Fibre Installation Guidelines

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Excel Networking has defined a set of manufacturer guidelines for both the Copper and Fibre product ranges, the following set of instructions relate to the Fibre Optic offerings from Excel Networking.

Fibre optic cables can be easily damaged if they are not correctly handled or installed. It is important that certain procedures be followed in the handling of these cables to avoid damage and limiting their performance.

This will also provide guidelines for the installation of Excel Networking Fibre Optic Systems to assure standards based performance to meet the requirements of the warranty applications.

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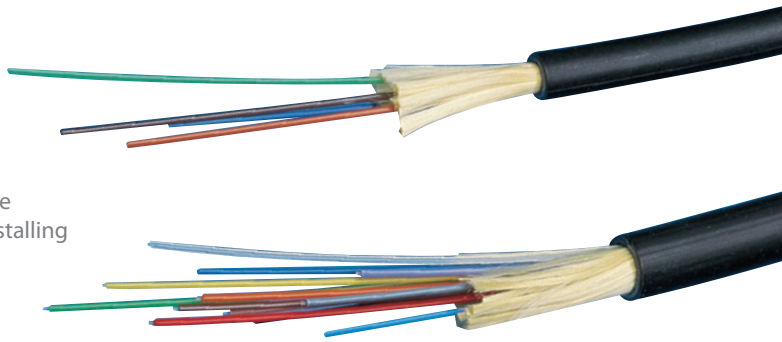
Overview

Optical fibres require special care during installation to ensure reliable operation. Installation guidelines regarding minimum bend radius, tensile loads, twisting, squeezing, or pinching of cable must be followed. Cable connectors should be protected from contamination and scratching at all times. Violation of any of these parameters causes increased attenuation or permanent damage to the cable. The following are a few general comments to consider when installing fibre optic cables.



Do not exceed maximum cable lengths

Make sure you check the installation instructions of the module for the appropriate cable lengths to ensure proper operation. You may experience additional attenuation loss when using bulkhead connectors to join cables even when the total length is less than the maximum allowed. Care should be used in maintaining total attenuation budget when joining cables with bulkhead connectors.

Do not compromise minimum bend radius for a given cable type

Exceeding the bend radius of the cable can cause unseen damage to the fibres of the cables that may not manifest itself for a period of time. This can lead to an expensive re-pulling of cables at a later date.

Avoid twisting cable

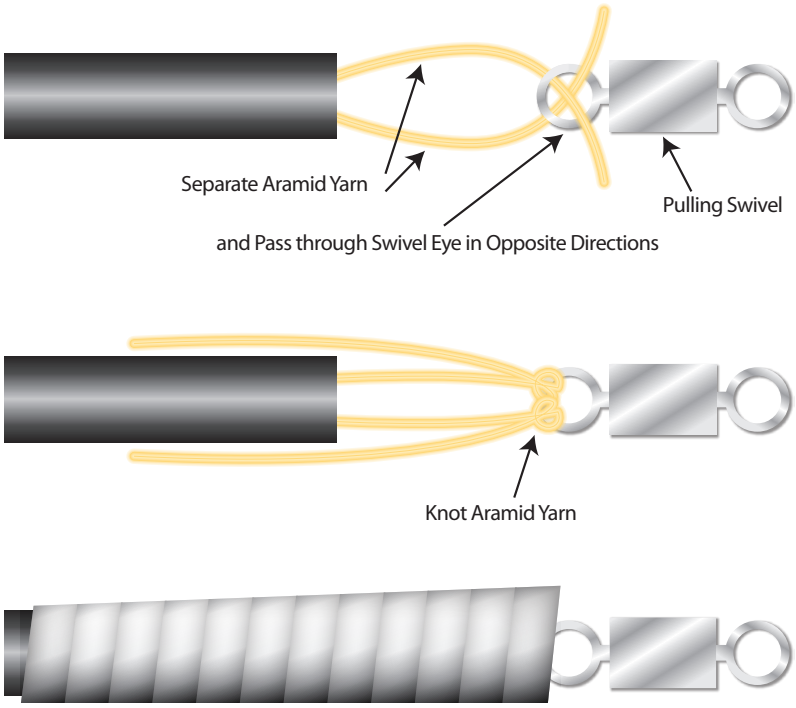
Use proper pulling techniques when installing the cables. Putting twists in the cable greatly increases the chances of breaking the fibres.

FIBRE

Fibre Optic Cable Pulling Techniques

Installation methods for both wire cables and optical fibre cables are similar. Just remember these rules:

- Never pull on the connector. The connector/cable interface is not designed for pulling.
- Use a pulling grip designed for pre-connected fibre optic cables. Grips with a fixed pull ring should use a swivel to attach the pull rope.
- Monitor tension. Do not exceed the maximum tensile load.
  - On runs from 40m to 100m, use proper lubricants and make sure they are compatible with the cable jacket.
  - On runs over 100m, use proper lubricants and pull from the middle out to both ends.
  - If possible, use an automated puller with tension control or at least a breakaway-pulling eye.
- Always use a straight pull. Use cable guides to maintain the recommended bend radius. Do not exceed the cable bend radius. Exceeding the bend radius harms the fibres. It may not be immediate, it may even take a few years but eventually by exceeding the recommended bend radius of the cable you reduce the useful life of the cable
- Use a swivel-pulling eye, to prevent additional twisting of the cable during installation.



Routing Fibre Optic Cables

Take care to properly route cables through cabinets and right angle bends within cable tray.

- **Install cables in containment without loops.** Avoid placing fibre optic cables in containment and conduits with copper cables to avoid excessive loading or twisting.
- **Protect cables from excessive or frequent bending.** Cables do not have a flex rating. Special care must be taken to protect the cable and to avoid exceeding the bend radius of the cable.

Installation Checklist

Use the following installation checklist to ensure proper handling.

Installation Procedure	Complete	Comments
Maximum cable length not exceeded		
Bending radius not exceeded		
Maximum tensile load not exceeded		
Correct pulling techniques used		
Cable not squeezed or jacket creased		
Cable installed without loops in containment		
Cable protected from sharp edges		
Fibre cable installed in separate containment or route to copper cable		
Communications Spaces thoroughly cleaned prior to termination of fibre cables, (direct or splicing).		
Fibre connector end face cleanliness maintained		
Fibre connector dust caps in place		
Correct labelling of both fibre cables and panels		

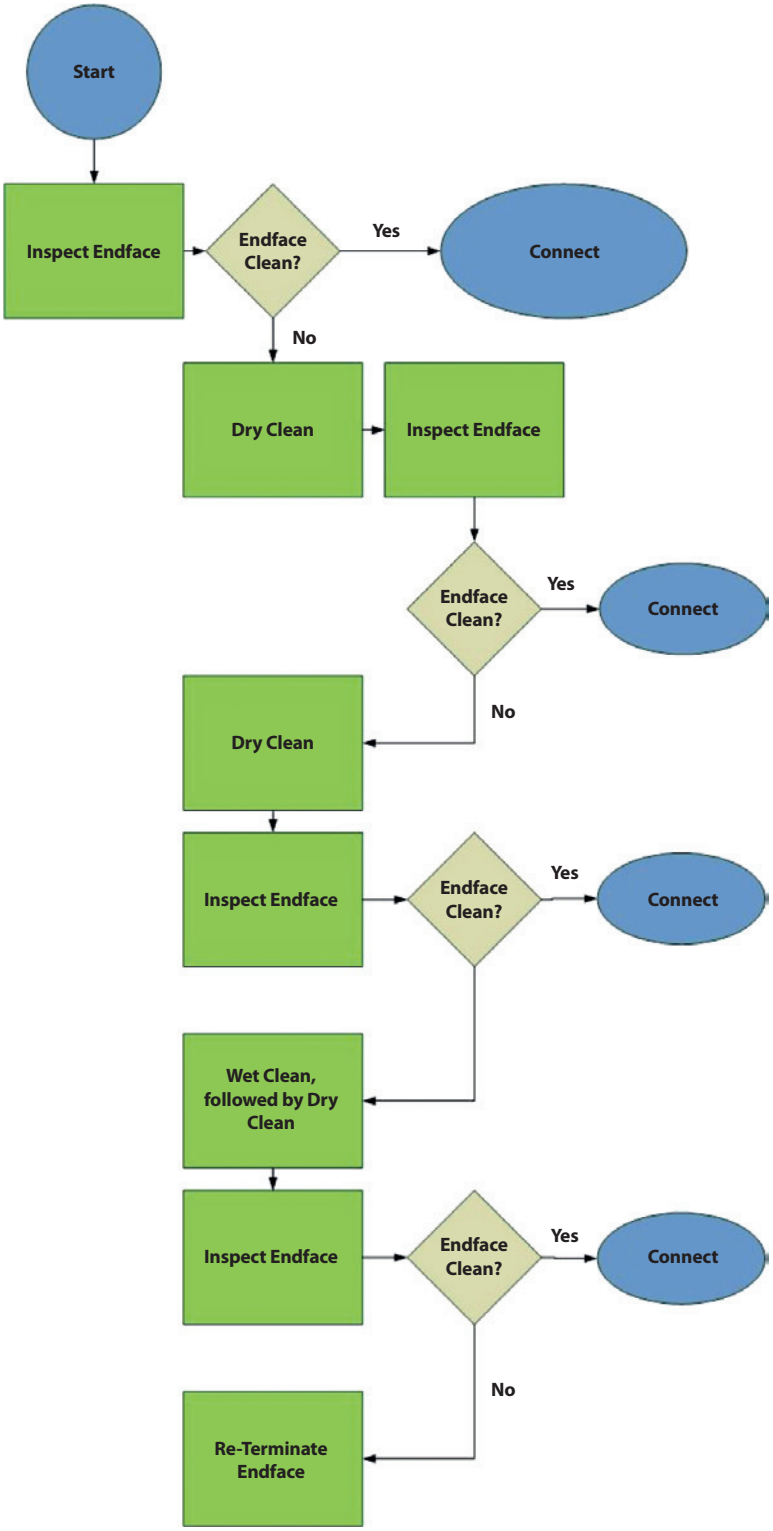
Cleaning Techniques for Fibre Optic Cables

Any contamination in the fibre connection can cause failure of the component or failure of the whole system. Even microscopic dust particles can cause a variety of problems for optical connections. In a survey carried out by Fluke Networks they claim that 85% of the failing links can be attributed to 'end-face contamination'.

Proper cleaning of the fibre optic cable ends and transceivers is essential to minimize system attenuation.

Dirty fibre optic connectors cross contaminate their mating transceivers. Conversely a dirty transceiver contaminates its mating fibre optic connector. There are a variety of ways to clean fibre optic components. Pre-packaged wipes, swabs and, canned air are suitable. Whatever the choice, it is important to follow the correct procedure/instructions. Failure to do so could lead to even more contamination being introduced.

The following is a flow chart outlining the suggested Excel process for cleaning fibre connectors.



Conclusion

Cleaning fibre is an essential process of any installation and there are a number of key elements to ensure success.

They are:

- Never touch the end-face of the fibre connectors – natural body oil can be a major cause of contamination
- Always keep a protective cap on unplugged fibre connectors – protection from both damage and contamination
- Do not clean bulkhead connectors without a way of inspecting them – how else will you know whether the cleaning is successful?
- Always store unused protective caps in a sealed container - they can also be a major source of contamination if not stored in a clean environment.
- Never re-use any tissue, swab or cleaning cassette reel
- Never touch any portion of tissue or swab where alcohol was applied – you could be introducing both dirt and body oil
- Never use a wet cleaning method without a way of dry cleaning immediately afterwards - the wet process can leave a harmful residue that is hard to remove when it dries

Finally, be warned:

Ensure all the fibre connectors you intend to clean are disconnected. And **NEVER** look into a fibre with either a fibre microscope or the naked eye when the lasers are on.

Termination Options

There are a number of methods for the termination of fibre connectors each one has its own merits and benefits, in ease of termination, cost and convenience. One factor that remains consistent across all of them is the importance of cleanliness.

Multimode connectors are usually installed in the field on the cables after pulling this may include direct termination or splicing of pre-termination of factory-made "pig-tails". While single-mode connectors are usually installed by splicing a factory-made "pigtail" onto the fibre this is due to the tolerances on single-mode terminations being much tighter and the polishing processes more critical and you may not be able to get losses lower than 1 dB with field termination.

Pre-terminated cables can be pulled with connectors already on them if, you clearly understand the potential issues: Firstly, the length must be precise, too long and you may have to store the extra cable length. Secondly, the connectors must be protected. Excel Networking offers protective sleeves to cover the connectors, but you must still be careful in pulling cables. In fact you may consider terminating one end and pulling the un-terminated end to not risk the connectors.

There is a growing movement to install pre-terminated systems especially with MPO/MTP 12 multi-fibre connectors.

Direct termination – Epoxy, Hot Melt, Anaerobic Adhesive, Crimp & Polish

A note on adhesives: Most connectors use epoxies or other adhesives to hold the fibre in the connector. Use only the specified epoxy, as the fibre to ferrule bond is critical for low loss and long term reliability.

Epoxy/Polish

Most connectors are the simple "epoxy/polish" type where the fibre is glued into the connector with epoxy and the end polished with special polishing film. These provide the most reliable connection, lowest losses (less than 0.5 dB) and lowest costs, especially if you are doing a lot of connectors. The epoxy can be allowed to set overnight or cured in an inexpensive oven. A "heat gun" should never be used to try to cure the epoxy faster as the uneven heat may not cure all the epoxy.

"Hot Melt"

This is a 3M trade name for a connector that already has the epoxy (heat set glue) inside the connector. You strip the cable, insert it in the connector, crimp it, and put it in a special oven. In a few minutes, the glue is melted, so you remove the connector, let it cool and it is ready to polish. Fast and easy, low loss, but not as cheap as the epoxy type, it is seen as suitable for relatively small quantities of connectors.

Anaerobic Adhesives

These connectors use a quick setting adhesive to replace the epoxy. They work well if your technique is good, but often they do not have the wide temperature range of epoxies, so only use them indoors.

Crimp/Polish

Rather than glue the fibre in the connector, these connectors use a crimp on the fibre to hold it in. Expect to trade higher losses for the faster termination speed. These connectors are more costly than epoxy polish types. A good choice only if you install small quantities and the customer will accept them.

Hints for field terminating connectors

- Have the right tools for the job and ensure they are in good condition.
- Is your Test Equipment and Leads in perfect condition?
- Ensure you have the means to inspect the end-faces.
- Dust and dirt are your enemies work in the cleanest possible location.
- Use lint-free wipes to clean every connector before connecting or testing it.
- Don't work under heating vents, they distribute dirty air.
- Don't over-polish, too much polishing is just as bad as too little. Polish too much and you create a concave fibre surface, increasing the loss.
- Change polishing film regularly. Polishing builds up residue and dirt on the film that can cause problems.
- Put covers on connectors and patch panels when not in use.
- Inspect and test, then document.

Splicing – Mechanical or Fusion

There are two types of splices, fusion and mechanical, and the choice is based on quantity, expected lifecycle and location.

Fusion Splices

These are made by "welding" the two fibres together usually by an electric arc. Obviously, it is not advisable in an explosive atmosphere. A good fusion splicer is usually fully automatic which gives maximum assistance and ensures good splices time after time.

This is the preferred option for field termination of Excel Fibre Systems due to the accuracy and consistency of Fusion Splicing of Excel warranted pre-terminated pigtails.

For full details on the correct procedures for Fusion Splicing please visit the following link.

http://www.fujikura.co.uk/products/videos/

Mechanical Splices

These are alignment devices that hold the ends of two fibres together with some index matching gel or glue between them there are a number of types of mechanical splices however they should only be used for temporary repairs and not long term installations covered by the Excel 25 year warranty.

Pre-terminated

The Excel pre-terminated fibre optic portfolio is available in OM1, OM2, OM3 and OM4 multimode and OS1 and OS2 single-mode categories of system. The choice of cable type allows for the assembly to match the environment that it will be installed.

Standard fibre termination is a costly exercise requiring highly skilled engineers and specialist equipment to complete an installation. With the Excel fibre pre-terminated solution it provides a fully tested fibre loom that can be installed by non-specialist personnel, vastly reducing the installation time onsite.

IMPORTANT NOTE:

Using pre-terminated assemblies is no excuse for a lack of cleanliness within the Communication Room the fibre connectors are still susceptible to air borne contamination, the rules regarding inspection and cleaning prior to plugging a connector into a device or patch panel outlined earlier remains the same.

Field Testing Overview

In order to test the performance of a Fibre system several key measurements need to be carried out, these can include some or all of the following:

- End-to-end optical link loss
- Rate of attenuation per unit length
- Attenuation contribution of splices, connectors and couplers
- Length of the fibre or distance to an event
- Linearity of fibre loss per unit length
- Reflectance or optical return loss (ORL)
- Chromatic dispersion (CD)
- Polarisation Mode Dispersion (PMD)
- Attenuation Profile (AP)

Other measurements such as bandwidth may also be performed.

Some measurements require access to both ends of the fibre, such as Tier 1 optical loss testing, others require access to just one, such as Tier 2 testing with an OTDR.

Field Testing of Fibre cables falls into three group: installation, maintenance and fault finding/rectification.

The following provides a summary of each of these topics, the exact details of which depends upon the system design and the contractual requirements as outlined in the Systems Specification as detailed by the Client or their representatives.

Installation Testing

Pre-Installation Tests

Prior to installation, perform fibre inspections to ensure that the cables received conform to the right specifications of the project (Category, Length and Attenuation) Also ensure that all connectors, pigtails and couplers, meet the requirements along with the end-face condition (particularly if pre-term assemblies have been supplied) have not been damaged in transit.

Installation and Commissioning Tests

During installation ensure that the area involved with the termination of the fibre is kept clean at all times and prevent the introduction of dust and debris, as this will have a major impact on the quality of system that will be handed over.

Perform tests to determine the quality of cable splices and terminations including, end-face condition, attenuation, location and reflectance. Also carry out testing to ensure the installed system is suitable for the intended application. All these tests should be recorded and provided both to the customer as well as Excel Networking as part of the warranty application.

Maintenance Tests

Maintenance testing involves periodic evaluation of the fibre cabling system to ensure that no degradation of the cable, splices or connections has occurred. The first stage of this should always be inspection of the end-face to ensure that no contamination has been introduced during the operation of the system. Other tests include cable attenuation along with attenuation and reflectance of splices and terminations.

It is the responsibility of the Client or their representatives to define the regularity of this testing.

Fault Finding and Rectification

During fault finding and rectification perform testing to first identify the cause of the fault (transceiver, cable, connector, patch cord) as well as the location of the fault.

Once rectification has been successfully completed carry out testing of the repaired system following the guidelines covered in 'Installation and Commissioning Tests'.

Configuring Test Equipment

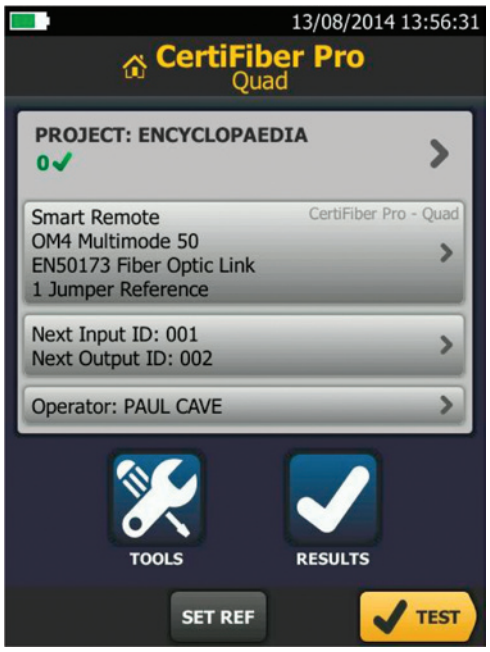
Fibre Testing – (Tier 1)

Excel requires Fibre testing to be carried out using a Power Source and Light Meter, sometimes referred to as Fibre Loss Testing, this should be completed using the One Jumper Reference Method, the following section will guide you through what is required and how to set up a Fluke DSX 5000 fitted with Certifber Quad Fibre Modules for Multimode testing, if you testing Singlemode or using any one of the other authorised testers please refer to the Test Equipment Instruction Manuals.

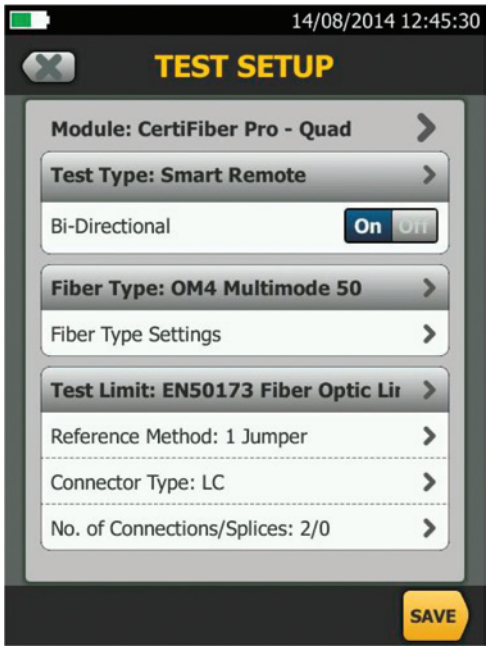
We suggest that you carry out the complete set up prior, to attaching the launch leads and referencing the two units. A lot of people shy away from fibre because they think it is difficult, however from the following you will actually see how simple and easy it really is.

Carry out of setting up the PROJECT INFORMATION as outlined in the Copper Section

However as soon as you attached the Certifiber Modules the DSX 5000 is intelligent enough to recognise this and starts part of the process for you as at the top of the Home Screen it shows the modules fitted.



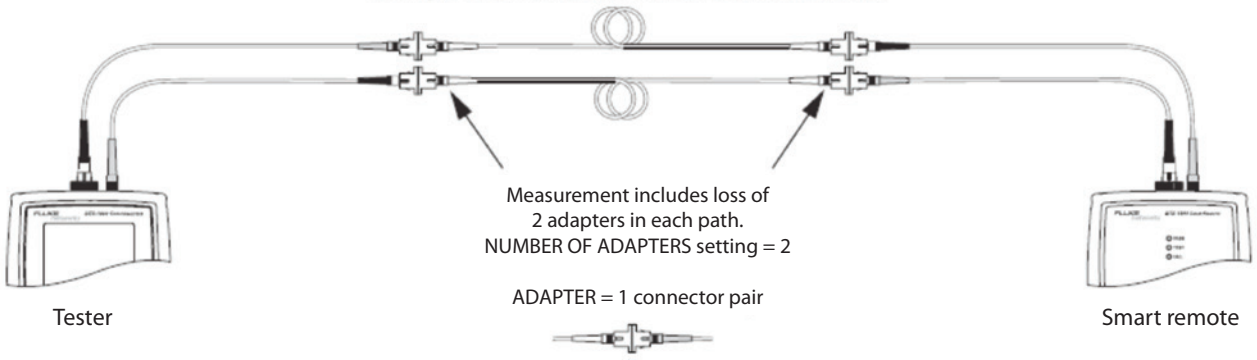
Select TEST LIMIT and you will have a number of options, once more we want to select the EN50173 Standards, if it isn't in the LAST USED list use the same process as previously described.



You will then have to change some of the other settings, ensure that Test type is SMART REMOTE and Bi-Directional is ON. Fibre Type is correct

The next stage is one of the most important during the set up phase, enter incorrect information at this stage and you WILL get incorrect results, you are setting up the 'Loss Budget' for the link you are about to test, get this wrong and successful passes will be reported as failures.

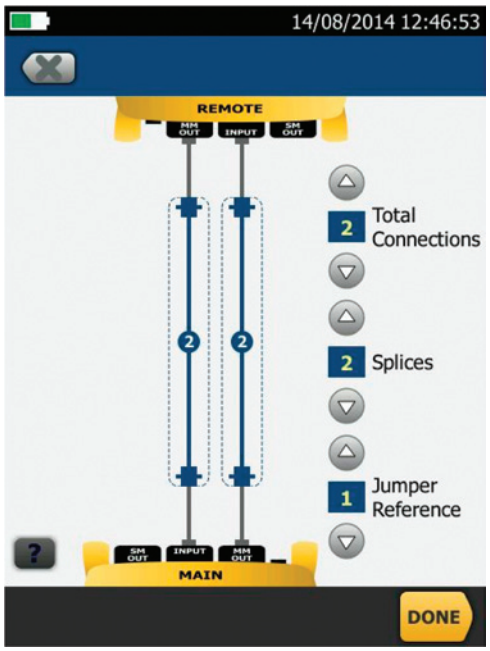
Example of Smart Remote mode test connections



You must therefore enter the correct number of Adaptors in your link as well as the correct number of Splices, (within Patch Panels etc.)

Underneath the Test Limit on the TEST SETUP Screen, there are 3 settings: Reference Method should always be 1 Jumper.

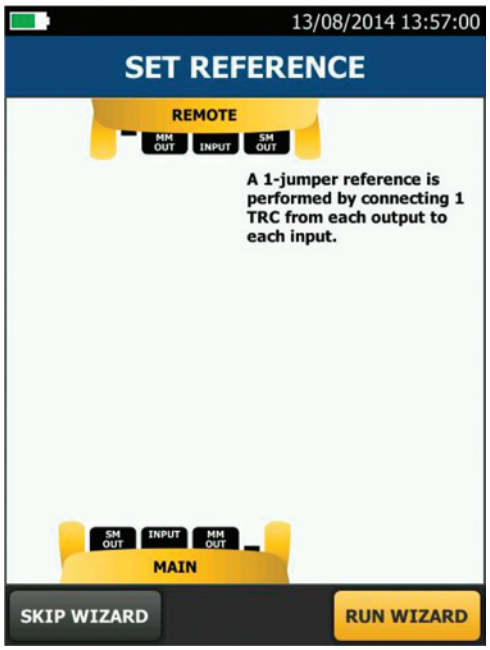
The next is the Connector Type the last one covers the number of Connections/Splices, select this and it will bring up the next screen.



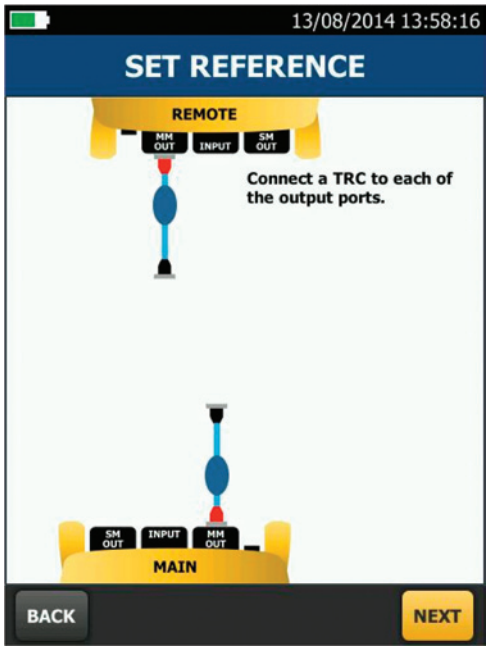
Once you have selected the right number for each item select DONE and you will be taken back to the TEST SETUP screen.

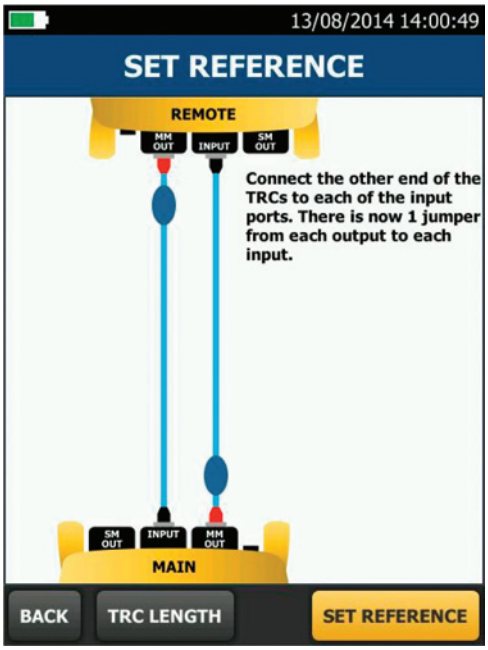
The final part of the setting up the test is to Reference the Fibre Test Leads. Select HOME, when the Home Screen appears; Select the additional icon SET REF.

This brings up the SET REFERENCE Screen, which provides two options.

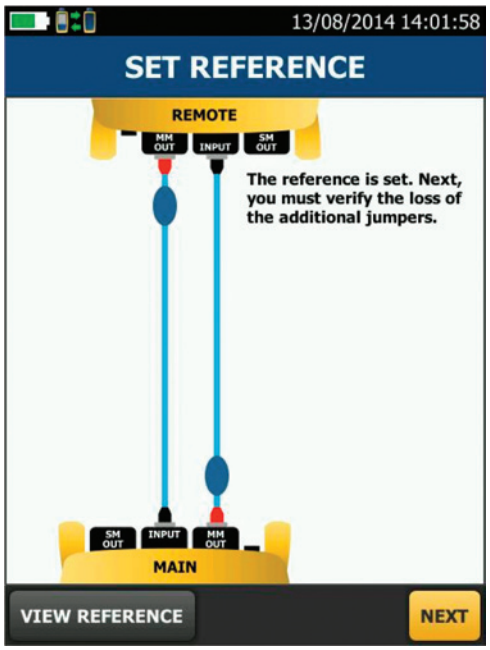


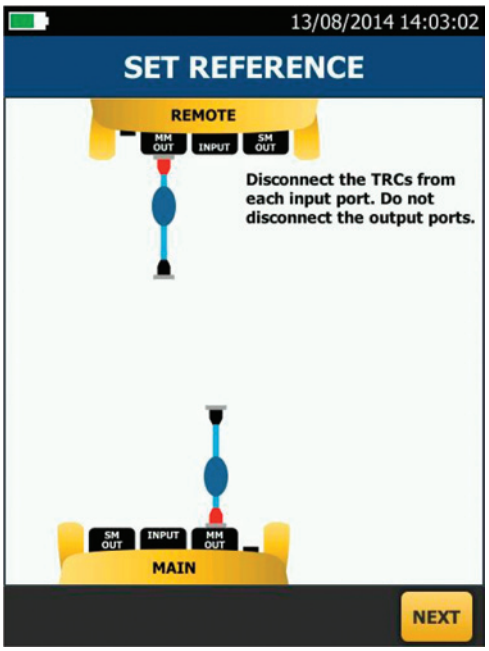
To ensure that you complete this important phase correctly select RUN WIZARD, this will take you through all the steps required.



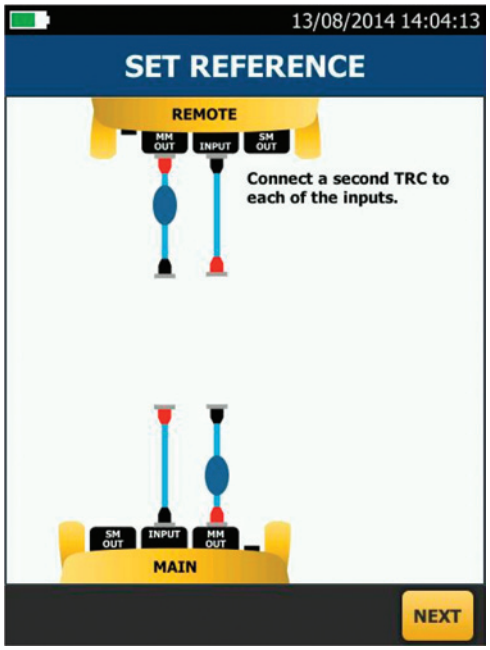


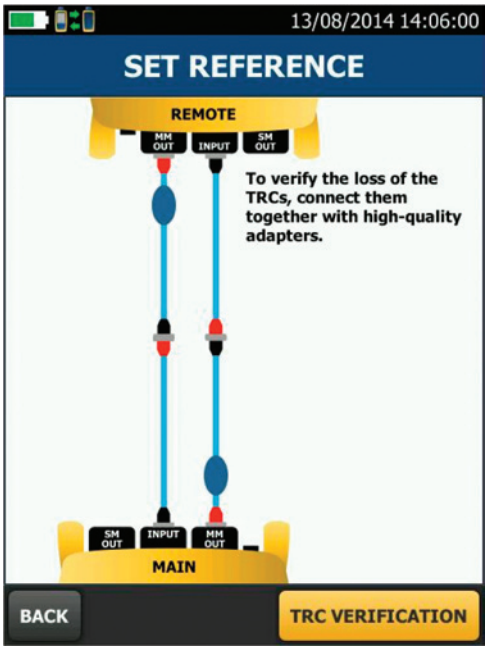
Once the units are connected Select SET REFERENCE



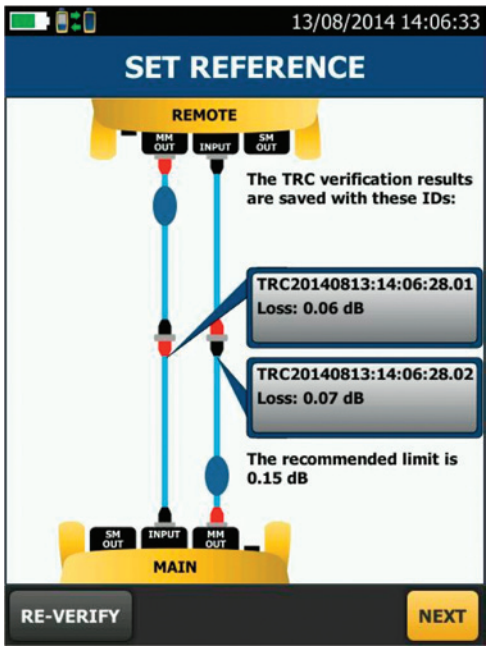


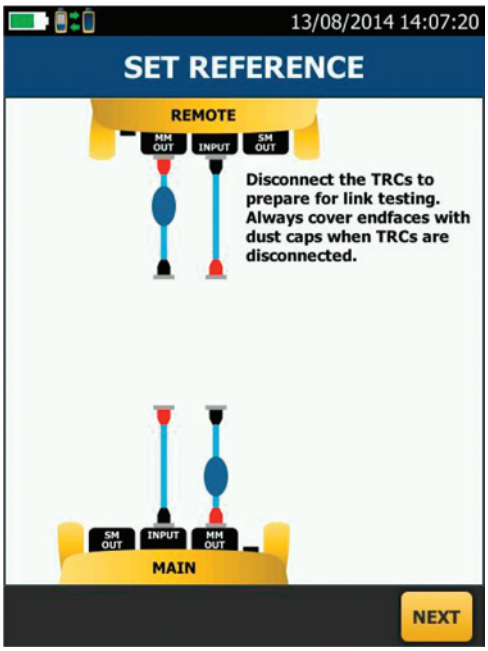
After each step select NEXT

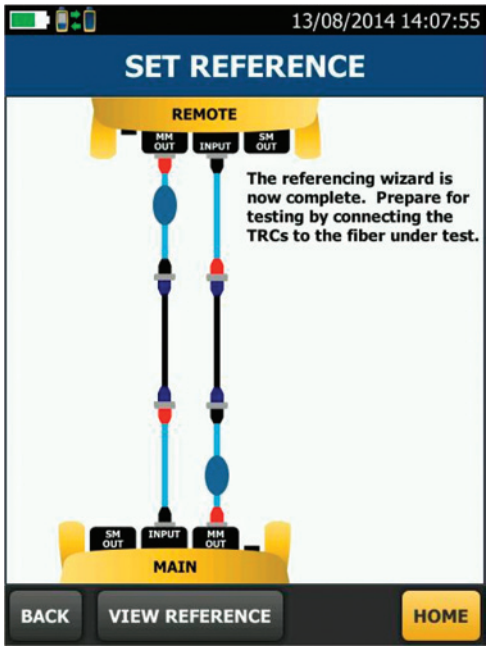




Select TRC VERIFICATION, this brings up the values of the leads that have been Referenced Out.







By selecting HOME it takes you back to the Home Screen, once there quickly verify the details and you are then ready to start testing.

You are now ready to start testing the fibre links. The process for setting up to Singlemode Links is almost identical.

If there are any doubts on how to set up you tester for a specific project it is recommended that you call Excel Technical Support, prior to commencing to avoid any confusion and delays with warranty applications at a later stage.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