves of the termination head following the color-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 5000 crimps or every 3 months. Keep oil away from the wire lacing head & color code labels, which may affect the electrical characteristics of the termination or cause color 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

NOT TO BE USED FOR TERMINATIONS

Cutter Knives
Hacksaw Blades
Credit cards & Driver's License
Screwdrivers
LSA Type Tool

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).

AEM
TestPro CV100

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

Ideal
Lantek IV Series
Lantek III Series
Lantek II Series
(discontinued with product support until March 2022)

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

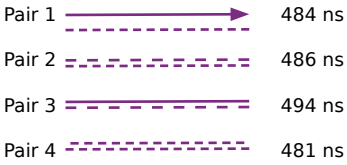
Softing
WireXpert WX500-CU
WireXpert WX500-PLUS
WireXpert WX4500-FA-SC

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.

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

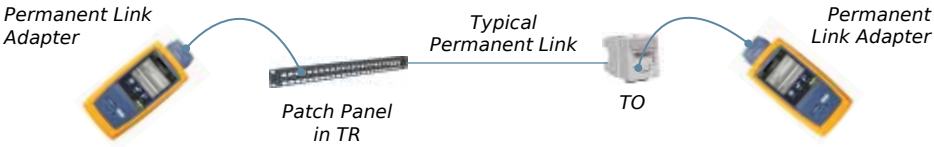
NVP	Report Length	
	(m)	(ft)
60	75.9	249
61	77.2	253
62	78.4	257
63	79.7	261
64	81.0	266
65	82.2	270
66	83.5	274
67	84.8	278
68	86.0	282
69	87.3	286
70	88.5	290
71	89.9	295
72	91.1	299
73	92.4	303
74	93.6	307
75	94.9	311
76	96.2	316
77	97.4	320
78	98.7	324

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.

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.

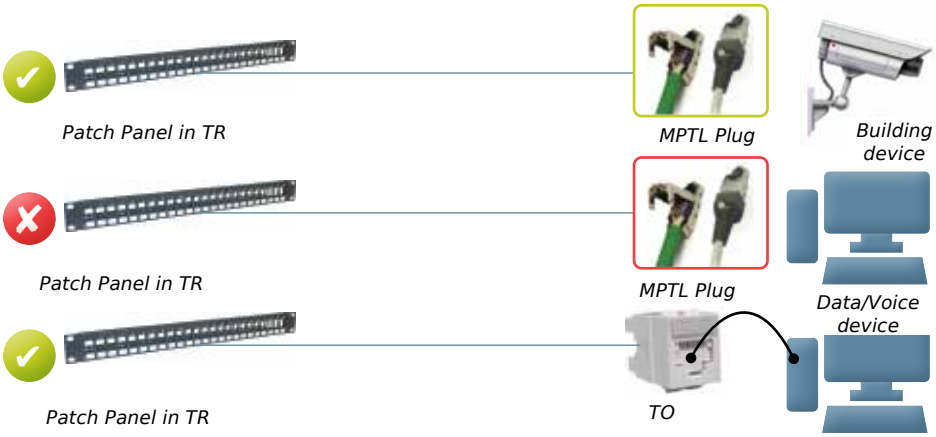
Note: Power over Ethernet. With field testing you will need to add Resistance Unbalance (between pairs and within a pair) and DC Loop Resistance as parameters to be tested.



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.

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 and AS/NZS 11801.1 Standards now include 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.

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

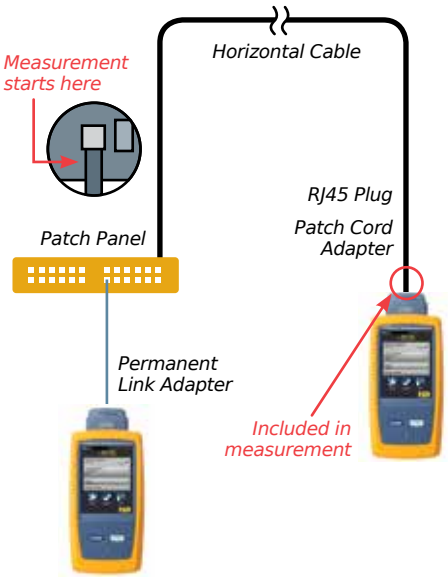
This new link model requires a new test limit (MPTL) and the combination of a Permanent Link adaptor and a Patch Cord Adaptor. This allows the result to contain the performance of the final plug connection at the far end.

- 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 that 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.



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

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.

Installation best practices – fiber optic

This section looks at installation practices that are specific to fiber optics. 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 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

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 fibers installed in Cabling Subsystems 1	**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 fibers	**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 fibers	**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 fibers	**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)

cables, especially multi-fiber per tube, must be terminated using a breakout kit when splicing and pigtails are not used.

- 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

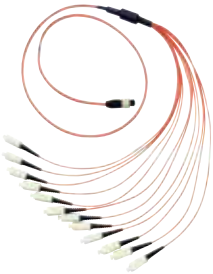
Fiber optic termination – Pigtail splicing

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
- 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.

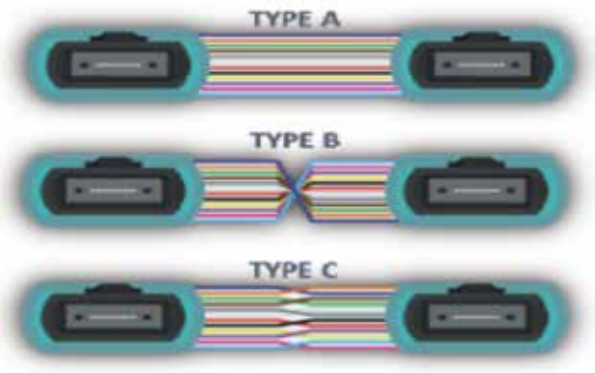
The ModLink fiber optic cable assembly requires proper maintenance. So, lengths of cable assemblies are very important. Short cable assemblies may prevent proper connectivity and longer cable assemblies require space to manage the slack lengths. Pre-configured ModLink fiber panels are designed to accommodate 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.



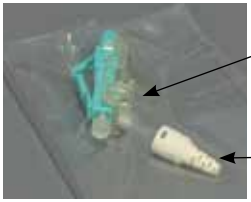
The G2 Xpress connector is a pre-polished, non-epoxy direct fiber connector:

- 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 airtight connection
- Re-usable

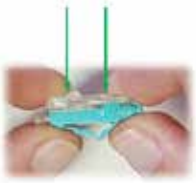
Assembly tooling

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.

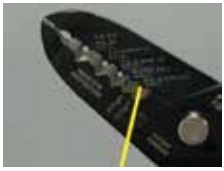


900µm tubing for the 250µm fiber supplied with a box of 10 connectors



You will need to ensure the plastic wedge is securely inserted prior to proceeding. As can be seen, there are 2 dimples on the wedge that need to align with the 2 slots in the connector body.

Depress the plastic wedge onto the connector body simultaneously at both ends, as shown, to ensure it is fixed securely. Once the wedge is inserted, ensure the locking tab is pushed down against the body to prevent the release of the wedge until required.

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.

Position yourself to enable the combining of the fiber and connector. To assist with steadiness, rest your hands on a flat stable surface.

Carefully insert the fiber into the connector until it is fully seated. Take care as hitting the connector will break the fiber.

Once inserted, ensure it is seated as can be seen with the deflection of the fiber.

Now to assist with the release of the clip, retain the fiber between the lower fingers as shown. Lift the lever on the plastic wedge atop the connector and squeeze sides together.

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

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

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.

Using a lint-free wipe which is dampened with alcohol

Using a pre-packaged alcohol wipe

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)

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
- As previously mentioned, any chipped or cracked connectors must be replaced
- Below are samples of inspected MPO/

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

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

Dirty MPO/MTP® connector

Clean MPO/MTP® connector

- **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

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

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.

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
- On the next page 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.

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

Fluke
Versiv DSX-5000
Versiv DSX-8000

Ideal
Lantek IV Series
Lantek III Series
Lantek II Series
(discontinued with product support until March 2022)

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

Softing
WireXpert WX500-CU
WireXpert WX500-PLUS
WireXpert WX4500-FA-SC

AEM
TestPro CV100

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

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

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

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

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	1300nm		850nm	1300nm		850nm	1300nm	850nm	1300nm	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	3.0	1.5	1500	500	2000	N/A
50	OM4	3.5	1.5	OM4	3.5	1.5	OM4	3.0	1.5	3500	500	4700	N/A
50	OM5	3.5	1.5	OM5	3.5	1.5	OM5	3.0	1.5	3500	500	4700	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		
	1310 nm	1383 nm	1550 nm	1310 nm	1383 nm	1550 nm	1310 nm	1383 nm	1550 nm	1310 nm	1383 nm	1550 nm
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	1.0	1.0	1.0	0.4	0.4	0.4

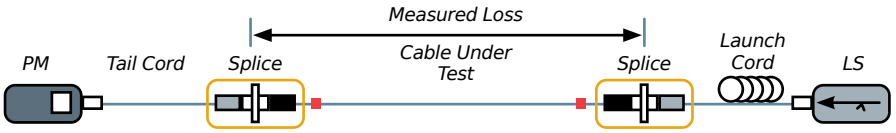
Connector and splice attenuation

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	1300nm	1310nm	1550nm
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	1300nm	1310nm	1550nm
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 1300nm. The mated connections shown represent a Ref to Non-Ref mated connection. This example shows the different loss budgets calculated at 1300nm 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 1300nm:
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

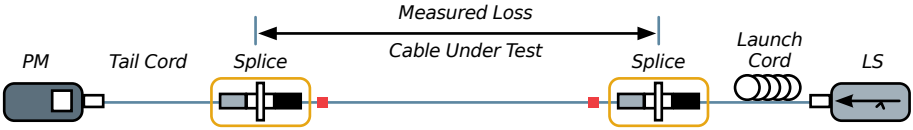
Reading on Tester is 1.35 dB which is within budget

Under TIA 568.3-D ISP (Ref Grade) at a wavelength of 1300nm:
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 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 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/MPT® design Link Loss Budget

This example on the next page shows the different loss budgets calculated at 850nm and 1300nm 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 1300nm

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

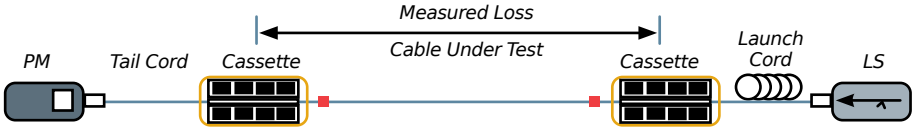
Molex custom approach against a MPO/MTP® design Link Loss Budget

This example shows the different loss budgets calculated at 850nm and 1300nm 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.

- 145m installed link being tested at 850nm and 13000nm
- 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



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 1300nm:
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

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

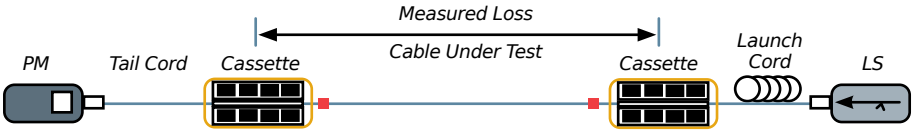
Fiber testing

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

Preface

We have seen an increasing number of incidents of confusion over what Molex Connected Enterprise Solutions requires with respect to being able to offer a Warranty. This document outlines our requirements in detail. The full requirements list is extensive, some of the main 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 entered into the Warranty Application must match those found in the Test Result files.

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 be under valid calibration as per manufacturer's recommendations. Please see further details in this document for complete information.

6. Ensure the tester used has the latest software updates and firmware.

7. Test results are provided in their native format.

8. Provided test results must not contain any FAIL or FAIL* results.

9. All copper links MUST be tested to **Permanent Link** test settings using appropriate adapters. Likewise, when MPTL connectors are used, appropriate adapters MUST also be used.

10. Fiber testing must be 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 directions and at both wavelengths**.

Molex Connected Enterprise Solutions reserve the right to conduct a site inspection if required.

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

Please read the entire document for further information.

Requirements per Warranty

Molex Connected Enterprise Solutions offers an extended **25 Year System Performance and Application Assurance Warranty or a 25 Year Product Warranty** for installed Molex Structured Cabling Systems conforming to applicable standards as detailed in our published Warranty Statements. These Warranties are NOT a site warranty, but a channel warranty for those channels detailed in the application.

For Warranty purposes we classify an end-to-end Certified Structured Cabling System as one comprising entirely of new, genuine Molex passive connectivity and cabling components (end-to-end patch cords included). This expressly excludes any active equipment, whether in or attached to it, public network interface, or terminal equipment.

1) Warranty type: 25 Year System Performance & Application Assurance Warranty.

Warranty Coverage

Molex Connected Enterprise Solutions 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 editions of ANSI/TIA-568-2.D:2018, ISO/IEC 11801.1:2017, EN 50173-1:2018, EN 50173-2:2018, and AS/NZS 11801.1:2019, which are current at the date of installation and which are most recognized by your local industry.

Eligibility

Installation companies who are applying for the above Warranty, must meet the criteria below:-

1. Have a Business Associate Agreement (BAP) ticket on the Customer Support Portal (CSP) which is in “Agreement Valid” status at the time of installation.

2. Certified in Molex Connected Enterprise Solutions’ Data Transport Solutions (DTS) as detailed on the BAP, with a relationship classification of Certified Installer (CI).

Conformance

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

1. Must submit a correctly completed warranty application via the CSP.

2. Must have acknowledged and answered YES to both Installer Declarations (A & B) within the warranty application form.

3. Have submitted all accompanying documentation:-

a) Test Results must be provided in the native tester format, tested in accordance with the requirements specified in the IEC and ANSI/TIA Standards, and the tester used must be specified in our List of Approved Testers, which may be found on the CSP.

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

If you wish to use a tester other than those listed in the Approved Tester List, please submit a Help Desk Support (HDS) ticket on CSP detailing the name and model of the tester, and the website where we may download the report viewing software and sample test reports in native format from. Molex Connected Enterprise Solutions will review the information before approving the tester and reserve the right to decline to accept a tester if it does not meet our strict requirements. This request must be approved BEFORE commencement of testing the installation at the project site.

b) The lengths of installed Permanent Links seen in the test results must be less than or equal to its specified maximum length for the applicable Category

c) As-Built documentation. See point 7 on next page

4. Test Result dates must not be:

a) Prior to the Installation Date specified within the warranty ticket

b) More than 6 months after the Site

Installation Date.

c) More than 6 months before the date of warranty application.

We recommend if working on a large site that is taking longer than 6 months, to break it into smaller logical "chunks" and apply for each separately. You can specify on the warranty ticket that it is part of a larger overall project/site.

5. Test Results must:

a) Show the same link counts for each applicable Category as

specified in the warranty ticket

b) Show the same total link count as specified within the warranty

ticket

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 multiple results with identical date & time stamps for the same individual tester

g) Have the correct NVP specified as per the cable specification (the NVP is also printed on the cable)

h) NOT have negative NEXT values

If recertified (RC) test results are submitted, we also require the original unaltered non-RC test results for comparison. These will be considered strictly on a case-by-case basis and acceptance will be entirely at the discretion of Molex Connected Enterprise Solutions.

Negative NEXT values are not accepted and will not be considered for the 25 Year System Performance and Application Assurance Warranty. Standards recommend the minimum length for a Permanent Link is 15m, or 15m between the Patch Panel and a Consolidation Point. Molex may consider down to 10m Permanent Links, but only if they exhibit positive NEXT values. Accepting these shorter links for warranty purposes is entirely at the sole discretion of Molex Connected Enterprise Solutions.

6. Testers used must:

a) Be calibrated by the tester manufacturer or authorized third party, and in accordance with the manufacturer's recommendations for frequency (usually annually). Testers MUST be under valid calibration.

b) Have the latest Firmware applied

c) Be used in conjunction with the correct adapters (also calibrated) according to the tests performed Molex Connected Enterprise Solutions will accept longer calibration intervals; however you MUST provide a certificate from an authorized calibration facility proving that the calibration has not expired.

Molex Connected Enterprise Solutions will also continue to accept test results even if that particular model has been discontinued and is not supported by the manufacturer anymore **SO LONG AS IT IS UNDER VALID CALIBRATION.** – Test reports showing a note such as "Calibration Due" or similar, will be rejected.

7. As-Built documentation:

The As-Built documentation must be uploaded to the warranty ticket and can be in PDF or native AutoCAD DWG format. At minimum, it should include:

a) A map showing the location of all work area outlets, consolidation points, and Multi User Telecommunications Outlet Assembly (MUTOA), and Telecommunications Room locations

b) Cabinet layout

— These can be neatly hand drawn (a photo or photocopy of evacuation drawings for commercial buildings is a good base), or Visio or CAD drawings.

— You must show the location of each WAO and their ID

— You must show the location of each TR and their ID

— Cabinet naming details should be clearly identified

— You must show the position of each Patch Panel and its ID

— Location of new outlets if additional are added, should be clearly identifiable

We receive many questions about why we require the exact cabinet layout at the time of warranty submissions:

• Risk mitigation – not only for Molex Connected Enterprise Solutions, but also you (the Installer), and most importantly, the End-User.

— The better and more accurate the documentation is, the faster we can manage a warranty claim which is of essence to the End-User. This may also cover the End-User against inaccurate records.

— This may identify the movement of the panel by a third party which unfortunately would void a Molex Connected Enterprise Solutions Warranty. The Permanent Link must remain permanent.

• Recording changes to an existing site.

— By listing what has been added to any panel, it is known which panels were worked on during the additional works.

— Can identify new panels to be covered without affecting the warranty on existing panels.

• Having a photo on file of the front and rear could also provide evidence of the installation quality

— Again this reference material would be available if there was a warranty claim in the future.

The following items are not mandatory, but are recommended:

a) Main copper and fiber cable routing (include drawings with red lines of cable runs if available)

b) BOM List

If provided, you should:

— Have some dimensions of the building to demonstrate run length

— Show the main cable pathway(s) and their ID(s)

In case of campus installations, you should:

— Show full pathway of cabling, including the external runs between buildings.

— Show the location of cabinets being connected

For the BoM, you should confirm the exact products used in the installation, and the quantities of each.

Note: These conformance requirements (including As-Built documentation) are mandatory for System Performance and Application Assurance warranties. Failure to conform to any of these requirements may result in the rejection of your warranty application or mean that it can only be considered for a Product Only type warranty. This depends on various factors including local RSD approval.

Optional but recommended

In fiber installations, we also highly recommend adding a TRC (Test Reference Cord) verification test every 500 tests and including these results with your submitted test results.

2) Warranty type: 25 Year Product Only 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 must have been installed by a Molex Connected Enterprise Solutions approved Certified Installer and must be comprised entirely of Molex 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 must have been installed and commissioned by an authorized Molex Connected Enterprise Solutions Certified Installer to the practices and guidelines specified by Molex Connected Enterprise Solutions and based on the published editions of ANSI/

TIA-568-2.D:2018, ISO/IEC 11801.1:2017, EN 50173-1:2018, EN 50173-2:2018, and AS/NZS 11801.1:2019, which are current at the date of installation and which are most recognized by your local industry.

Eligibility

Installation companies may not directly apply for this type of Warranty. Rather, this is a secondary option in case the application does not meet all criteria for a System Performance and Application Assurance Warranty as described from page 3, above.

Approval for a Product Only warranty is purely at the discretion of the local Regional Sales Director (or in some cases, the local Technical Manager). However, installation companies must still meet the criteria detailed below:-

1. Have a Business Associate Agreement (BAP) ticket which is in “Agreement Valid” status at the time of installation.

2. Certified in Molex Connected Enterprise Solutions’ Data Transport Solutions (DTS) as detailed on the BAP, with a relationship classification of Certified Installer (CI).

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

Conformance

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

Must submit a correctly completed Warranty application via the CSP.

Must have acknowledged and answered YES to both Installer Declarations (A & B) within the Warranty application form.

3. Have submitted all accompanying documentation:

a) Test Results must be provided in the native tester format, tested in accordance with the requirements specified in the IEC and ANSI/TIA Standards, and the tester used must be specified in our List of Approved Testers, which may be found on the CSP.

Permanent Link testing is highly recommended; however channel tests may be accepted in the case of a Product Only warranty.

If you wish to use a tester other than those listed in the Approved Tester List, please submit a Help Desk Support (HDS) ticket on CSP detailing the name and model of the tester, and the website where we may download the report viewing software and sample test reports in native format from. Molex Connected Enterprise Solutions will review the information before approving the tester and reserve the right to decline to accept a tester if it does not meet our strict requirements. This request must be approved BEFORE commencement of testing the installation at the project site.

The lengths of installed Permanent Links seen in the test results must be less than or equal to its specified maximum length for the applicable Category

4. Test Result dates must not be:

a) Prior to the Installation Date specified within the warranty ticket

b) More than 6 months after the Site Installation Date.

c) More than 6 months before the date of warranty application.

5. Test Results must:

a) Show the same link counts for each applicable Category as specified in the warranty ticket

b) Show the same total link count as specified within the warranty ticket

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 multiple results with identical date & time stamps for the same individual tester

g) Have the correct NVP specified as per the cable specification (the NVP is also printed on the cable)

If recertified (RC) test results are submitted, we also require the original

unaltered non-RC test results for comparison. **These will be considered strictly on a case-by-case basis and acceptance will be entirely at the discretion of Molex Connected Enterprise Solutions.**

6. Testers used must:

a) Be calibrated by the tester manufacturer or authorized third party, and in accordance with the manufacturer's recommendations for frequency (usually annually). Testers MUST be under valid calibration.

b) Have the latest Firmware applied

c) Be used in conjunction with the correct adapters (also calibrated) according to the tests performed Molex Connected Enterprise Solutions will accept longer calibration intervals; however you MUST provide a certificate from an authorized calibration facility proving that the calibration has not expired.

Molex Connected Enterprise Solutions will also continue to accept test results even if that particular model has been discontinued and is not supported by the manufacturer anymore **SO LONG AS IT IS UNDER VALID CALIBRATION.** – Test reports showing a note such as "Calibration Due" or similar, will be rejected.

Optional but recommended

In Fiber installations, we also highly recommend adding a TRC (Test Reference Cord) verification test every 500 tests and including these results with your submitted test results.

A note regarding Consolidation Point (CP) Testing

Please note the architecture diagram below, which should be referred to when installing and testing Consolidation Points:

If your site is a Cat 6a installation containing CPs in the configuration, and is to be tested to Class Ea under ISO/IEC 11801 testing, please note:

a) The correct testing for the complete link, through the CP is the ISO 11801 PL3 Class Ea test parameter.

b) This is the required test for warranty of the installed links.

Molex Connected Enterprise Solutions recommends the following actions for site testing of a Class Ea installation through a CP:

1. Upon completion of the cable installation from the cabinet to the CP, conduct the ISO 11801 PL2 Class Ea test.

a) This is to confirm the compliance of the permanently installed cabling between the Patch Panel and CP.

b) It is recommended to upload these results for reference when completing the site warranty.

2. Upon completion of the cabling from the CP to the TO, conduct the ISO 11801 PL3 Class Ea test.

a) This test configuration is required to warranty the fully installed links.

b) Optional MPTL testing of the link from the CP to outlet, to ensure compliance of the cabling.

c) This is only available when outlets and field terminated plugs are used at the CP, which are required on shielded solution to ensure shield continuity.

3. When completing the warranty application, you will need to list the number of CP links installed AND the number of outlets installed.

a) By design, a CP would normally have spare capacity for future expansion.

b) The warranty provided for the site is only for the completed links from the Panel to the TO and tested as ISO 11801 PL3 Class Ea.

Copies of the PL2 and MPTL tests conducted are recommended to be uploaded in the warranty application for reference purposes only as they are not individually covered for warranty purposes.

When processing Warranty Applications, Molex Connected Enterprise Solutions will:

Open the Warranty Application and check:

1. Installer Declaration section

2. Site Name

3. Installation Date

4. 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)

5. Validate Business Associate Agreement (See Eligibility, above).

6. All items listed under the relevant conformance sections above are present

Review related Test Results:

For Copper Tests:

1. Ensure Cable ID’s are not repeated.

2. Check Tested date, Installation date, and Calibration Date

3. Check if the test report shows a PASS* percentage greater than 5%

4. Check if the test report has any FAIL / FAIL* results.

5. Check for any identical results - Lengths, Cable IDs, Date and Time Stamps, Loss Values, etc.

6. Check cable lengths (Depending on Channel and Permanent Link).

7. Test Limits.

8. Ensure the correct adapters have been used

9. Frequency range must be specific to the Category being tested.

10. Check that the tester used is a Molex Connected Enterprise Solutions Approved tester.

11. If a shielded solution, ensure the shield test is enabled.

For Fiber Tests:

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 Multimode; TIA-526-7, Method A.1 for Singlemode) 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 Connected Enterprise Solutions insists that tests be conducted in both directions and at both wavelengths for sites seeking a 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. Check for any identical results - Lengths, Cable IDs, Date and Time Stamps, Loss Values

7. Test Limit (We do not accept Fiber test reports tested using General Fiber custom (fixed loss) test limits)

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 Connected Enterprise Solutions requires Multimode field tests to be performed with the encircled flux launch condition as defined in TIA/TSB-4979.

10. In any instances where your link configuration requires setting up a Custom Limit, please contact us at ces.support@molex.com to discuss before conducting any site installation testing.

Reference @850nm and 1300nm for Multimode and @1310nm and 1550nm for Singlemode.

11. 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) may be provided but only as a supplement to the 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.

Reminder: Molex Connected Enterprise Solutions reserve the right to abandon Warranty Applications pending input from a Certified Installer for more than 45 days.

List of approved test equipment

Copper

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

To warrant installations completed by Molex Connected Enterprise Solutions Certified Installers, using end-to-end Molex Connected Enterprise Solutions products in the installed Channel / Permanent Link, the test results to be submitted by the Certified Installers must be in their native formats.

It is mandatory to test all the installed links using Permanent Link test settings on the tester with appropriate adapters.

Molex Connected Enterprise Solutions insists that the test equipment be factory calibrated annually or as recommended by the tester OEMs, and that the latest firmware is applied to testers before installations are tested for warranty purposes.

The list of approved test equipment is as follows:

1. Fluke Networks

- DSX Cable Analyzer Series: DSX-600, DSX-5000 and DSX-8000
- DTX 1500 (Manufacturer discontinued support in June 2020, however it may still be in valid calibration until end of May 2021)

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

2. Ideal Networks

- LanTEK IV Series
- LanTEK III Series
- LanTEK II Series (This has been discontinued by Ideal Industries. Product support is available until March 2022)

Note: For more information about the listed tester models, please refer to the Ideal Networks website https://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 to the VIAVI Solutions website https://www.viavisolutions.com/en-us

4. Softing

- WireXpert WX500-CU
- WireXpert WX500-PLUS
- WireXpert WX4500-FA-SC

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

5. AEM

- TestPro CV100

Note: For more information about the listed tester models, please refer to the AEM website http://aem-test.com

Fiber optic

Factors that affect the integrity and performance of the installed fiber optic cable may include severe cable bends, poorly installed connectors, or presence of dirt on the face of the connector.

The attenuation measurement results 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 verify-

ing the cable length and the polarity add up to **Tier 1** testing as specified in the standard. **Tier 1 testing is required for Molex Connected Enterprise Solutions Warranty Certification. Tier 2,** which is optional, includes Tier 1 testing plus an OTDR trace.

The list of test equipment is as follows:

1. Fluke Networks

- CertiFiber Pro

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

2. Ideal Networks

- Ideal Networks OC 1

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

5. Softing

- WireXpert WX500-PLUS
- WireXpert EX4500-FA-SC

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

6. Optical Wavelength Laboratories

- Fiber OWL 7 BIDI OLTS

Important notes on this tester:

1. The Fiber OWL 7 gives us all the information that we look for in the test reports. Since we insist on bi-directional testing, you must opt for the Fiber OWL 7 BIDI model. Here is the link:

http://owl-inc.com/products/sub/olts/htm/bidi-chooser.htm

2. Currently, we do not see the latest Standards in their firmware for ISO which we believe may be added at any time. At this point, you should choose TIA 568.3-D as your test Standard.

The other settings remain the same for 1 jumper method.

This tester is capable of measuring cable length, however the tester software "OWLView" supports different tester models where a few variants do not measure the length and it is instead manually keyed in the test report. As a result, the software gives the option to edit Link Parameters like Length, Number of Connections, Number of Splices and Fiber Type. Our advice is not to modify any of these parameters once the measurements are made and any modifications later identifications will void the warranty. Just as with any other approved OLTS, the lengths mentioned in the reports MUST match the physical length derived from the marking on the cable sheath.

5. The test reports must be submitted in their native format (.fo7 in this case).

6. We believe this tester has custom setup (User defined), in case it is required.

7. Like a few other tester OEMs, OWL recommends annual calibration and the installer is required to ensure that the tester is within valid calibration at the time of testing.

8. Finally, it is always recommended to share sample reports from the site before testing of the complete site, so that we can review and advise of any changes required in the test settings.

In case you have further queries on this tester, please contact us at ces.support@molex.com.

7. AEM

- TestPro CV100

Note: For more information about the listed tester models, please refer to the AEM website http://aem-test.com

Alternative tester model policy

If you wish to use a tester model that is not listed in this document, and which has the ability to test the installed cable to our requirements, please send an email to ces.support@molex.com giving details of the tester. This must be done prior to the purchase of the tester/testing of the installation.

Important Reminders

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.

A Molex Connected Enterprise Solutions-approved tester must be used and the resulting measurements must be in that tester's proprietary format.

Some tester Software can re-certify (RC) with adjusted NVP without affecting the results.

Note that Molex Connected Enterprise Solutions does not accept (RC) test results on their own for certification. Should you need to use this function please ensure you provide the original results with the (RC) results.

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. This is the required test for Molex Connected Enterprise Solutions Warranty Applications.

The optional Tier 2 includes the Tier 1 testing plus an OTDR trace.

The test leads required for Multimode fiber testing are required to be encircled Flux Test reference cords used for the output on the tester.

Remember that Molex Connected Enterprise Solutions MPO cassettes have a loss of no more than 0.5dB which will require a custom setup.

Tester calibration

The tester must be under valid calibration at the time of testing. This is a key requirement.

In addition:

1. Tester Calibration should be as per manufacturer's recommendations (i.e., Fluke Networks recommends calibration intervals of 1 year)

2. Molex Connected Enterprise Solutions will accept longer calibration intervals however you **MUST** provide a certificate from an authorized calibration facility proving the calibration has not expired.

Molex Connected Enterprise Solutions will also continue to accept test results even if that particular model has been discontinued and is not supported by the manufacturer any more **so long as it is under valid calibration.**

Test repots showing a note such as "Calibration Due" or similar will be rejected.

Notes

Notes

Notes

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Order No. UK-SK/2020.11 v1.4

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