



AROONA-P2P

A new youth for your LAN

Don't be limited to 100 Mb/s!
AROONA offers up to 4 x 10 Gb/s,
without changing fibers

Instruction Manual

CAILabs
Shaping the light



AROONA-P2P

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1. INTRODUCTION

The AROONA series grants your LAN a new youth. AROONA devices are spatial multiplexers/demultiplexers that enable you to upgrade multimode link capacity. AROONA-P2P allows for each mode group to function as an independent transmission channel and in so doing, is able to upgrade transmission capacity up to 4 x 10Gb/s on a point-to-point multimode fiber link.

This manual presents the AROONA-P2P solution along with its technology and user instructions. This user guide also addresses how to install and connect AROONA-P2P equipment to your optical link.



1.1 AROONA-P2P Series

AROONA-P2P exists in several versions, each responding to the same need of increasing bit rates in multimode fiber networks but for different distances. There are 2 AROONA-P2P series: AROONA-P2P 800 and AROONA-P2P 2000+.

PARAMETER	AROONA-P2P 800	AROONA-P2P 2000+
Bit rates	4 x 10 Gb/s	4 x 10 Gb/s
Maximal distance	800 m	10 km

NB: for a multimode fiber link of 850 m for example, AROONA-P2P 2000+ is recommended. Proper functioning of AROONA-P2P is not guaranteed if used beyond its maximal recommended distance.

The instructions given in this guide are applicable to all AROONA-P2P series (AROONA 800 and AROONA 2000+).

1.2 Technical support

If you encounter any problems after reading this manual or when using AROONA equipment, please contact CAILabs' technical support.

To contact technical support:

Web: www.cailabs.com/support

Email: contact@cailabs.com

Phone: +33 9 77 21 63 96

1.3 Warranty

CAILabs' products are warranted to be free from defects according to article 10 "Warranty" of the General Terms and Conditions valid at the moment of purchase.

2. PRODUCT OVERVIEW

2.1 Description

CAILabs' AROONA-P2P is a spatial multiplexer/demultiplexer placed on a rack for mode group multiplexing. Single-mode input channels are simultaneously converted into distinct mode groups of a standard multimode fiber, in an efficient and flexible way through Multi-Plane Light Conversion technology (MPLC). This conversion is achieved through high mode selectivity and coupling efficiency.

2.2 MPLC technology and mode group multiplexing

Standard multimode fiber with gradient index profile, OM1-2-3-4 type, has linear polarized modes called LP with degenerate propagation constants LP_{ij} . Degenerate modes couple very strongly within their mode group, while modes from distinct mode groups are much more isolated and can be considered as independent transmission channels within the same optical fiber.

Standard multimode fibers can support dozens of modes divided into few mode groups. The AROONA solution uses the first 4 mode groups:

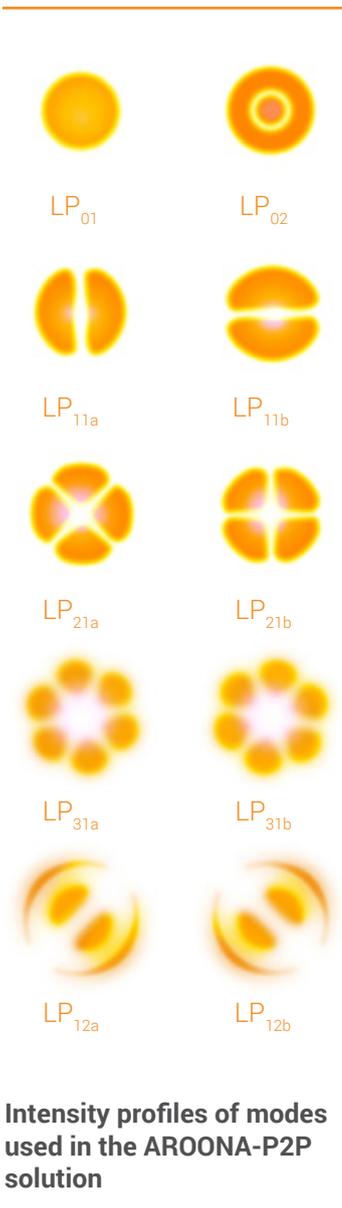
- Channel 1 : LP_{01} mode
- Channel 2 : LP_{11a} and LP_{11b} modes
- Channel 3 : LP_{21a} , LP_{21b} and LP_{02} modes
- Channel 4 : LP_{31a} , LP_{31b} , LP_{12a} and LP_{12b} modes

Spatial multiplexers and demultiplexers must cover performances of each mode group.

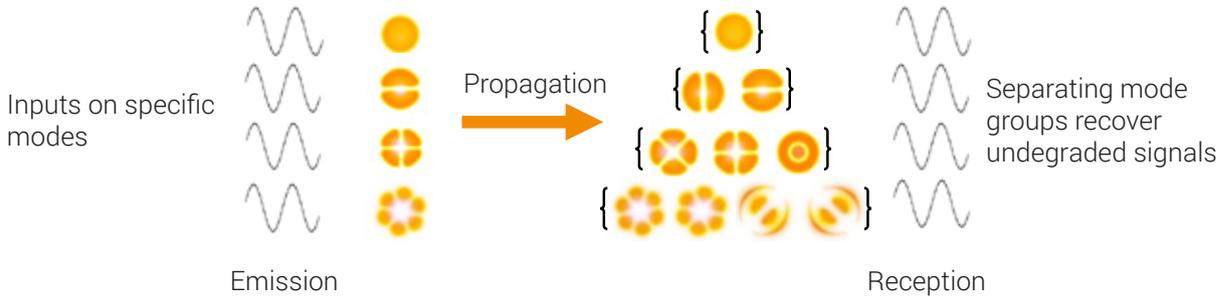
More precisely, during the multiplexing phase, only one mode of the utilized mode group is excited. During propagation in the fiber, due to the large intra-mode group coupling, all modes of this group will be excited. It is necessary to detect all modes of each group at the receiver in order to detect all transmitted data.

Spatial multiplexers and demultiplexers integrated in the AROONA solution are based on MPLC technology, which was patented in 2009.

Mode group multiplexing is obtained through the use of just 4 fiber inputs of the multiplexer, so as to excite LP_{01} , LP_{11b} , LP_{21b} , LP_{31b} modes. Mode group demultiplexing is achieved by demultiplexing the global 10 modes and then summing the powers of each mode from a same group so that there is one fiber per mode group at the demultiplexer output.



This last step of optical power summation within a same mode group is also performed by MPLC technology.

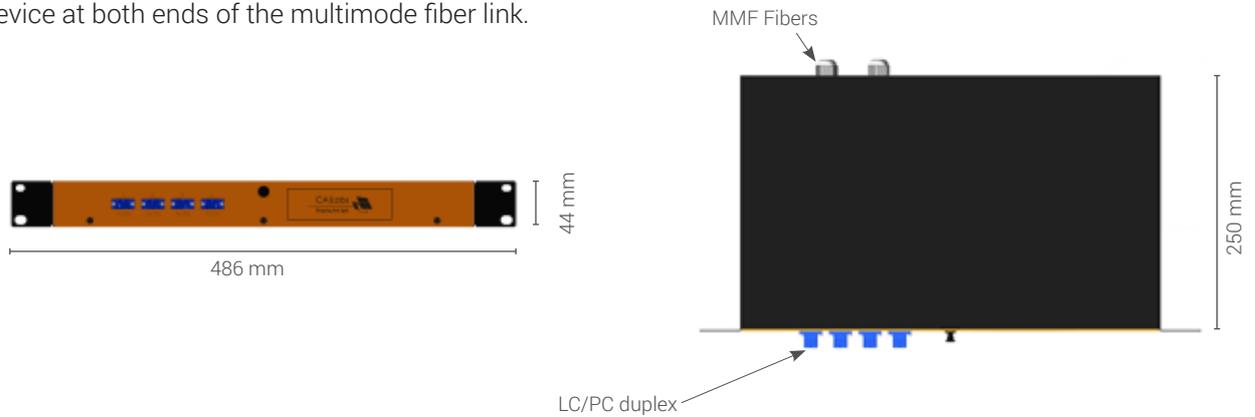


Spatial multiplexing and demultiplexing through MPLC technology enables AROONA-P2P solution to have high mode selectivity and avoid crosstalk between different transmission channels.

2.3 Technical specifications

AROONA-P2P equipment dimensions:
H: 44 mm x L: 486 mm x P: 250 mm (1U 19" rack)

To implement the AROONA-P2P solution, it is necessary to install one device at both ends of the multimode fiber link.



AROONA-P2P equipment's technical specifications:

PARAMETER	AROONA-800	AROONA-2000+
Wavelength	C-band (1550 nm)	
Signal distance	< 800 m	Jusqu'à 10 km
Number of channels ¹	4	
System capacity	From 10 Mb/s to 50 Gb/s per channel independent bit rates on each channel	
Insertion loss of one Multiplexer	< 4 dB (usual : 2,5 dB)	
Isolation between channels	> 15 dB	
Communication protocol	Transparent to standard protocol (Ethernet, Fiber Channel, SDH, etc)	
Transceivers compatibility	All types of singlemode transceivers (Rx PIN) Form factor: SFP, SFP+, XFP, GBIC, XENPACK, X2 Recommended specifications: 1000BASE-EX, 10GBASE-ER	

¹subject to link complexity

3. GETTING STARTED WITH AROONA-P2P EQUIPMENT

There are 2 AROONA-P2P devices in each pack:

AROONA racks are 19" 1U drawer racks.

In each AROONA-P2P rack there is a small bag of consumables required for the installation process, which includes:

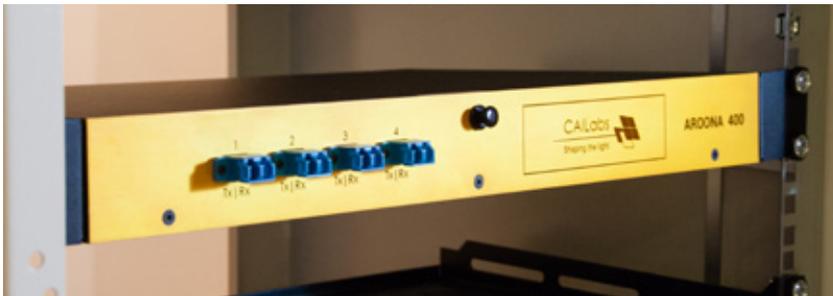
- 4 M6 cage nuts
- 4 M6 pan head screws
- 4 M6 black nylon flange washers
- 4 plastic bases
- 8 plastic straps
- 2 white stickers
- 5 thermo-retractable sheaths (from 3 mm to 1 mm)
- 2 thermo-retractable sheaths (from 6 mm to 2 mm)
- 4 thermo-retractable fiber fusion splice protection sleeves
- 1 splicing tray

AROONA-P2P equipment is sent by CAILabs ready to work. No configuration is necessary once the installation process is completed.

4. EQUIPMENT INSTALLATION

4.1 Recommendations

This section describes the installation of AROONA-P2P racks (H: 44 mm x L: 486 mm x P: 250 mm, 1U rack) on a standard 19-inch storage bay as well as the connection to the multimode fibers to be upgraded. The following instructions and operations listed below have to be performed on each end of the link in order to be upgraded.



For safety reasons, CAILabs advises that the installation be completed by two people.

Choose the space for the AROONA-P2P rack in such a way so that it is not far from the optical drawer in which the fiber you wish to upgrade is located. Each AROONA-P2P contains a 10-meter long fiber emanating from its backside. Make sure that the distance between the AROONA-P2P fiber and the fibers to be upgraded is long enough to splice the fibers together.

Warning: To prevent injuries during product fixation in the storage bay, make sure the system is stable.

4.2 Connection setup

a. Your optical drawer

1. Open the optical drawer in which the fibers are located and identify the multi-mode fiber pair you wish to upgrade. If fiber identification is unclear, find a way to easily identify them for the remainder of the process.
2. Cut the connectors at the end of the fibers.

Warning : The fiber lengths available are usually short. It is important to maximize available fiber length to facilitate splicing operations.

a. Your optical drawer



b. AROONA-P2P rack



b. AROONA-P2P rack

1. First of all, it is necessary to prepare the multimode fiber initially placed on the AROONA-P2P rack.
2. Open the drawer of the AROONA-P2P rack. Unwind the quantity of fiber required so that you can link the AROONA-P2P rack to the rack where the production fibers are located. Make sure you have more fiber length than necessary. Be careful not to bend or constrain the fiber. Place the wound fiber in designated excess fiber organization zone in the rack.
3. Pass each fiber through the designated cable connector: the fiber with arrows going out of the box must pass through the «OUT» cable connector and the fiber with arrows going into the box must pass through «IN» cable connector. Screw the cable connectors so that the fibers are blocked.
4. Close the AROONA-P2P drawer rack with the rivet.
5. Insert the AROONA-P2P rack in the network storage bay.

NB1: In case the AROONA-P2P rack needs to be placed above the upgraded fiber rack, we advise that the AROONA-P2P rack is placed in a non-risk area around or at the bottom of the bay so that you can easily access the fiber you wish to upgrade. Splice the fibers, and then insert the AROONA-P2P rack into the bay.

NB2: Make sure you have easy access to fibers before inserting and fixing the AROONA-P2P rack in the storage bay.

The AROONA -P2P rack has to be fixed to the frontside of the storage bay with the 4 cage nuts and 4 screws provided. In a partially filled storage bay, charge it from bottom to top and make sure the heavier equipment is placed at the bottom.

If a stabilization system is provided along with the storage bay, please install it first before fixing the AROONA rack.

Note: AROONA-P2P is a passive solution and it is therefore unnecessary to ground the equipment.

4.3 Connection of AROONA-P2P equipment to multimode production fibers

a. Splicing principle

Fiber connection must follow certain rules and methods to ensure:

- respect of fiber and cable bending radius;
- a pathway for fibers limiting breaking risks, and post installation macro or micro bending;
- an identification of different connections and fibers in to ensure ease the use and network evolution.

When the AROONA-P2P rack is fixed to the rack of upgraded multimode fibers in the storage bay according to accessibility conditions, the next step is to perform the splice between the output multimode fiber from AROONA-P2P rack and the deployed multimode fiber to be upgraded.

Note: Splicing is the most important step during AROONA-P2P installation. A poor-quality connection will have a significant impact on AROONA-P2P solution performance.

There are 2 splicing methods: mechanical splicing and fusion splicing.

- Mechanical splicing is performed with a tool that aligns fiber cladding and maintains fiber contact.

Warning : To use AROONA-P2P equipment under optimal conditions, we strongly recommend you do not use mechanical splicing for the connection.

- Fusion splicing is achieved with a fusion splicer that aligns and connects two prepared fibers by merging with an electrical arc. It is necessary to prepare fibers beforehand so that they can be spliced by fusion.

For the connection process, you must have the following set of tools:

- Optical fusion splicer¹
- Lint-free wipers²
- Cleaning solvent for fibers (isopropyl alcohol or isopropanol or ethanol)³
- Kevlar scissors⁴
- Stripper for cable and optical fiber⁵
- Optical fiber cleaver⁶



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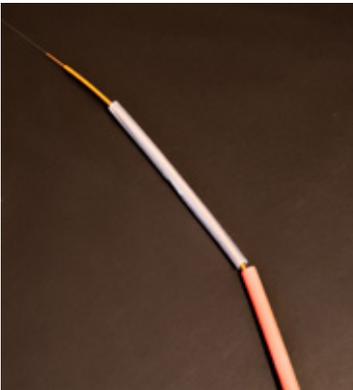


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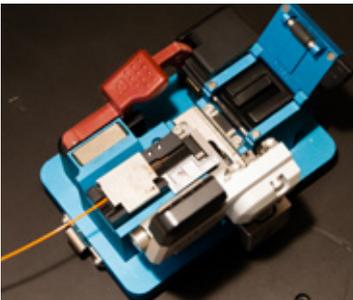


b. Splicing process

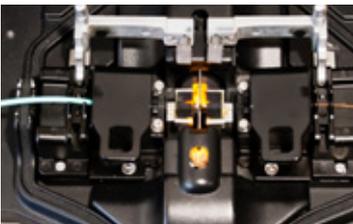
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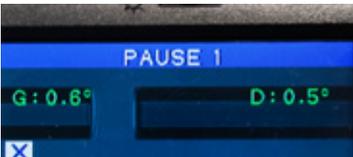
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6.



7.



- Thermo-retractable fiber fusion splice protective sleeves⁷
- Thermo-retractable sheaths⁸

Note: Splice protective sleeves and thermo-retractable sheaths are provided with each AROONA-P2P rack.

b. Splicing process

To perform a splice follow these different steps:

1. Identify the two fibers you wish to splice together (production fiber and the AROONA output fiber).

Note: You may use the white stickers provided to help identify production fibers.

2. Prepare both fiber ends for the splicing process. Bare a few centimeters (3 to 6 cm) of the fiber with the stripper. You must first cut the connector of the production fiber. According to cable structures, it may have few layers to bare (1-3 mm plastic cladding, Kevlar protective, 900 µm plastic coating and 250 µm polymer coating)

Note: Use adapted scissors to cut the wired Kevlar structure and an adapted stripper for each cable diameter.

3. Thread splice protective sleeve and thermo-retractable sheath before the following cleaving operation.
4. Properly clean the nude part of the fiber with the solvent and lint-free wiper.
5. Pick up the cleaver, which allows you to precisely cleave the fiber at an angle of 90°. This tool is necessary to connect the two fibers at an identical cutting angle. The fiber is cleaved by a "scratch and break" method.
6. When the fibers to be connected are cleaved, place them in the designated guide in the optical splicer (V-groove, holder, ...).

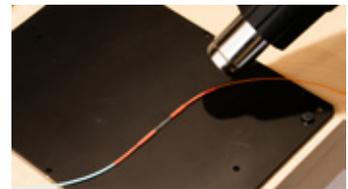
Note: If you forget to thread the splice protective sleeve, pull the fiber out, put the protective sleeve on and then repeat the cleaving operation.

7. Examine cleave quality on the splicer control screen. The end of the fiber should appear flat with no defects, ridges or cracks that spread into the fiber core. Additionally, CAILabs recommends there be a minimum cleave angle of 2° for optimal splicing. If you find the cleave quality insufficient, it is better to repeat the operation before placing the fiber in the optical splicer.
8. On the optical fusion splicer, select the mode for standard multimode fibers (MM = multimode = cladding alignment).

9. Start the splice in automatic mode.
10. When the splice is done, gently remove the fiber from the fusion splicer.
11. Put the protective sleeve on the splice to cover the bare part of the fibers.
12. Put the splice protective sleeve in the shrinking oven of the optical splicer. The protective sleeve protects the spliced fiber in order to reinforce the bare area which can be potentially weakened.
13. The splice protective sleeves are available in several sizes: 40 mm, 45 mm and 60 mm. CAILabs advise you to use a 60 mm protective sleeve in order to cover all the fibers' bare area (125 μ m cladding diameter).
14. Next, place the thermo-retractable sheaths over the splice protective sleeve. Heat the sheath with a heat gun. The thermo-retractable sheaths will cover and protect the fiber cable's bare area.
15. When the splice operation is completed, replace the fiber in the original rack of the multimode fibers to be upgraded. A splice tray is provided for that, but not essential. If there is not sufficient space to insert the splice tray, secure the splice protective sleeve with scotch tape to the rack.
16. Close the multimode fiber rack. If there is excess optical cable at the output of the AROONA-P2P rack, wind this part of the fiber cable and fix it to the storage bay with the plastic strap provided.



12.



14.

4.4 Connection of different fiber sections in case of intermediate connectors on the link

It is possible that the multimode fiber link to be upgraded is made up of a concatenation of different fiber sections, with potential intermediate optical patch cords in network bays. These intermediate connection points imply the presence of optical connectors.

Optical connectors have eccentricity tolerances of a few micrometers which do not allow an optimal optical core alignment for mode group multiplexing. These intermediate connectors must be removed in order to ensure proper modal alignment and increase transmission performances over the multimode link.

MPLC technology actually allows distinct modes to be excited within the optical multimode fiber. This precise modal excitation must be preserved throughout the transmission in order to overcome the physical phenomenon of modal dispersion which naturally limits the bandwidth of multimode fibers

To avoid modal misalignment due to intermediate connectors, you must replace each connector by fiber splicing.

Note: A reflectometry measurement of the link to be upgraded may allow for the identification of all intermediate connectors.

5. USING AROONA-P2P

5.1 Transceivers compatibility

The AROONA-P2P solution is compatible with all types of commercial single-mode transceivers which can be found on the active network equipment of various manufacturers (SFP, SFP+, XFP, XENPACK, X2, GBIC).

Transceivers are available with a large range of transmitters and receivers. It allows users to select a transmitter-receiver couple with an appropriate optical budget to ensure proper fiber distance range.

It is recommended that single mode transceivers over C-band (~1550 nm), such as 1000BASE-EX for 1 Gb/s bit rate or 10GBASE-ER for 10 Gb/s bit rate are used with AROONA-P2P equipment.

Additionally, AROONA equipment is transparent to the communication protocol used (Ethernet, FiberChannel, SONET/SDH, OTN, etc.)

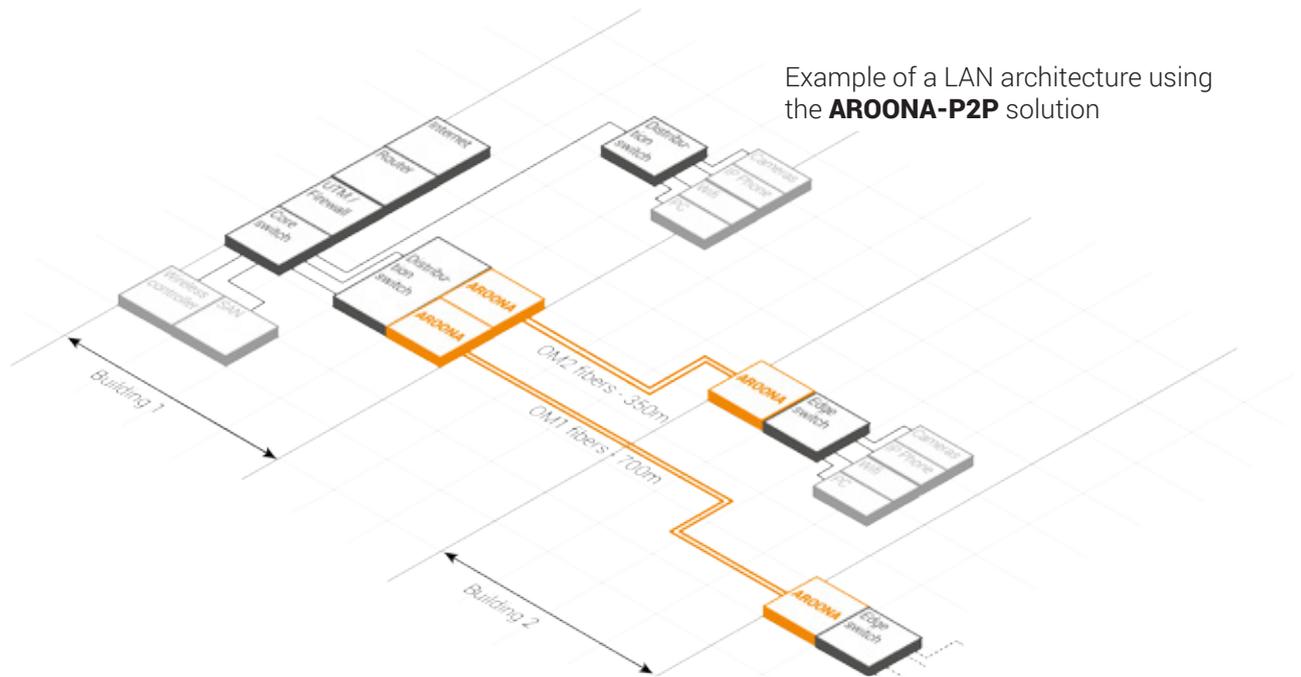
5.2 Operating AROONA-P2P

The AROONA-P2P solution can be used on several types of networks. This solution is recommended for upgrading a point-to-point fiber link.

AROONA-P2P devices must be placed on both ends of the multimode fiber link you wish to upgrade.



Once the AROONA-P2P has been installed, that is, when splicing between multimode fibers and AROONA-P2P is completed, and the intermediate connectors have been replaced by fiber splicing, you can then operate AROONA-P2P.



Each AROONA-P2P channel can be used independently.

To use a transmission channel, first make sure that the correct transceiver is inserted into the switch on both sides of the upgraded fiber link.

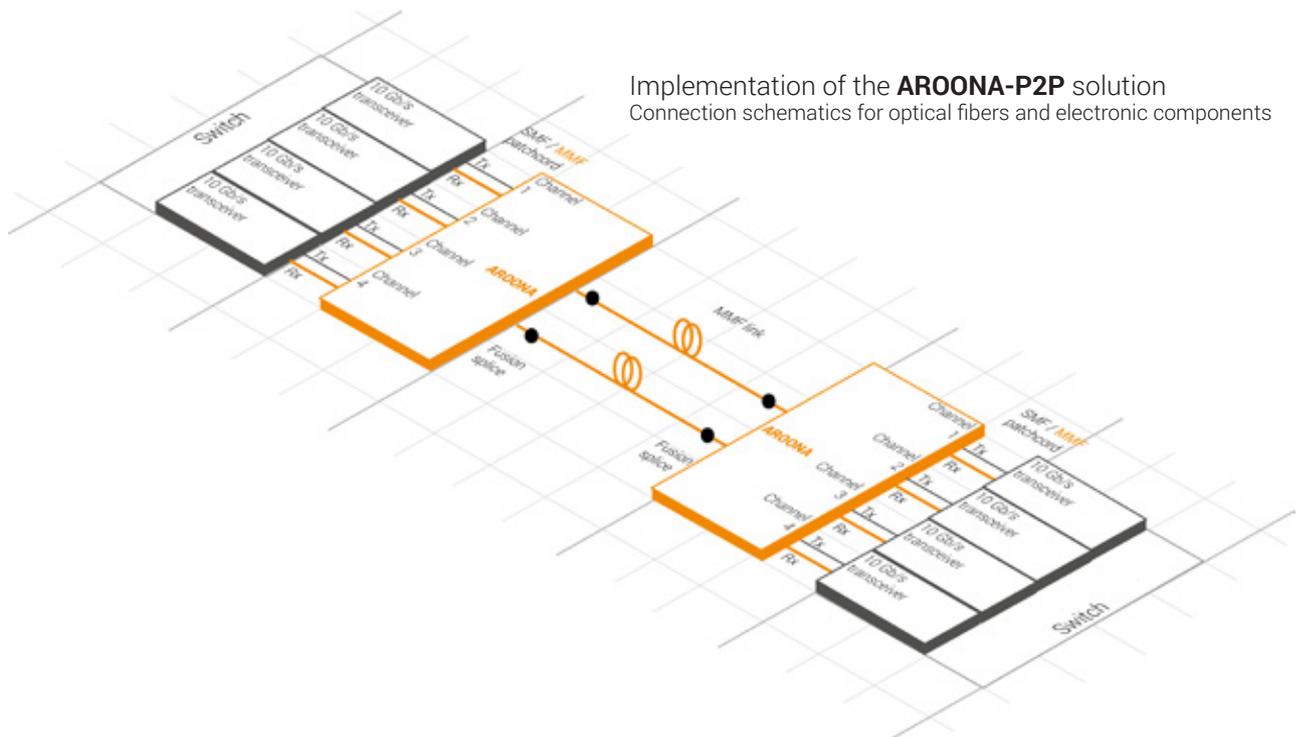
Take two optical patch cords to connect the transceiver to the AROONA-P2P rack:

- 1 single-mode fiber simplex patch cord (SM - 9/125 μm): **the output Tx of the transceiver must be connected to the input Tx of the channel in use by a single-mode fiber patch cord.**
- 1 multimode fiber simplex patch cord (MM - 50/125 μm): **the input Rx of the transceiver must be connected to the output Rx of the channel in use by a multimode fiber patch cord.**

Insert the patch cord connector into the transceiver port. Put the opposite end of the optical patch cord in the channel port. Repeat the same procedure for each of AROONA-P2P channel you wish to operate.

Remarks:

- Make sure you respect the rules regarding **connection with single-mode and multimode patch cords**. Otherwise, the AROONA-P2P solution may not function properly.
- The suitable transceivers that can be used with AROONA-P2P are listed in section 5.1 of this guide. For detailed instructions on installation, removal or connection of transceivers modules, please refer to the guide provided with the transceiver or switch.



6. TROUBLESHOOTING

6.1 Cleaning instructions for connectors

Under proper conditions of use, AROONA equipment requires little maintenance. The only potential maintenance for the user is cleaning the optical connectors.

If an AROONA-P2P channel is not used, we advise that the connectors' protective cap be left on in order to prevent the accumulation of dust on the fiber end, which could lead to additional losses when operating this channel.

A reliable fiber network must have clean and well-maintained connectors. Before inserting a connector, it is essential that it be clean, with no defects.

To clean the input and output connectors of a channel, refer to the standard cleaning procedure of a LC/PC connector.

There are two cleaning methods: cleaning with a solvent and dry cleaning. Combining both methods allow for the removal of all contaminants on a connector extremity.

a. Dry cleaning

This type of fiber cleaning is most efficient when contaminants are small dust particles or solvent residues.

Use dry air spray to clean. Spray it on the end of the connector or on an input or output connector jumper of a channel so that you can clean the connectors within AROONA-P2P equipment.

There are certain dry cleaning systems which exist in the form of cartridges (ReelCleaner/ Cletop), with which only a few straight back-and-forth movements with the cleaning wipe's connector are necessary to remove impurities.

For AROONA-P2P equipment connectors, there are certain dry cleaning systems such as CleanConnect) which allow you to put the tool inside the connector jumper on the frontside of the rack and properly clean it.

Because the AROONA-P2P rack is a drawer rack, it is possible to open the rack, remove the connector and clean it directly.

a. Cleaning with a solvent

The goal of this cleaning method is to remove dust, grease and hand sebum residue from a connector without scratching or damaging it. For patch cord connectors, use optical cleaning paper/wipes (generally in polyester and cellulose).

Soak a small quantity of appropriate solvent (isopropyl or isopropanol alcohol) on a wipe. Next, place the end of the connector on the moist part of cleaning wipe.

Make a few gentle straight back-and-forth movements, without applying too much pressure on the connector, from the moist part to the dry part, without lifting the connector. Avoid circular movements because the contaminants removed could potentially drop onto the optical side of the connector. Two or three movements are sufficient. Do not place the connector on the same place on the wipe.

For AROONA-P2P connectors (input/output channels), we suggest the use of a non-fluffy cotton ball for optical cleaning. With or without a solvent, you have to carefully work your way into the connector. Do a few gentle rotations with the cotton ball so that you can remove contaminants at the extremity of the connector.

Note: If you have an inspection tool (microscope or inspection probe), check the connector extremity to make sure there is no residue left and that the connector is not scratched or damaged.

6.2 Diagnostic of dysfunctions

AROONA-P2P is a passive device and rarely has technical failures.

If you detect some unusual losses in the system, follow the instructions on the cleaning of LC/PC connectors of the channel in question.

If the problem persists, make sure there is no bending constraint on the AROONA-P2P output multimode fiber (bending radius has to be higher than 2 cm).

If excessive losses are still being detected, there is definitely an issue with the splice quality between the AROONA-P2P output fiber and the fiber deployed. In such instances, it is best to do a new splice between both fibers. Intermediate connector replacement splices may also be involved in the issue. A reflectometry measurement can help identify which splice is problematic.

When all these steps have been taken and losses continue to persist, please feel free to contact CAILabs' technical support.

6.3 Safety

When the transceiver is connected, optical emissions from the connector output and from the AROONA-P2P output fiber are produced by a laser source and could potentially be dangerous to the eyes (laser class 1/1M).

Unless there is no light source at the other end of the fiber, do not look directly at the optical cable's core. An optical power meter can be used to ensure that there is no light inside the fiber.

It is extremely important to respect the safety rules.

Additionally, fibers themselves present some serious risk as they are composed of glass and can easily break. During splicing operations, make sure that no tiny fragments of glass get into your skin, causing irritations. Wash your hands each time you have handled the bare fiber before eye contact.

Do not open or dismantle AROONA-P2P equipment. The spatial multiplexer/demultiplexer is bound within its box and must remain contained within it. Any opening or dismantling could damage AROONA-P2P equipment and thereby void the warranty.

Handle AROONA equipment carefully. Do not shake the rack. Do not pull on or bend AROONA-P2P input and output fibers.

All instructions regarding technical data in this guide are valid when the equipment is appropriately used as outlined in the conditions of use.



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