



**Dept. of Signal Theory and Communications and
Telematics Engineering
Higher Technical School of Telecommunications Engineers**

GUIDED COMMUNICATION SYSTEMS

Connectorisation and Fusion Optical Fibers

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LEARNING GUIDE

CONNECTORISATION AND FUSION

OPTICAL FIBERS

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1 Introduction

This guide tries to fix the most relevant concepts that have been studied about components, connectors and fusion splices. This lab session has two clearly differentiated parts. On the one hand, there will be an experimental fiber optic connectorization exercise and on the other hand, an optical fiber fusion exercise.

2 Objectives of the lab session

The objectives that are intended with this lab sessions are those that are detailed below:

- To build FC/PC connectors with multimode fiber and loss measurement.
- To fusion multimode optical fibers using a professional and automatic optical splicer.

3 Making optical fiber connectors

In this part of the lab session we are going to make a couple of connectors and we are going to check the losses that we introduce. You will be able to follow the indications of the theoretical classes, with which we will only give below a few explanatory steps of the assembly to be carried out:

1. Prepare the fiber ends and check the cuts.
2. Try inserting the selected end of the fibers into the connector and verify that it protrudes between 1 and 2 cm.
3. Fill a syringe with epoxy and inserting it into the connector, fill it with epoxy until a small ball of it protrudes from the ferrule. Do not allow the ball to be too large, as it would be much more difficult to polish the end of the connector, but also do not allow the hole in the ferrule to go unfilled, as it will weaken the connector.
4. Then insert the end of the fiber until it stops.
5. Lay the connector on some dirty sheet of paper and use the accelerator spray to speed up the curing process. A small amount is more than enough.
6. Wait approximately one minute and check that the epoxy is dry. To do this, you can gently touch the end of the fiber, where there are always traces of epoxy, and check that it is sufficiently dry. You can also pull lightly on the end of the fiber to check that it is sufficiently tied to the connector.
7. Then use the fiber cutter. It should be as close as possible to the epoxy when cutting. To do this, gently grate the fiber with the cut at the point where you want to make the cut, until the fiber breaks.
8. Now the polishing process begins. The normal thing is to have several sizes of sandpaper through what you have to go through, from the one with the greatest grain to the least. However, you have to be careful, since a very common mistake is over-sanded. For this reason, it is important to consider the actual amount of epoxy that we want to remove (which will depend on our ability to form the epoxy bubble on the ferrule). If there is little epoxy, sometimes the wet sandpaper can be

- used directly. In any case, if you deem it convenient, use sandpaper with a greater graininess and draw a maximum of 5 or 6 eights. Check with the light microscope that you have achieved a sufficient initial polish.
9. Go to the water sandpaper. Put a few drops of water and draw 4 or 5 eights. Be careful not to over sand. **IMPORTANT:** When moving from one sandpaper to another, cleaning is essential. Therefore, clean the connector with isopropyl alcohol to ensure that no impurities remain.
 10. Make a second connector of the same characteristics.
 11. Use a bracket to join the two connectors and calculate the losses.

3 How to fusion splicing optical fibers

The automatic fusion splicer model T-201eVS/M4 of Sumitomo automatically pre-examines and aligns a pair of optical fibers with its built-in microscopes, then fuses them with the heat of an electric arc to achieve a low attenuation splice. The splice protector is placed on the bare fiber and heated in the heat shrink oven that is integrated.

3.1 Structure of the fusion splicer model T-201eVS/M4

The structure of the automatic fusion splice T-201eVS/M4 (Figure 1), is the next one:

1. Power button.
2. Touch screen
3. Cover of the splicer (where the fusion takes place)
4. Oven for the shrink protector
5. Input for the connector to the power supply
6. I / O panel

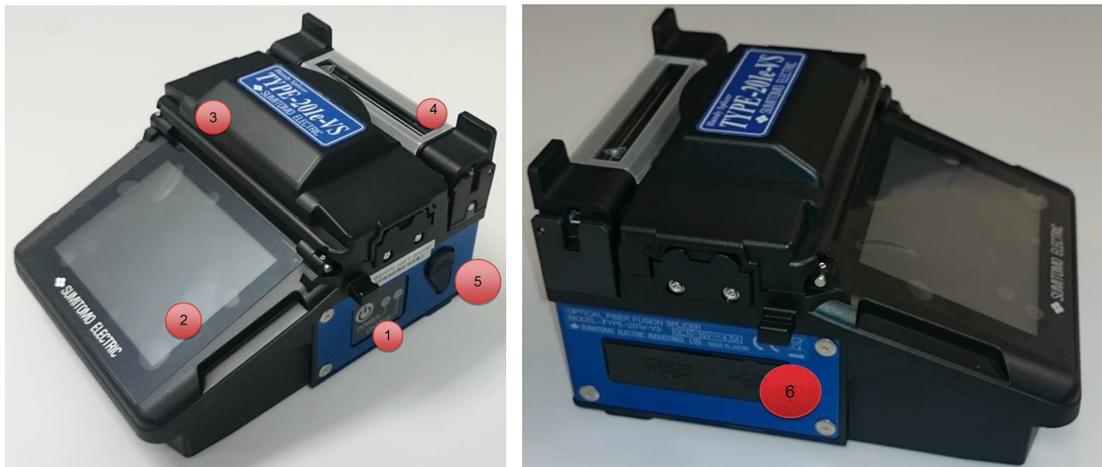


Figure 1. Structure of the automatic fusion splicer model T-201eVS/M4 of Sumitomo.

Once the cover is open (Figure 2), the following elements are observed (remember **DO NOT TOUCH ANYTHING INSIDE UNDER ANY CONCEPT**):

7. Space for Fiber Holders. The fiber holders are pieces to hold the ends of the fiber to be cut. These pieces go in the indicated position.

8. Electrodes: The arc is generated between these two metal tips.
9. LEDs to observe the fiber.
10. Microscope lens used to observe the fiber inside the automatic splicer.

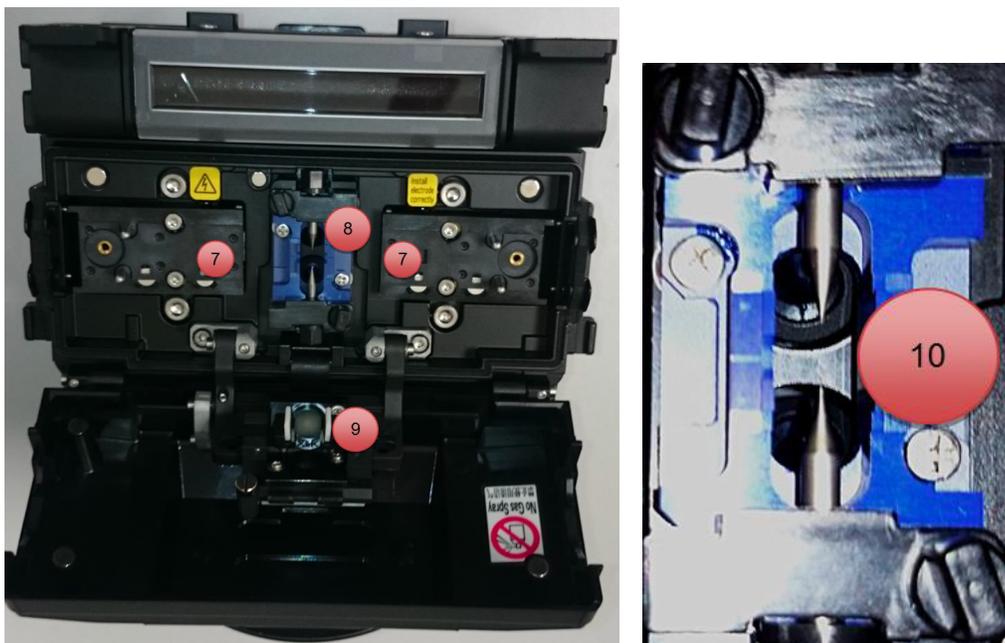


Figure 2. Internal components of the automatic fusion splicer model T-201eVS/M4 of Sumitomo.

3.2 Steps and materials for the fusion splicing and the protection

To make a proper splice you must first have on hand and prepare the following material:

1. T-201eVS/M4 fusion splicer
2. Optical fiber to be spliced
3. Cover peeler
4. Fiber cleaver
5. Isopropyl alcohol (do not bring the splicer near at any time. Work on a different table from the splicer with this liquid)
6. Drying paper
7. Splice protectors

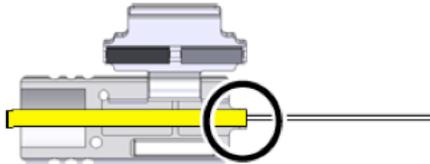
Once you have all these elements, the general steps that you will have to take to carry out a fusion splicer are the following:

1. Strip the fiber coating/Clean the stripped fiber
2. Cut the fiber
3. Place the fiber in the splicer
4. Turn on the T-201eVS/M4 fusion splicer
5. Initial screen

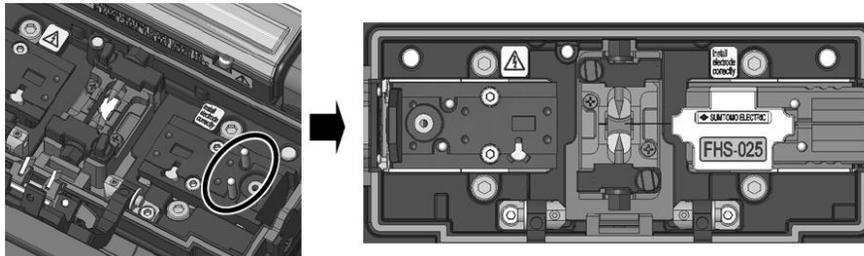
6. Setting the fiber type of the splice protector
7. Arc test
8. Re-prepare the fiber
9. Start automatic splicing
10. Splice evaluation
11. Tension test
12. Splice protection

Place de fiber in the automatic splicer

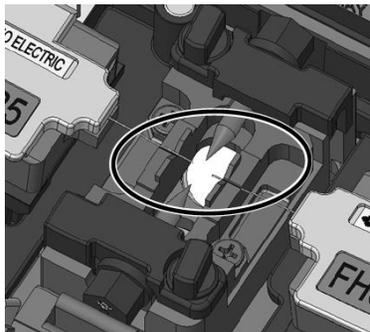
- 1) Carefully place the fiber in the fiber holder of the splicer. Protective jackets must be aligned with the edge of the fiber holder.



- 2) Open the splicer cover.
- 3) Put the fiber holders in position. Be careful to make sure the fiber does not touch any surface. If you touch any surface under no circumstances try to manipulate the fiber, not with your fingers or with any other element. Take out the fiber holder again and reattach it carefully.



- 4) Make sure the fibers are resting on the V-groove



- 5) Close the splicer cover
- 6) Turn it on.

Initial screen of the automatic splicer

Once the splicer starts, you will see a first screen with several icons. The icons are as follows:



: Displays the main menu screen where various options can be selected.



: Displays the splice program you selected.



: Shows the selected oven program.



: Displays the observation screen. The screen changes with each touch X / Y



: Starts the splice program that has been selected



: Starts and cancels the heat shrinkable oven heating process



: Arc test

Splicing program and oven settings

The automatic fusion splicer has several predefined programs that allow you to automatically fuse different types of fiber. You will have to choose one program or another depending on the type of fiber. To change the default program, proceed as follows. Tap the icon of the currently selected auto program (Figure 3).

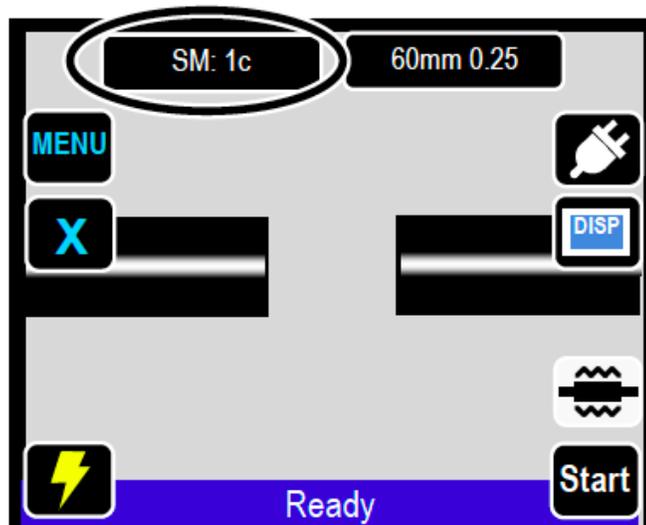


Figure 3. Splicing program and oven settings of the automatic fusion splicer.

This will give you access to a screen where you can select from several available options:

- *Auto*: Can be used to fuse standard identical fibers. You will find three options inside SM (single mode ITU-T G.652), MM (ITU-T G.651), DS / NZ (DSF ITU-T G.653, NZDSF ITU-T G.655)
- *SMF*: Single mode fiber. (ITU-T G.652)
- *DSF*: Dispersion Displaced Single mode Fiber. (ITU-T G.653)
- *BIF*: Single mode fiber insensitive to bending. (ITU-T G.657)
- *MMF*: Multimode Fiber (ITU-T G.651)
- *NZDS*: Single mode fiber with non-zero dispersion. (ITU-T G.655)

Entering each of them, the only option that should be available is *option 1c*, corresponding to the fusion of a single fiber (Fig. 3).

To choose the oven program, since we have 60 mm heat shrinkable protectors, you should keep the program that appears by default (60 mm 0.25).

Arc Test

Before making a fusion between two fibers, it is advisable to calibrate the equipment, since it may have become out of calibration during the process. Therefore, an arc test should be performed. Follow the steps below:

1. Touch the arc test icon
2. The display shows “Arc Ready Test” at the bottom.
3. Touch the “Start” icon
4. An arc test starts. The fiber is not spliced due to being in test mode.
5. One of the following four options may occur as a result of the test:
 - a. Very weak bow
 - b. Very strong bow
 - c. Center arc
 - d. Bow OK
6. If the message is not Arc OK, re-prepare the fiber and retest until Arc OK is obtained.
7. If the message is Arch OK, re-prepare the fiber. BEFORE CUTTING THE FIBER, MAKE SURE YOU PLACE A SPLIT PROTECTOR AT ONE OF THE ENDS.

Starting automatic splicing with the splicer

Once the arc test part is finished, you can start the splicing process. To do this, click on the “Start” icon, and the splice will be carried out automatically, going through the stages shown in Figure 4.

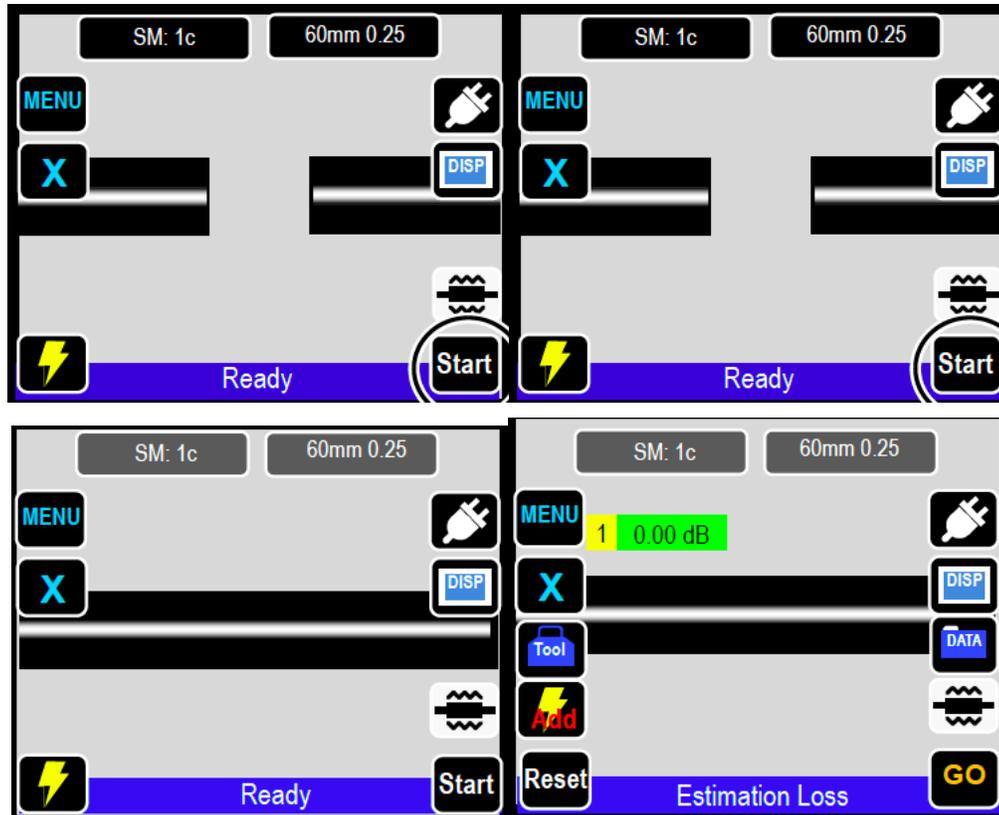


Figure 4. Starting automatic splicing with the splicer.

At the end of the splice, the estimated losses that it will introduce will be indicated.

Splice Evaluation

You can carefully check the characteristics of the splice just made, as it can be observed in Figure 5. To do this, click on the “Data” icon, a table like the one you see will appear, where each column has the following meaning:

- Offset: It is the offset found between the axes of the cores of the two fibers
- CutR: It is the cutting angle found in the right grain
- CutL: It is the cutting angle found in the left fiber
- Gap: It is the distance of the fibers during the formation of the arc
- Irregular: Irregularity found for the left or right fiber
- Losses: Losses that the fiber will have due to fusion.

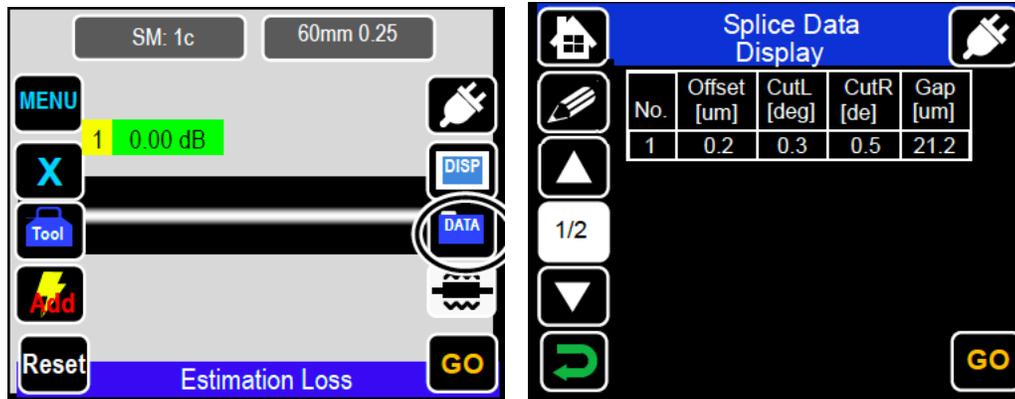


Figure 5. Evaluation of the fusion splice

Finally, a visual inspection of the fusion is possible. This inspection is important as it can detect some problems that the machine may not be able to detect automatically. To enter the visual inspection mode, tap on the “Tool” icon (Figure 6). A magnifying glass will appear, pressing on it will allow you to zoom in on any area of the splice. The sun icon allows you to change the brightness of the image.

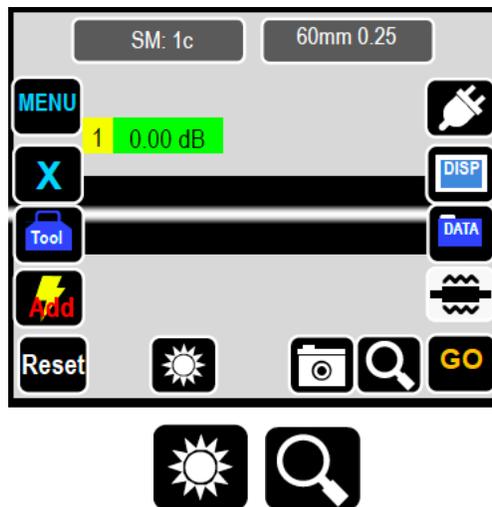


Figure 6. Visual inspection of the fusion splice

Splice tension test

To finish checking the quality of the splice, the splicer is able of carrying out a tension test, that is, checking if the splice is strong enough to withstand tensions.

To start the voltage test, touch the “GO” icon on the main screen, as it can be observed in Figure 7. The tension test will immediately start and cannot be canceled. Once the tension test is finished, the splicer will instruct you to remove the fiber from it.

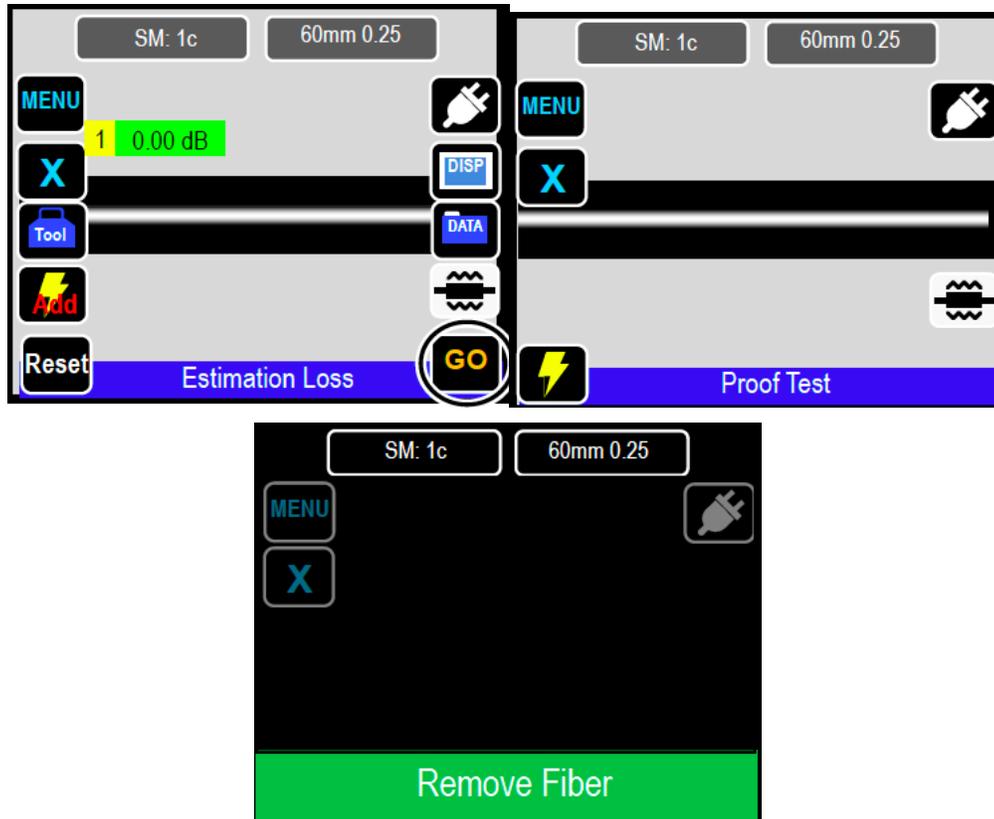
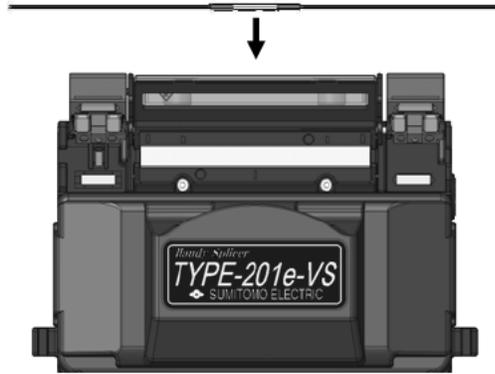


Figure 7. tension test of the fusion splice

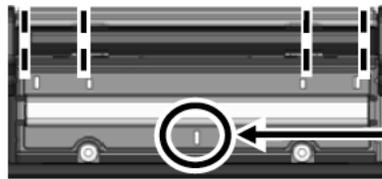
Add splice protection

To protect the splice perform the following steps:

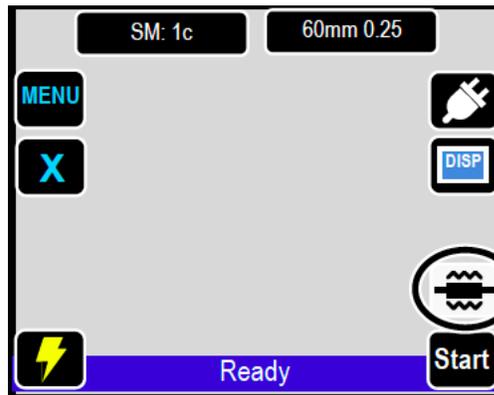
1. Open the lid and tongs of the warming oven.
2. Move the splice protector closer to the holder so that it is easy to position.
3. Open the lid and clamps of the holders to release the spliced fiber (do not try to remove the fiber with the holders, it will almost certainly break)
4. As you remove the fiber from the splicer, place the protector in the area of the splice.
5. Move the splice protector until it is centered (it should catch part of the liners on the left and right)
6. Close the right tab of the oven, capturing the fiber, gently pull the other end of the fiber and while keeping the end of the fiber in tension, place it inside the oven and push down the lid (do not twist the fiber, do not bend the fiber)



- When lowering the fiber in the oven, use the oven markings as a reference so the splice protector is inside the oven.



- Touch the “Heat” icon on the screen. The heating cycle starts (it can also start automatically after the lid is lowered, if so, do not touch anything)



- The oven indicator changes to indicate the current status of the process.



10. When the heating process is finished, an acoustic signal will sound. Take the protector out of the oven at this time.
11. Place the shield on the cooling tray.
12. Once the protector has cooled, check that the procedure has been carried out correctly.

5 Cable and fiber preparation

In the photo of Figure 8, you can see the tools that are needed in the first steps of fiber preparation. These are peelers of different thickness. In our case, since we are only going to remove the secondary and primary protection sleeve, first use the CFS-2 tool, and later if there is any remainder of the primary protection sleeve and you want to clean it some more, use the KNIPEX tool 1285100.



Figure 8. Tools needed in the steps of the fiber preparation.

1. Remove approximately 30-40mm of the coating, as shown in the Figure 9.

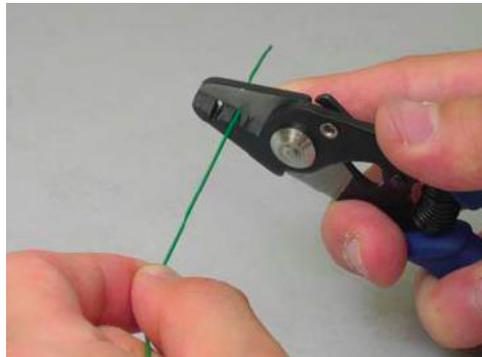


Figure 9. Step 1 of the fiber preparation.

2. Repeat this operation for the two fibers to be spliced.
3. Clean the end of the stripped fiber with lint-free paper moistened with isopropyl alcohol. Throw the stripped fiber onto the moistened paper. Rotate the fiber ninety degrees to remove any residue from the deck. Do not reuse used paper.
4. **MAKE SURE THE ENDS ARE PERFECTLY CLEAN OF ANY RESIDUE. ANY RESIDUE MAY AFFECT THE SPLITTER.**
5. To cut the fiber you will use the CT-06 fiber cutter, as it can be observed in Figure 10. The first step is to unlock the device. To do this, lightly press the top cover (1) while lowering the side button (2) to fully open the top cover. **DO NOT TOUCH THE BLADE AT ANY TIME.**

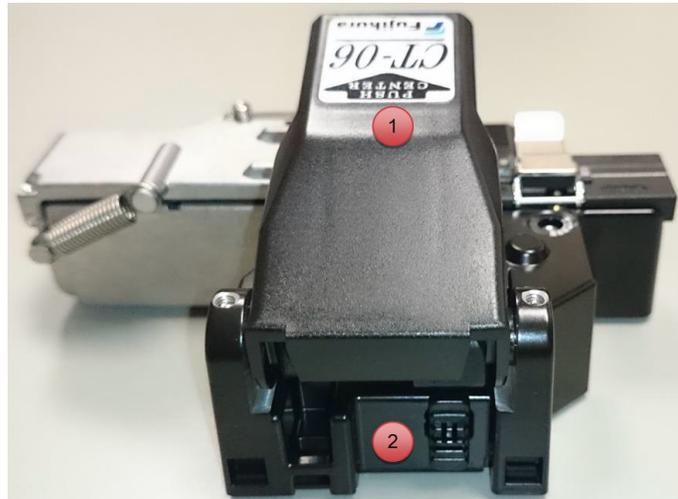


Figure 10. Steps of the fiber preparation.

6. Lift the metal tab to place the fiber (1), and the cover (2) that closes the fiber deposition box (Figure 11).



Figure 11. Steps of the fiber preparation.

7. The beginning of the protective sleeves should be at the 10 mark on the scale, in such a way that the cut results in about 10 mm of bare fiber.
8. Lower the metal tab to secure the fiber and the waste box lid.
9. Lower the cutter cover gently until a side spring trips. The cut will have been made.
10. Lift the cover, the metal tab that holds the fiber and remove it from the cutter
11. If any piece of fiber is hanging, use the metal wheel to drag the piece of fiber into the disposable material container.