MythBusters
In the land of PLC, part 3

PLC splitters are passive devices for optical power distribution, manufactured using planar processing methods and used as main components in fiber-optic access networks such as PON. Until recently considered rather exotic, PLC splitters are now gaining popularity among operators and installers due to the spreading of PONs. The popularisation of PLC splitters is caused mostly by the decrease in their pricing as well as the increase of the suppliers introducing these splitters to their offer. At the moment, PLC splitters became so popular that many operators began to consider them as mass-produced and widely accessible devices, so simple they cannot be malfunctioning. With such an approach the only matter that should be taken into account when selecting the supplier is obviously the price. Is this justified? In this series of articles we shall be exploring the most important myths regarding the splitters. It is time for the last part of our trilogy.

MYTH 4 –INSTALLERS COULD NOT CARE LESS ABOUT THE SPLITTERS YOU CHOOSE

What if an operator installs all of their splitters in heated and cosy basements, has all links no longer than 1 km and uses the 1x32 split configuration in the network? **Surely now it makes no sense to pay attention to anything apart from the price**, does it? Precisely, but only if installers work as volunteers. In case of difficulties in finding well-qualified volunteers (and such may occur in most places), it is worth to take a closer look at the products anyways. The reason behind this is simple – **operational costs**, because the installer may find himself spending a lot of time struggling with some of the splitters.

Take the innocent-looking **900 µm tube** for example. In the Myth 3, it was mentioned that the tube itself may bring a lot of joy during environmental tests. Many of the suppliers are aware of this fact, though. One of the simple tricks to solve this issue (or rather to go around it) is to use tight-buffered fibers instead of the loose-tube (usually better but also more expensive). Tight-tube is cheaper and does not allow the fiber to move freely inside it, thus it is often used in splitters from Asia. It allows, indeed, to save a few cents, however, it definitely does not save the installers' health. A typical tight-tube from Far East is so tight that it is impossible to strip more than few millimetres at once. Therefore, **it takes ages to prepare one port for splicing** (if the installer is not a volunteer, the operator will eventually have to pay for the time spent on this struggle). Every other installer can tell you by the bonfire heart-breaking stories of how he had to singe a tight tube with a lighter or otherwise he would not be able to get the job done. Not mentioning the situations when the installer tries to strip too much at once and a fiber fractures.

The fiber itself can bring in an element of surprise as well. We should not delude ourselves that the cheapest splitters contain the Corning fiber – they are usually manufactured using a made in China fiber and very often the consequences will follow. Firstly, such fiber is cheap thus the splitter is much cheaper as well (it's rather an advantage, isn't it?).

Secondly, however, very often such fiber is unrepeatable and unpredictable in terms of its parameters (and this is much more of a disadvantage). The technology for manufacturing optical fibers is complex and demanding in terms of process purity. If the cleanliness is not being kept at satisfying level, **the fiber becomes fragile**. Nearly every experienced installer can recall a situation when they worked on a fiber that was fracturing with the slightest bend or tension. This, again, equals to the wasted time and higher costs.

Furthermore, even completing the stripping and cleaving the fiber does not guarantee an overall success in splicing the fibers. Ironically, the cheapest and worst splicers splice every two fibers together and with the same (typically poor though) effect. Better splicers are more picky and can announce that e.g. **the fiber is of unknown type**. It is obviously the result of the complexity of the technology for optical fibers production and the necessity of preserving the absolute repetitiveness of parameters. Even the slightest change in technology can result in altering the geometry of fiber or in different refractive index's profile, which directly influences the splicer's functionality. **As a result, installers' time is wasted again and the network is 'enriched' with bad-quality splices** (with higher insertion losses and lower mechanical durability).

Ok, let's say the splice is finally completed and all we have to do now is arranging a pigtail in the cassette and the work is done. It turns out, however, that even at this step things can get complicated. **When dealing with renowned suppliers, a G.657A1 fiber will always be a G.657A1 without any doubts.** In case of dealing with cheaper and iffy suppliers, one cannot be so sure anymore. We have tested ten Xyyyy-branded 1x32 splitters again. For each of them the macrobending test had been conducted – the input pigtail and two randomly chosen output fibers were wound loosely around a mandrel with 20 mm diameter (one turn around the mandrel for each fiber). It turned out that within the same batch of splitters the power loss on one winding can come out as approx. 0.6 dB for one splitter, while for another as 0.05 dB! What's more, **there had been splitters with 0.05 dB loss on the input and 0.6 dB on the outputs while another had 0.45 dB on the input and 0.05 dB on the outputs!** If there is any repetitiveness here, it is only repetitiveness in randomness.

Anyway, the issue with the repetitiveness is also visible at a deeper level. For the same Xyyyy splitters the fiber **core diameters had been measured** using Photon Kinetics 2400 analyser (another myth-busting machine in our test lab aresenal). **The diameters varied between 8.82 and 9.56 µm**! How would the poor splicer be able to cope with that?

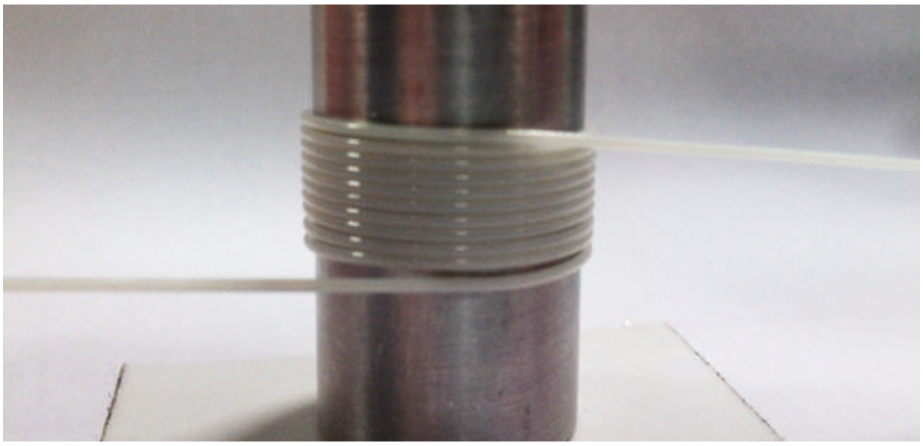

FIGURE 1 – An example of macrobending measurement – a mandrel with a determined diameter

But let's carry on with our installation. Eventually, the installer managed to splice everything and arrange fibers in cassettes. What a relief! Now he could proceed to another location. Unfortunately, an unlucky colleague of our archetypical installer nudged the prepared **splitter and it fell onto the concrete floor**. Result? If the splitter comes from a verified supplier, nothing will happen. The primary housing should be filled with cushioning gel, which absorbs the energy of the fall and protects fragile glassy parts inside the splitter. But if the splitter comes from a supplier whose ambition is to be the cheapest in the galaxy, it will probably lack the gel (as it generates further costs) and such an incident won't have a happy ending. **The procedure of impact resistance test is described in European norm IEC 61300-2-12**. The test itself is rather trivial – the device needs to be simply dropped from the height of 1.5 m onto a metal board. Fig 2. shows two examples of cheap splitters (1x4 and 1x8), which were purchased online, after the such a drop test. If the unlucky fellow dropped splitters of this kind, he may not even bother to pick them up.

MYTH 4 CONCLUSION?

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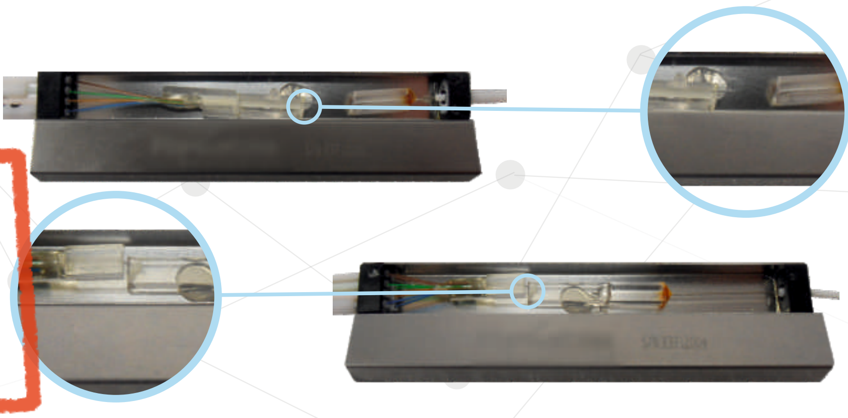

FIGURE 2 – ZZZ-branded splitters which failed the impact resistance test

MYTH 5 – A SUPPLIER IS A SUPPLIER – IT DOES NOT MAKE ANY DIFFERENCE

Really? Throughout the last dozen or so pages we were proving that splitters from different suppliers do differ and that most often the differences in pricing do not come out of nowhere. But the quality of splitters (or the lack of it) most often reflects the quality of the manufacturer on deeper levels than only the manufacturing process.

What is important for the end-user is the repetitiveness of technology. Thanks to this, an installer gets used to certain products and works faster, and the investor's network can function efficiently and without failures. Is it possible to call a supplier repetitive, when every single splitter coming from one batch contains different fibers and has internal elements glued differently? A supplier whose splitter No. xxx-0113 has 4 connectors (out of 33) with incorrect polishing angle, while the splitter No. xxx-0122 **has only 2 connectors polished correctly** (which means that remaining 31 connectors are faulty!)? Clearly, buying such stuff is a roulette.

Such differences prove the lack of any control over the technology and there is no plan for quality assurance and this is always the first step towards issues with the quality of products.

The cheapest splitters are usually manufactured manually, in some sort of a garage, under rather uncontrolled conditions. **Splitters manufactured by well-established producers, on the other hand, are assembled using automated equipment in cleanrooms**, where the amount of dust in the air is under precise control. Do recall, every single particle that may stick on a chip or a fiber array element can lead not only to the increase in attenuation but will most likely cause a delamination and failures in the future.

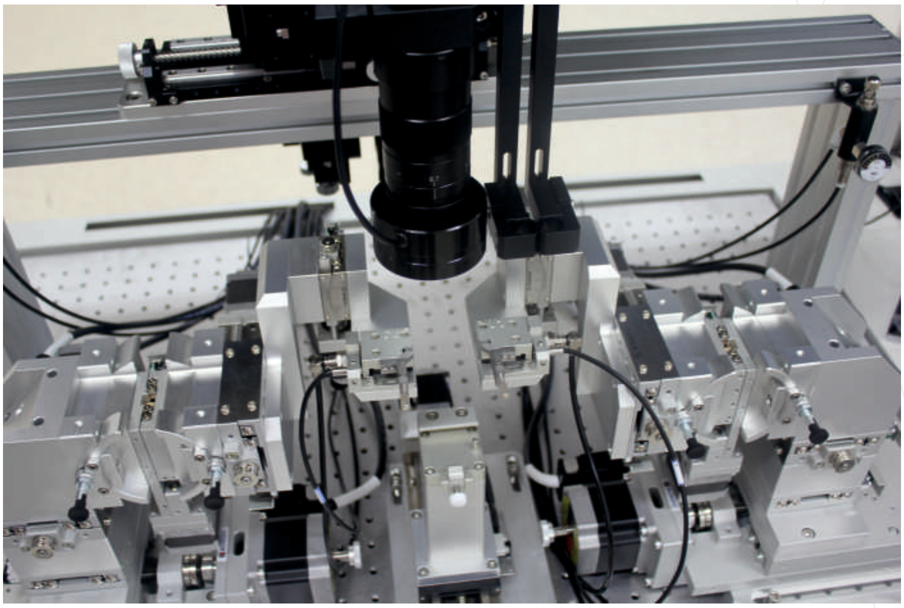

FIGURE 3 – An exemplary automated positioning station for manufacturing PLC splitters – the very same station is used for manufacturing the Fibrain splitters

If a producer manufactures everything manually, the quality of products depends on an operator's skills. It's great for short series artsy artefacts, but not really good for mass-produced industrial products. In the case of PLC splitters, the operator must position the elements with accuracy to within a few microns! Such skills cannot be acquired within a month. On the other side, **the rotation of employees among the producers within the telecommunication industry in Shenzhen is such, that the average worker only works for one manufacturer for 3 months!** In this situation, it is not surprising that every batch of splitters delivered from such a producer might be completely different in terms of their performance. As we mentioned before, **well-established suppliers, however, use automated positioning stations**, which are obviously about 10 times more expensive than the manual ones but guarantee the highest quality of products regardless of the operator's experience (hence the better uniformity of Fibrain splitters, to disclose one of our trade secrets). A typical automated positioning station have computer-controlled 12 stepper motors with a sub-micrometre resolution, and automatically aligns the elements of splitter to minimise the insertion loss measured in real time (shown in Fig. 3) – no matter if operator had a big long party last night, splitter will be the same.

Sometimes, however, despite the advanced quality assurance system and the control over the technology, issues may occur (after all even NASA shuttles had failures). There is always a slight chance that some technological stage has not been 100% evaluated and maybe at some point in time it turns out that a certain batch of products has been released with a failure. In the automotive industry context in this case the producer announces then so called 'service action'. In splitters/telecoms industry the situation may vary. The cheapest suppliers have no control over the technology and are simply not able to determine what really happened. The reputable suppliers care not only about the stability of technology but also about traceability. **In the case of the Fibrain splitters, essential data (with traceability info) for all of them is archived and the test reports are kept with information about batch and technology.** This way, should the unexpected happen, we are able to determine which batches are vulnerable.

MYTH 6 – IT IS QUITE AN ACHIEVEMENT TO MAKE A CHEAP SPLITTER

Ermmm, not really. In fact it is quite easy to manufacture a cheap splitter. Here's the recipe:

1. Buy the cheapest components (second class PLC chips and fiber array elements with fibers coming from unverified sources, poor quality UV epoxy and cable tubes)
2. Give up on additional luxuries such as cushioning gel or extra amount of glue inside the splitter
3. Speed up the manufacturing process (there is surely no need for such a long UV epoxy curing or thermally curing the connectors)
4. Give up on quality control (Suppliers' control? Testing the geometrical parameters of connectors? What for, as nothing ever really happened to us)
5. Simplify the technology (Cleanroom? Automated positioning? Technology tests?)

One has to take into account, however, that such splitters will be proportionally worse than splitters manufactured with more care, time and money dedicated. From an operator's point of view, it is crucial to remember that the cost of a splitter is not only **the cost of its purchase, but also the cost of installation, exploitation and potential substitution, as well as the cost of the entire network which works with the splitter.**