BACKHAUL CONSTRUCTION

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1. INTRODUCTION

This document aims to give a general view with the construction instructions that must be considered to create the Backhaul section for the network deployment of UGG (Unsere Grüne Glasfaser) in Germany.

Other norms focussed on more detail for some parts of the network must prevail over the content of this document in case of conflict.

This document does not detail how must be carried out the civil works to execute the duct and cable installation, or the manhole installation in detail. For this purpose, there are available other normative focused that must be follow. Along the document those normative are referenced where it procced.

1.1 REVISIONS

This document is the second edition of the "Construction Instruction: Backhaul Construction" document.

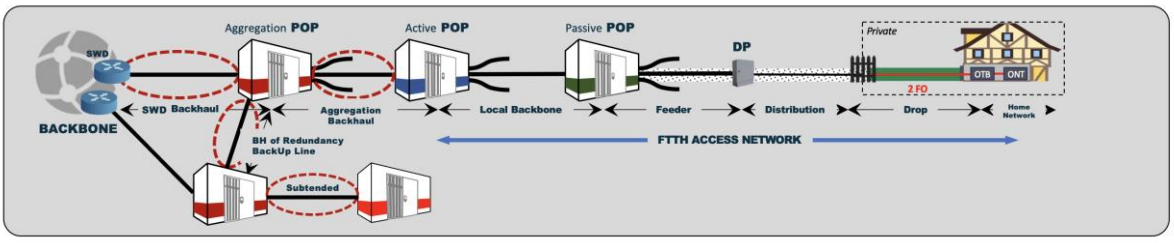
EDITION	DATE	REVISED SECTIONS	CHANGES	OBSERVATIONS
1st	NOVEMBER 2022			This document is extracted from the document "Construction Instruction for fiber deployment" and is modified including more information and detail.
2nd	DECEMBER 2023	All	New codification of document	The document is codified with the document code: TEF-NORM-00006. The title of the document is modified removing the text part of "Construction Instructions" from it. The logo of UGG is updated in the page header. References to other documents are included along the document.

2. BACKHAUL

2.1 DESCRIPTION OF THE BACKHAUL NETWORK

The backhaul is the network that aggregate all the traffic from the active POPs (Points of Presence) and that connect with interconnection points around the country. The types of backhaul lines are:

- BH connecting Active POPs with Aggregation POPs for concentrating the traffic of several Active POPs' serving areas into the aggregator installed in the Aggregation POP. This type will be referred as " Aggregation Backhaul"
- BH connecting Aggregation POPs and regional transport network. This transport network is provided by Telefonica Germany and the interconnection point is the SWD on the edge of this regional transport network. This type will be referred as "SWD Backhaul"
- BH connecting Aggregation POPs between each other, also known as "BH of Redundancy" when the two Aggregation POPs belong to different clusters and "Backup Line". when the two Aggregation POPs are within the same cluster. The aim of this type of BH is implementing the redundancy scenario consisting of "U" structures (two Aggregation POPs connected to a differentiated SWD each one and between both). This type will be referred as " BH of Redundancy"
- BH connecting two Aggregation POPs, one acting as "Header" and the other as "Subtended". In this structure the header is connected to one or two SWDs and the subtended aggregator is only connected to one or more header aggregators. This type will be referred as "Subtended"



NOTE: the scheme includes the section of the FTTH access network with centralized splitter architecture. Nevertheless, this does not affect the backhaul section.

Figure 1. Network architecture scheme (Backhaul)

For the point of view of implementation, there are two alternatives: fully constructed by UGG and rented relying on fibers provided by a Dark Fiber Provider (DFP). In the latter case, there will always be a constructed section in order to reach the planned point of interconnection (PoI) of the DFP from the POP (Active of Aggregation) needing that BH line. For the specific case of SWD backhaul, the connection to the SWD will be performed directly by UGG when constructing or by the DFP. In the latter case it may be necessary to construct the section for

reaching the POI at any of the two ends (POP, SWD). Next figure shows the different ways of BH implementation for each purpose or type of BH:

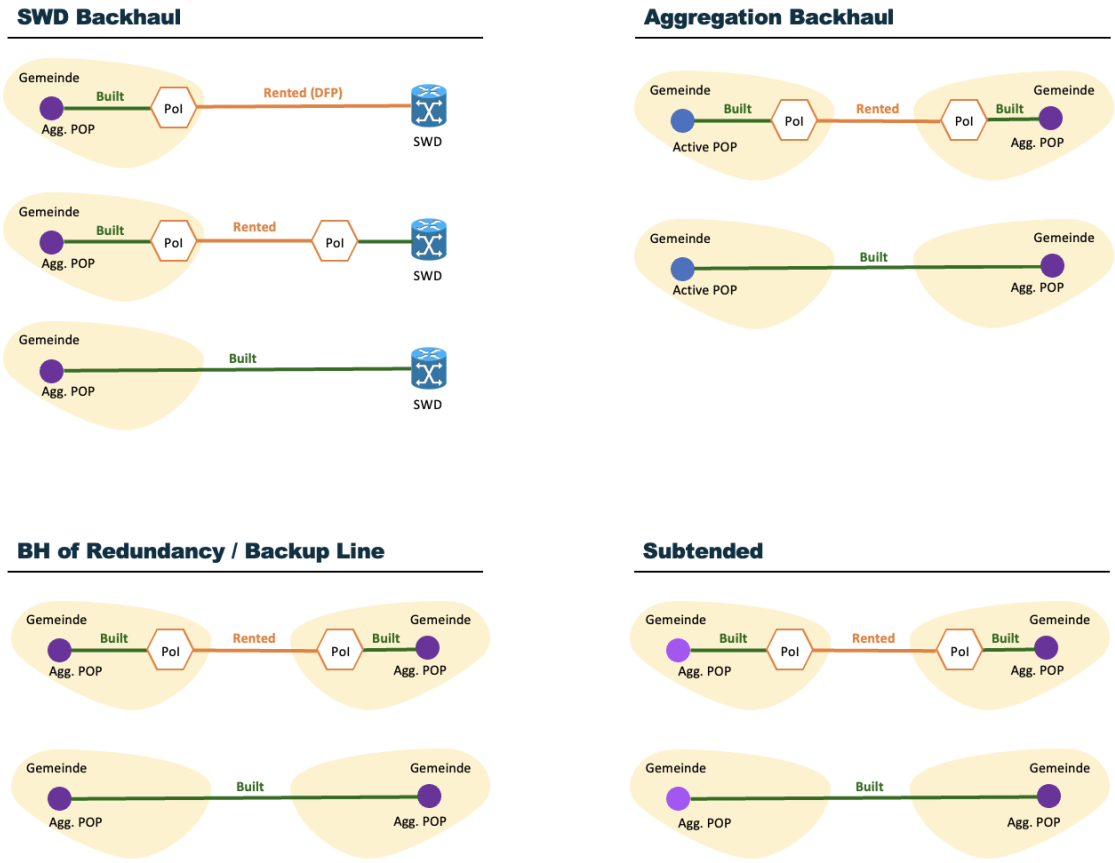


Figure 2. Different backhauls schemes.

The backhaul network pipeline architecture normally is a simple line deployed close to a road, that is used to join different central offices, POPs, or any other singular point in a telecommunications network that are in different cities or villages.

In these backhaul paths, the number of fibers to be deployed normally is not so high, and the number of ducts to be deployed are few. But, to take advantage of the deployment made, for future extensions or needs, more than one duct or bundles or micro-ducts should be installed.

The distance to cover in the backhaul could be very large. In this part of the network, it will be necessary to make fusion splice between different cables to reach the destination.

2.2 CHARACTERISTICS OF THE PIPELINE (BACKHAUL)

The pipelines in the backhaul network, will be installed **directly buried** into the ground.

Normally the best way to deploy the backhaul ducts is the ploughing method. It is the cheapest and fastest technique but, in some cases, depending on the type of soil, or if in the layout there are some road crossings or similar, it is necessaire to use an alternative.

If the type of soil is too hard, and the ploughing method is not possible to use, the HDD (Horizontal Directional Drilling) technology could be an alternative to cover big distances, instead of using a traditional trench or a mini trench to lay the ducts.

Of course, if there are no other alternative (for any reason) the use of the mini-trenching or traditional trenching could be used also. In this case, should be respected the distance and depths required by the current legislations or laws. The following depth values can be taken as a reference:

- On Secondary Roads or Gemeinde Responsibility Roads:
  - 45 cm with Authorization
- On non-secondary roads:
  - 60 cm with authorization (desirable)
  - 80 cm with authorization (default regulation)
  - 120 cm (in certain cases by request)

NOTE: The depth values are included as a reference, but in all the cases the depth of the pipelines must be validated by the competent body.

All these mentioned techniques (Ploughing, HDD, trenching, etc) are described in detail in the technical normative "TEF-NORM-00001 - Civil Works for Fiber Deployment" of UGG. Also, the way in which the bundles or micro-ducts will be laid must follow and comply the mentioned normative and with all the recommendations given by the manufacturers of ducts and micro-ducts.

The pipeline will be formed by micro-ducts and ducts. The micro-ducts that must be used in this section of the network are **14/10 mm (outer/inner) diameter ducts** and must be suitable for blowing optical fiber cables. The duct that will be deployed as an additional spare duct will be a 50/40 mm duct.

NOTE: if the route for backhaul section is shared with a local backbone section it will be used as exception the microduct sizes 16/12 for all the microducts installed. It is recommended to not execute paths with transitions of different diameter ducts.

The micro-ducts must be deployed in bundles of 7 or 4 units each, depending on the necessity of each part of the backhaul network.

50/40 mm duct 14/10 mm micro-ducts

Figure 3. Different shapes of the micro-ducts bundles and ducts for the backhaul.

Each 1500 meters a manhole must be installed to facilitate cable installation and subsequent maintenance of the network. On these points a cable reserve of 6 meters of should be left.

The rest of connections needed to give continuity between ducts should be done with the corresponding connectors and the duct joint will be left directly buried.

When a fusion splice between cables is needed to give continuity, it will be done with a splice closure that will be installed inside the manhole. **NOTE:** the use of optical splice points must be avoided, and the distance limit for its use must be set by the length of the cable drums (6 km).

IMPORTANT: All the joints between ducts must be registered in the inventory system with GPS coordinates with a precision of centimetres (tolerance: 2 cm max), to know in the future the exactly point of the singularity for maintenance purposes or networks upgrades.

A detailed picture (.jpf, .png format) should be also included in the inventory system.

The joints between ducts, must be done according to the recommendations of the manufacturer of the ducts. For example, the joint of the seven ducts of a bundle, must be done in a staggered manner, avoiding that all the connectors meet in the same position.

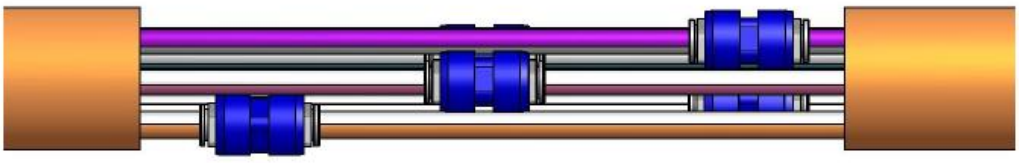


Figure 4. Example of duct bundle joint (the connectors doesn't coincide in the same position)

The manholes and the splice closures also must be registered in the inventory system with GPS coordinates (2 cm tolerance).

The cables that normally are going to be used in the backhaul network have 48 ooff, but this is something that will be defined in each project.

3. POINTS OF INTERCONNECTION (POIS) IN THE FIELD WITH DARK FIBER PROVIDERS

The backhaul networks of the UGG network can be made in different ways depending on the characteristic of each project. The network can be made entirely by UGG or can be formed by the combination of sections made by UGG and sections property of third parties (for example, dark fiber providers) and in some cases, the backhaul network is basically rented (almost complete) to a dark fiber provider, in which only the last meters of the sections are made by UGG to get access to the network of a dark fiber provider.

Although only a few fibers are needed to be connected to the interconnection nodes, the pipeline and the optical cable installed by UGG (in the sections needed), will be prepared for future uses or updates with enough reserves.

3.1 MANHOLES FOR INTERCONECTION WITH OTHER OPERATORS

For the points of the network in which it is expected to have a connection with other operators, or if it is decided to offer the connection to other operators in some point in the path of the backhaul network, it is necessary to install a manhole with a splice closure inside.

For these cases, UGG must install a manhole, to connect with the network of a dark fiber operator, the manhole of UGG will be installed at 1-2 meters distance from the manhole of the other operator.

For the connection between the different manholes, tubes of 50 mm will be used. A minimum of 2 tubes of 50 mm must be installed between manholes. **Note:** it is not necessary to subduct these 50 mm ducts of interconnection between manholes.

The manhole that must be installed is the TC model with the following characteristics:

- external dimensions: 995 x 1300 mm (large x wide) with a height of 900 mm.
- internal dimensions of 800 x 1165 mm (large x wide).

NOTE: The cover type to be used, will depend on the area in which the manhole is installed.

The installation of the manhole manholes must be done according to the technical instructions document "**TEF-INST-00002 - Installations of Manholes"**, in which is defined clearly how must be done the civil works associated to the installation of the manhole itself.

No other operators should open and work in the manhole and the splice closures of UGG. To avoid that, in the cases in which other operators needs a connection to the backhaul network or UGG in the manhole, UGG will prepare a splice closure in the manhole with an optical cable of 48 fibers installed in the closure and stored in the manhole conveniently protected, (that means that should be inside a micro-duct). This cable will be passed to the manhole of the other operators to make the splice with their own network in their own splice closure.

The next picture shows an example of the situation. At the right side is the UGG manhole, with a splice closure needed to give continuity to the backhaul network. In this closure is added a new cable to make possible the connection of the other operator to the fibers of the UGG backhaul network. This cable will be guide to the other operator's manhole.

The cable used for the connection between manholes, will have the appropriate fibers, for example a 48 fo cable. Not all the fibers of this cable will be spliced with the fibers of the UGG network, only the ones that have been selected in the project to connect with the other operator (only 2 fibers could be a possibility).

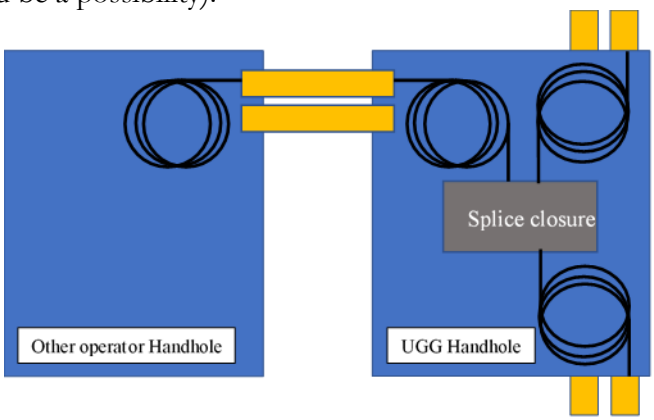


Figure 5. Manhole interconnection scheme

If there are several operators, the same scheme should be repeated, that means, that the new operator must install their own manhole, the pipeline connection to the UGG manhole, and UGG will prepare another cable to pass to the manhole of the new operator manhole.

The opposite situation could occur when UGG needs to connect to the dark fibers of other operators. In this other case, UGG must reach with his network the interconnection point (the manhole) of the other operator (for example a dark fiber operator). UGG should install their own manhole, to install there their own splice closure.

The other operator must pass the cable until the UGG manhole, and this end of the cable should be installed in the splice closure of UGG by UGG.

IMPORTANT NOTE: It is very important in this point, to have very clear the colour coding of the tubes and fibers of the other operator, because can be different from the colour coding of UGG.

The cable and ducts connection between manholes, must be correctly sealed between the manhole's walls, the ducts or microducts installed, and between the ducts or microducts and the cables installed.

The arrangement of the closures and cables inside the manholes must be done according to the technical instructions document "**TEF-INST-00003 - Installations in Manholes"**, in which is defined clearly these topics.

A reserve of cable of at least 6 meters (for each end) should be stored in each manhole to make easy the fusion works in the field.

All the manholes installed must be registered with GPS coordinates with centimetre precision (tolerance: 2 cm max).

4. TERMINATION OF THE SWD BACKHAUL NETWORK

The termination points of the SWD backhaul network can also be different, depending on the ubication of the nodes in which the backhaul network should be finished. One side of the backhaul network will be always an aggregation POP of UGG, but in the other side several scenarios can be found. The termination point will be a site with a switch, or a router installed on it, for example it can be found in:

- a mobile base station in a rural area, or
- a mobile base station on the top of a building (typically in urban areas),
- a central office/datacenter.

The way in which UGG should terminate the network in the premises of those different facilities, will depend of course on the technical restrictions that are imposed by the owner of the building/facilities, but to have a homogeneous solution will be defined in this document the schemes and the different elements that must be used for each situation.

Before the pipeline deployed by UGG reach the termination point facilities a manhole should be installed. From that manhole will be deployed the ducts and microducts needed to connect the manhole with the termination point facilities.

If the site/building facilities has an entrance manhole already installed, UGG will install their own manhole as close as possible to their manhole, and will connect both manholes with a minimum of 2 ducts of 50 mm.

If the site/building facilities doesn't have any entrance manhole already installed, UGG will install their own manhole at a maximum distance of 20 meters of the site.

The cable of UGG will pass this manhole normally without the need of installation of a splice closure inside, and only will be used to store some cable overlength (at least 6 meters).

4.1 BACKHAUL NETWORK TERMINATION ON A BASE STATION (GROUND LEVEL)

In this case, the backhaul network of UGG must reach a router or a swich that is located inside a base station (ground level). This case can be found normally in rural areas.

The termination scheme can be seen in the next picture:

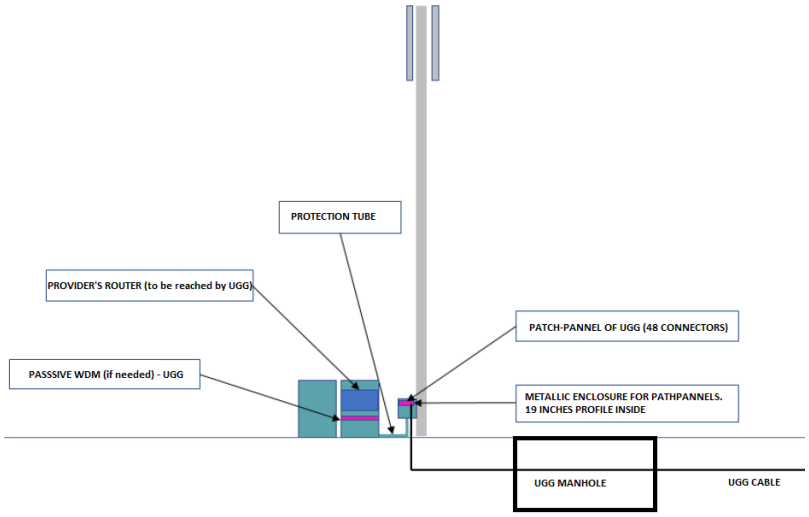


Figure 6. Termination scheme in a base station (ground level)

Before reach the base station, and at a maximum distance of 20 meters (approximately), a manhole should be installed (an OC type manhole is enough) as a register point for the UGG network and to facilitate the future maintenance and the blowing tasks during the cable installation.

The pipeline used to reach the manhole will be the defined in the concrete project, based in the use of a 50 mm duct as spare, and a bundle of several microducts of 14/10 mm (4- or 7-ways bundles).

From the manhole to the base station, will be extended the same type of pipeline if there are no restriction from the owner of the facilities.

It is common that the point in which UGG must finish the optical cable is a metallic envelope (called typically "carrier box"), that inside has 19 inches profiles and space to install different modules of patch-panels.

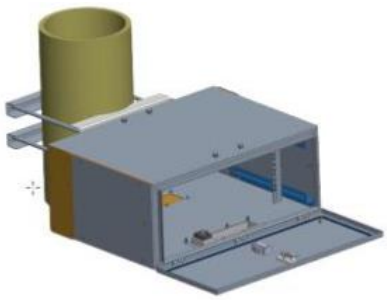


Figure 7. Carrier box example

The microduct that is going to be used in this first stage for the installation of the optical cable, should be installed to reach the final element in which the optical cable should be terminated ("carrier box"). The microduct must be fixed into the carrier box, and the entrance to the carrier box must be correctly sealed. After de cable installation, the microduct must be correctly sealed with the appropriate gas-blocker.

Figure 8. microduct termination inside the carrier box (with gas-blocker).

Inside that metallic envelope UGG will install a compatible module patch-panels (splice and connectors type) with the necessary capacity to terminate the optical cable of the backhaul.

The module that should be used can be see in the next figure:

MODEL: MFPS Fiber Optic panel, 19 inch, 1RU, 48 fibers/HU, splice/patch, SMOUV/right, 48 LSH/APC, grade B

Note: LSH/APC is an equivalent denomination of E2000 connectors).

Main characteristics:

- Metallic module to be installed on 19" profiles (in a rack cabinet)
- Dimensions approx.: Width: 19", Height 1 HU, Depth 280 mm
- Enough capacity to manage cables up to 48 ooff
- 48 E2000 connectors

Figure 9. Module for the termination of the optical cable (for 48 fibers with a panel of 48 E2000 connectors)

The optical cable must be installed and guided inside the "carrier box" up to the module.

The termination of the cable inside the module must be done professionally following the instructions of the manufacturer of the element. **NOTE:** special attention to the fiber colour coding of the cable.

From the "carrier box" to the cabinet in which the switch or the router is installed, must be a protected path, (based in a protection tube, for example: a corrugate tube), that allow the patching between both elements. The patching will be done with the appropriate patch-cords with the appropriate length and connector termination in each side.

4.2 BACKHAUL NETWORK TERMINATION ON A BASE STATION (ROOFTOP OF A BUILDING)

In this case, the backhaul network of UGG must reach a router or a swich that is located on the top of a building (where there is a base station for mobile services). This case can be found normally in urban areas.

The termination scheme can be seen in the next picture:

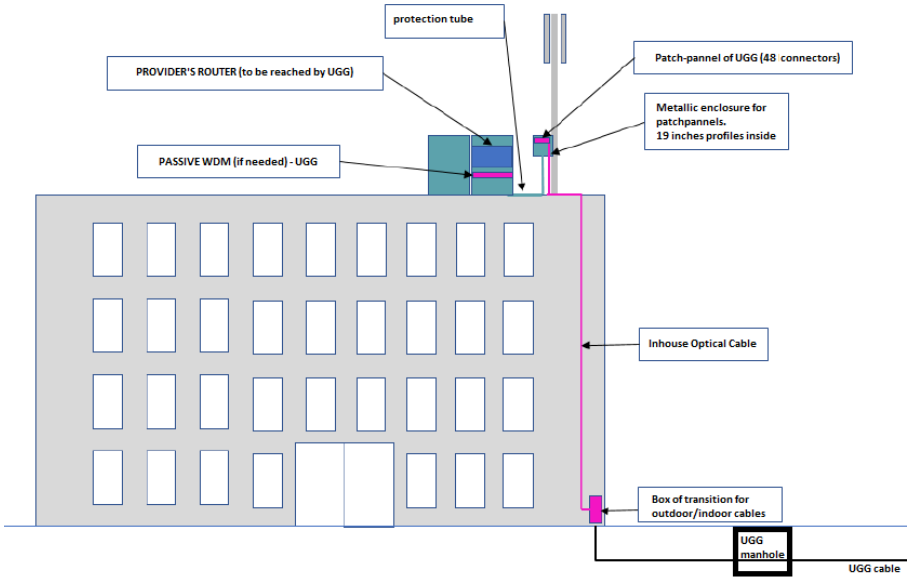


Figure 10. Termination scheme in a base station (rooftop of a building)

The main difference between this case and the previous one in which the base station is at ground level, is that it is needed to make an in-building installation to reach the rooftop of the building. For that, it is necessary to do a transition from the outdoor cable and outdoor microducts to a and indoor cables and if needed to indoor microducts also.

The rest of the installation is like the previous case.

To do the transition inside the building, will be needed to use a splice box to splice the outdoor cable coming from outside plant to an indoor cable.

As splice box, should be used the Budi box from Commscope already authorized for indoor DP applications (fusion type model).

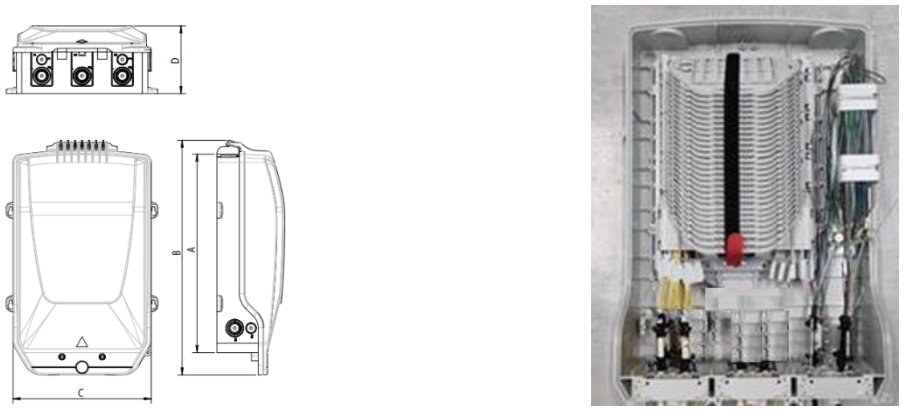


Figure 11. Budi S Box from Commscope

The indoor cable to be used is a riser type of 48 fibers. The cable should be installed by pulling though ducts available in the building. If there are not ducts available a special project for deploy the necessary infrastructure must be done. When the cable reaches the rooftop, it must be protected until the entrance of the carrier box (the cable is not prepared to support UV radiation).

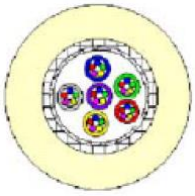


Figure 12. Riser Cable structure