Leveraging fiber indexing technology

FTTH application guide

COMMSCOPE®

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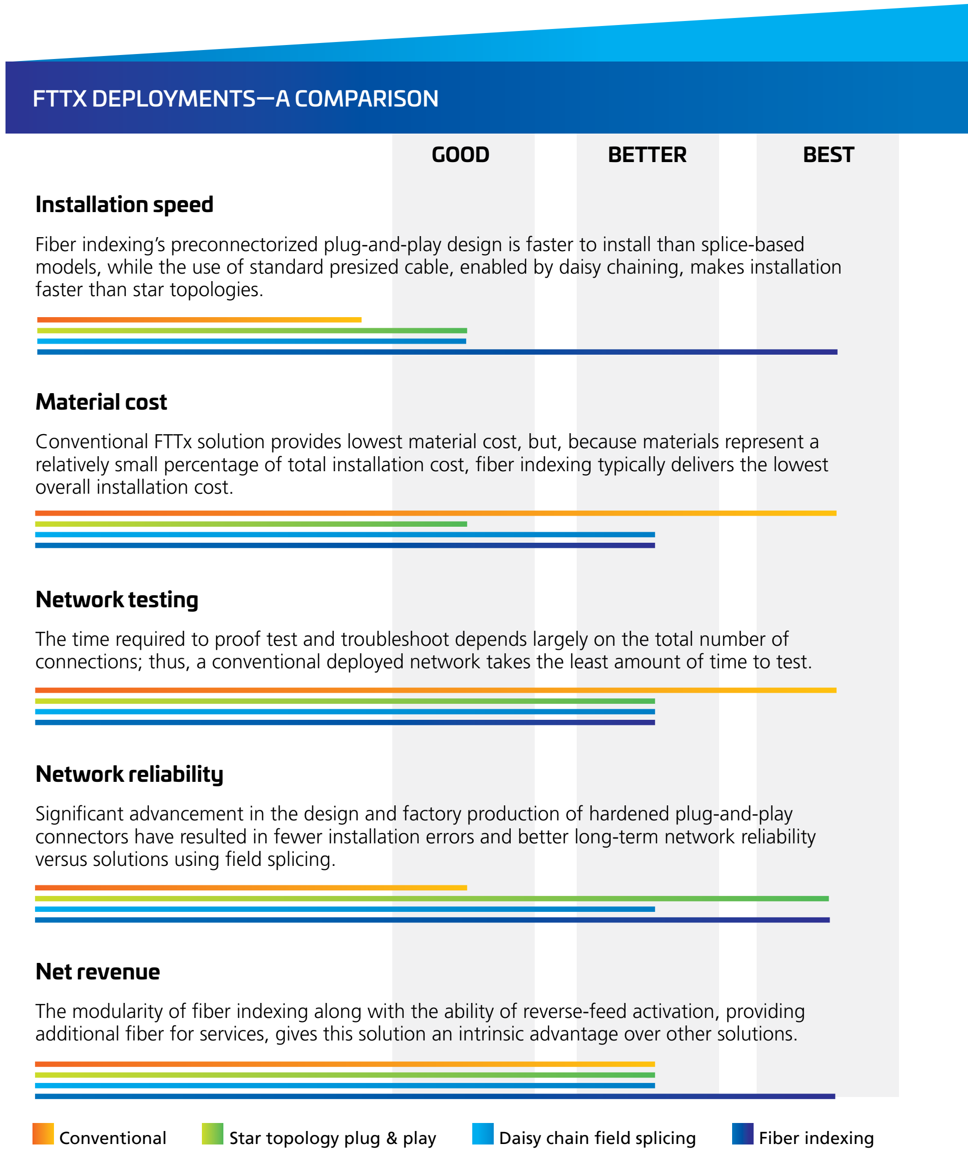
Fiber indexing—many advantages

At CommScope, we believe fiber indexing is key to the next evolution of FTTX deployments. This innovative technology allows a dramatic increase in plug-and-play connectivity. When deployed in a daisy chain architecture, fiber indexing terminals have all the advantages of a fully connectorized solution: speed, flexibility, and density. Equally important, fiber indexing brings significant reliability and financial leverage to deployments.

Fiber indexing advantages

- Saves as much as 70 percent of fiber cabling budget
- One of the most reliable deployment methods
- Gives providers future flexibility
- One of the best returns on investment in the industry



> “A pioneer in the field, CommScope first brought the MST series to market four decades ago. Today these industry-standard terminals have been improved with new configurations for added versatility, and tougher housing materials for increased reliability. It's good to see that, just as their customers' needs evolve, so does CommScope's determination to improve their equipment...to keep pace with that evolution.”

INDUSTRY EXPERT

A pay-as-you-grow approach

In a fiber indexing deployment, up to 12 terminals are daisy chained in a series. This allows a fast and repeatable "cookie-cutter" approach to network design and deployment. In a typical FTTX network, signals from the fiber distribution hub travel "forward" from the first terminal to the last. When a second distribution hub cable is connected to the last terminal, the signal runs "backwards" toward the first terminal. Called "reversed feed," this technique makes additional fibers available, which providers can use to respond quickly to unforeseen demands for a wide range of revenue-generating services. Fiber indexing's modular design enables efficient, cost-effective connections for new subscribers and services, while allowing providers to take a pay-as-you-grow approach to FTTX deployment.

FIBER INDEXING—HOW IT WORKS

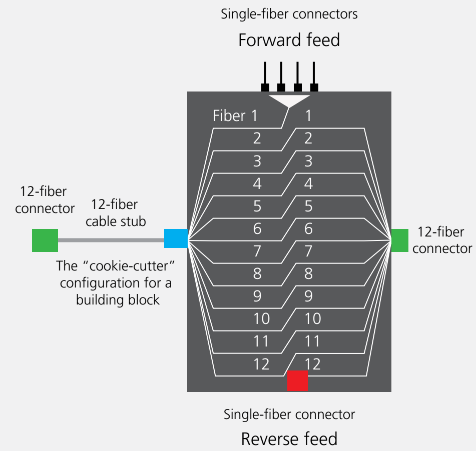
Fiber indexing is the shifting of a fiber's position from one multifiber connector to another, within each terminal.

1 The process begins with a 12-fiber cable from the fiber distribution hub entering the first index terminal.

2 Inside the terminal, the fibers divide and the signal from the fiber in the first position is routed to a 1:4 or 1:8 splitter for servicing local customers.

3 The remaining fibers are "indexed"—advanced one position in the order—then combined using a 12-fiber multifiber optic connector (MFOC).

4 The exiting 12-fiber cable connects to the next terminal where the indexing process is repeated.



Want to learn more about fiber indexing?

WATCH VIDEO

CommScope fiber indexing terminals

Designed specifically for fiber indexing deployments, giving providers multiple mounting options and quick and easy installation. These fast, efficient deployments provide several advantages:

- No splicing required in the terminal
- No terminal re-entry required
- Available with standard or hardened connectivity
- Available in multiple cabling configurations
- Available with 12 or 24 fibers
- Connector ports color coded and clearly labeled for fast installation
- Available with dielectric input stub cables
- User-friendly packaging allows for easy unspooling

INDEX TERMINAL PORT COLOR CODES

BLACK	Single-fiber drop connector (forward feed, split signal)
WHITE	Single-fiber drop connector (forward feed) first output of splitter
RED	Single-fiber/multi-fiber connector (reverse-feed)
GREEN	MFOC (forward feed) cable output to the next terminal
BLUE	MFOC-branching only (forward feed) cable output that routes a portion of the input fibers to another terminal
ORANGE	Single-fiber drop connector (forward feed, unsplit signal)

Terminal configurations

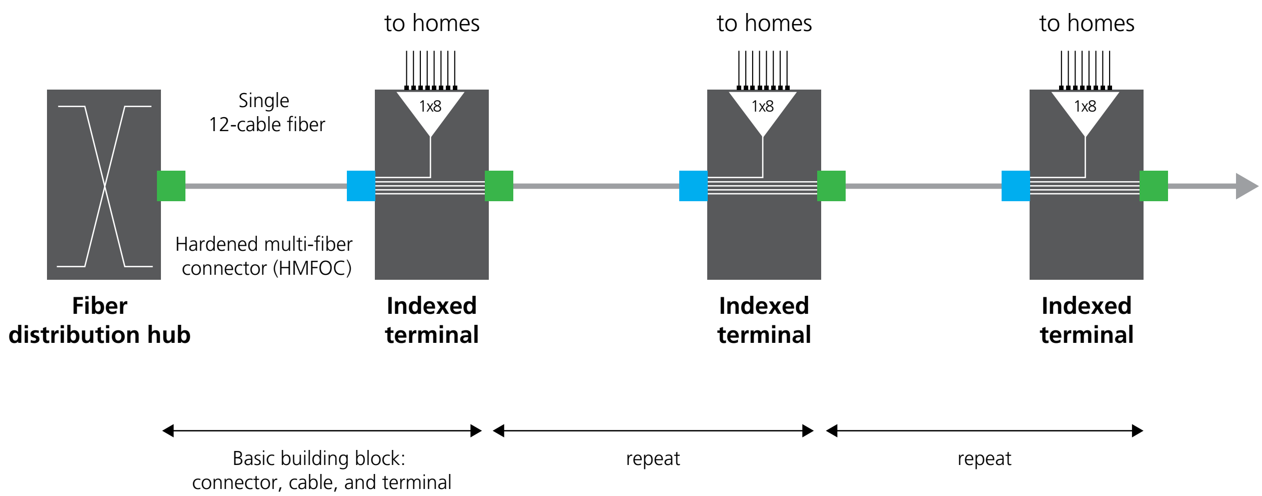
To build the network, each terminal housing type is available in four configurations:

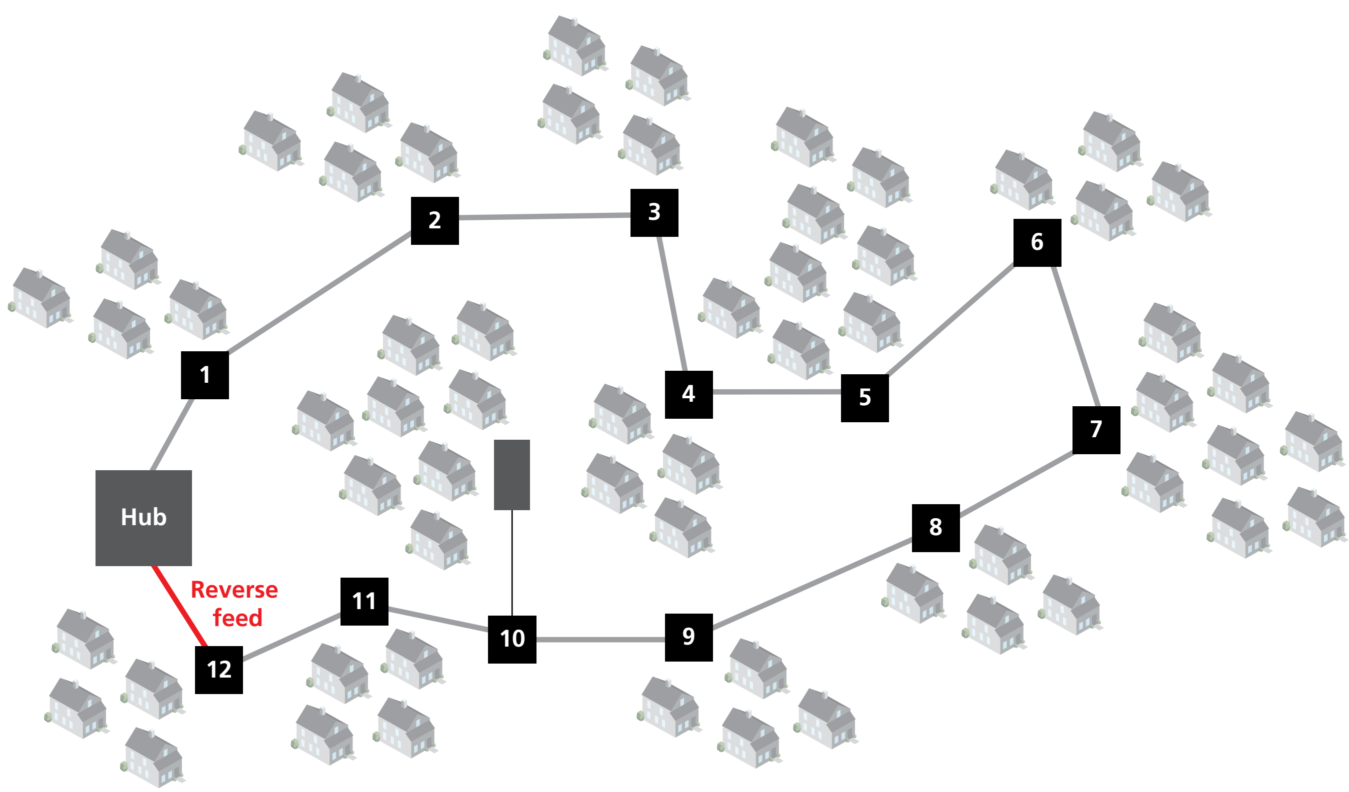
- Indexing only (1- and 2-fiber variants)
- Standard indexing terminal with splitter (1:4 and 1:8 variants)
- Branch terminal (2- and 6-fiber variants)
- 12-fiber multi-use indexing terminal (2- through 4-fiber variants)
- 12-fiber multi-use indexing terminal with integrated splitter and pass-through fibers (2- through 4-fiber with 1:4; 2-fiber with 1:8 variants)
- 24-fiber multi-use indexing terminal (2- through 4-fiber variants)

The cable stub on the terminal is terminated with a female (non-pinned) MFOC, and the available cable length ranges from 10 to 2,000 feet, or 3 to 610 meters. Please see the ordering guide for details. Terminals with stub lengths less than 100 feet, or 31 meters, are shipped coiled. When the stub cable is 100 feet or longer, the terminal is shipped on a spool, with the terminal secured on the spool flange.

Fiber indexing: deployment concept

Fiber indexing deployments are quick and simple because the technology is based on fast and repeatable installation procedures. The first step in creating an effective design is to define the basic building blocks for an installation scenario, and the parameters that will determine the terminal configurations to be used. Once these parameters are set, installation teams simply repeat the defined building blocks to create a plug-and-play network. This network design concept is applicable to any scenario; for example, a medium- to low-density residential area.

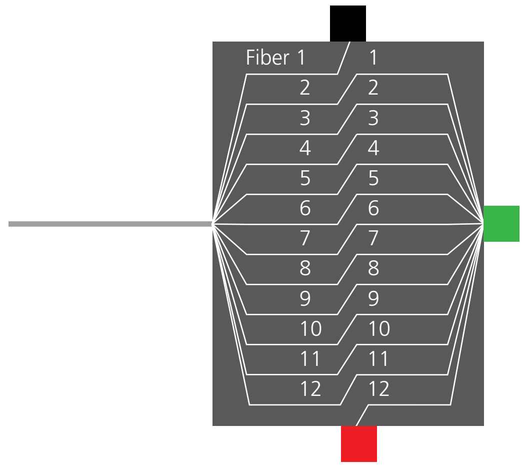




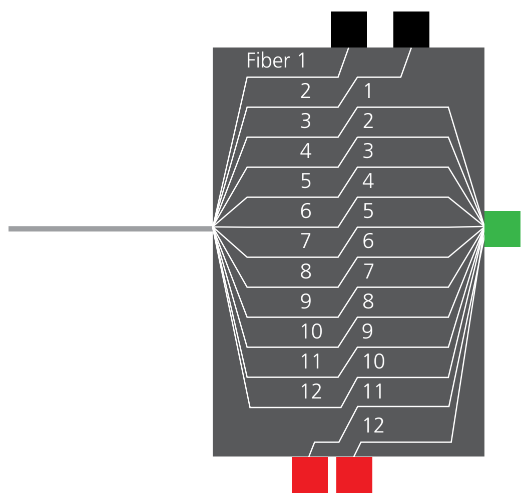
A Indexing-only terminal with reverse port

The indexing terminal is also available without an integrated splitter. In this case, the unsplit signal of the first fiber of the incoming chain goes to a single drop, the black port in the 1-fiber variant illustration seen here. This single drop can be connected to a more peripheral terminal where splicing and/or splitting is performed. This topology enables a greater spatial coverage, though the possible number of drops remains the same for each chain. It allows for either the feed of very low customer density, or the deferral of CapEx when market penetration is uncertain, by adding integrated splitter terminals as services are required. The images here show the schematics inside the terminal and the color codes of the adapters.

1-fiber variant



2-fiber variant

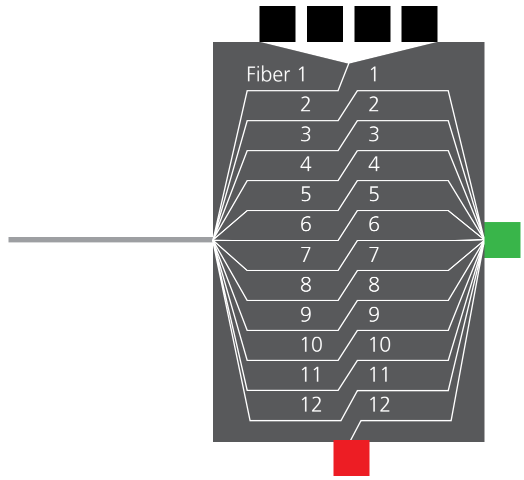


B Standard indexing terminal with splitter and reverse port

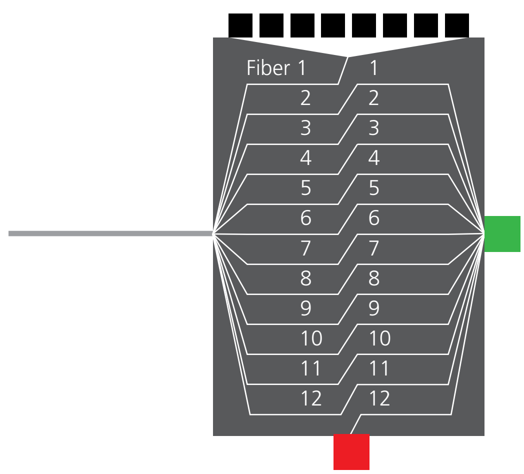
In this configuration, the terminal will drop the first fiber from the incoming 12-fiber strand. This fiber will be routed to an integrated 1:4 or 1:8 splitter. The other 11 fibers from the incoming 12-fiber strand cable will proceed unsplit and be terminated on an MFOC adapter port, together with the fiber coming from the reverse port. The fiber coming from the reverse port will take number 12 of the outgoing 12-fiber MFOC; the incoming fiber number 2 will take number 1 of this outgoing 12-fiber MFOC. The MFOC adapter port is colored green and indicated with an “A” on the terminal. The reverse port is colored red and indicated with an “R” on the terminal. The image here shows the schematics inside the terminal and the color codes of the adapters.

The 12-fiber strand cable terminated on a female MFOC of this terminal is connected to the green MFOC adapter port of its up-stream terminal, to the distribution hub of the first terminal of the chain, and a forward feed path is created. Four or eight subscribers, or homes, can be fed around this indexed terminal by connecting a drop cable to one of four or eight black adapter ports, depending on the incorporated splitter. As many as 12 indexed terminals can be connected one after the other in a link installation.

1:4 splitter variant



1:8 splitter variant



C Branch terminal

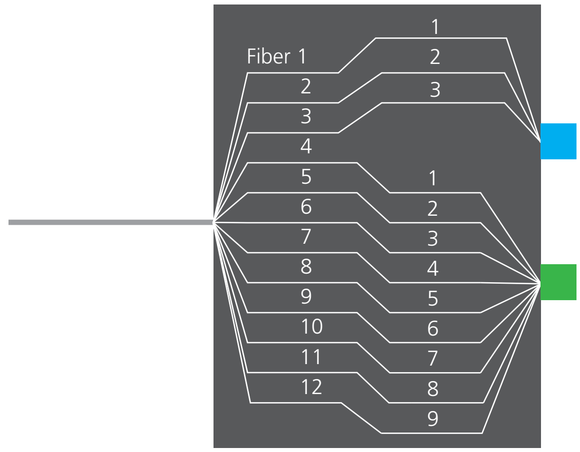
The branch terminal enables the division of the incoming 12 fibers into two MFOC adapter ports. This configuration provides more flexibility in the distribution network, since a greater spatial coverage area can be achieved. Reverse-feed ports and single drop ports are not included on a branch terminal. The images here show the schematic inside the terminal.

The first fibers from the incoming 12-fiber tail are always routed to the blue MFOC connector, indicated with the letter B. The remaining fibers are routed to the green MFOC, indicated with the letter A. The fibers always take the first fiber positions in the multi fiber connector. The 3-fiber variant image here shows the first three fibers from the incoming 12-fiber tail routed to the first three positions in the blue MFOC connector. The last nine fibers from the incoming 12-fiber tail are routed to the first positions in the green MFOC connector. The remaining positions of the green and blue MFOCs are unused. The branch terminal is available with the incoming 12 fibers divided in a variety of ways.

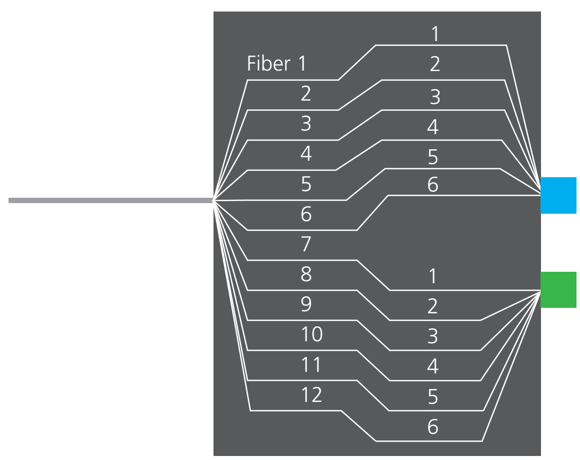
B (blue)	A (green)
1 to 2	3 to 12
1 to 3	4 to 12
1 to 4	5 to 12
1 to 5	6 to 12
1 to 6	7 to 12

The daisy chaining installation can continue from each MFOC adapter port, but with a reduced chain in either direction as defined by the fiber branch quantity. Although the branch terminal has no reverse-feed adapter port, the reverse-feed functionality is still available in the reduced chains. The next page illustrates the positions of the different terminal configurations in an outside plant network.

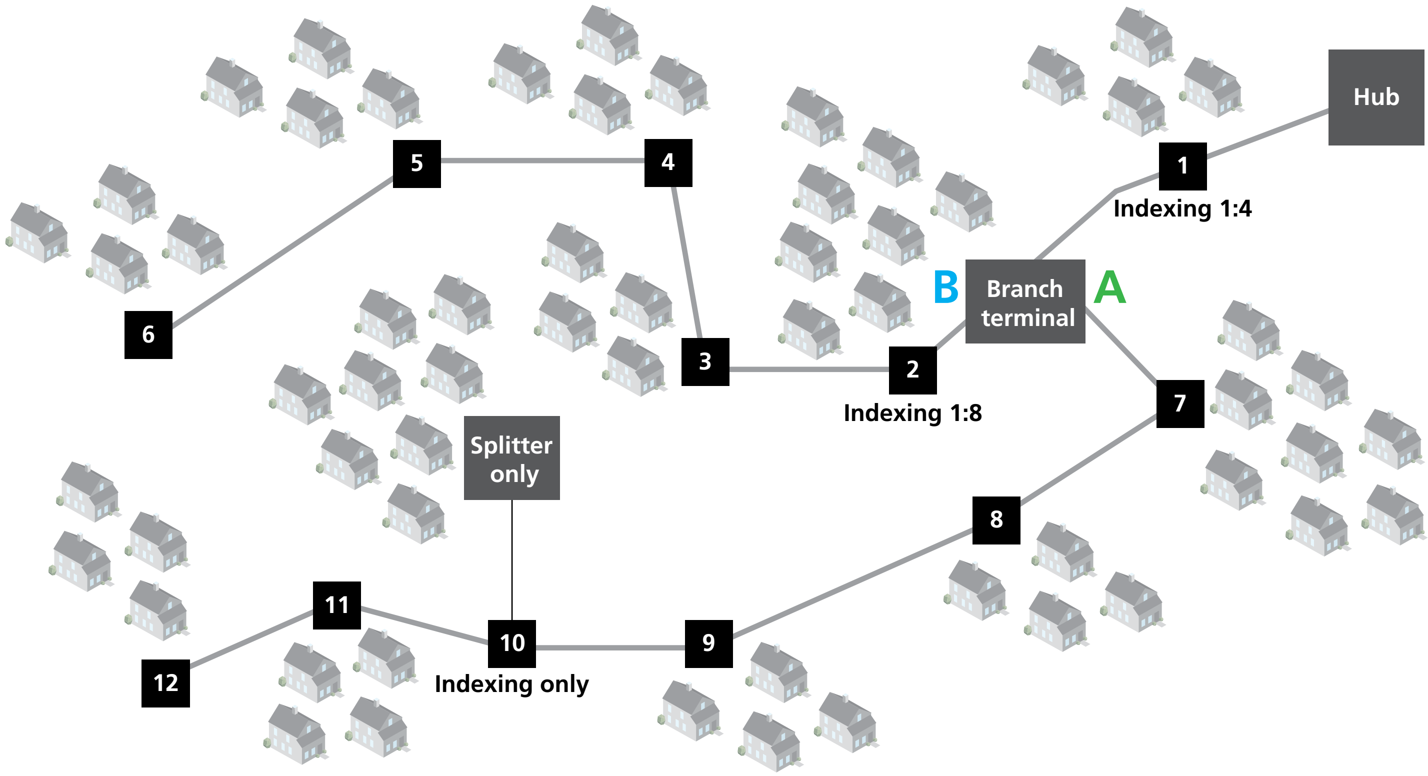
3-fiber variant



6-fiber variant

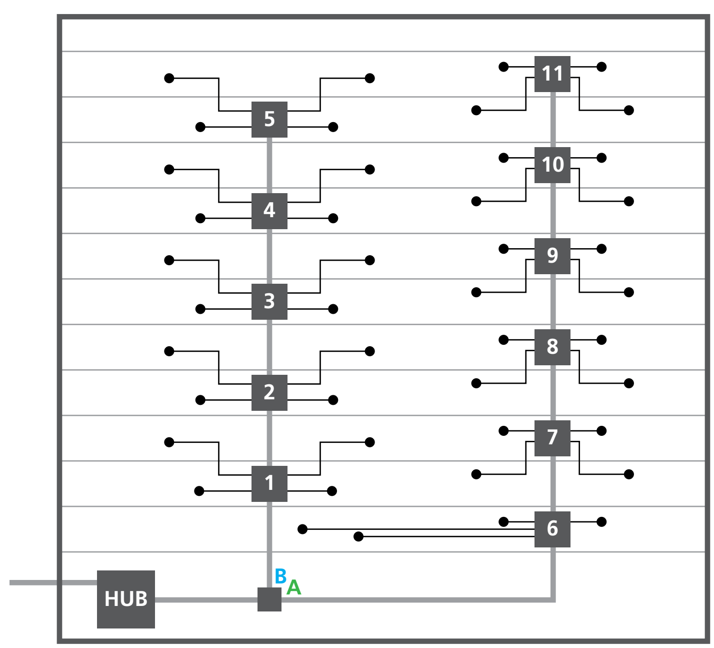


Outside plant network terminal configurations



Following the same criteria, an indexing network can be designed to provide service within a residential or office building—adapting the number of ports and branches, if necessary, to the specific needs of the deployment. Different terminal housings would be used for different situations, depending upon the access point (such as roof top or basement) and distribution (such as façade or vertical/ horizontal in-wall ducting). The image here illustrates a possible configuration for a building network.

Possible building network configuration



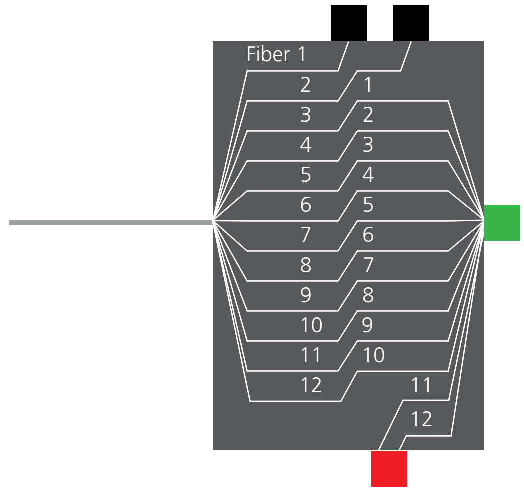
D 12-fiber multi-use indexing terminal with reverse port

This terminal drops the first two to four fibers from the incoming 12-fiber strand, and these fibers are routed to the single drop ports—the black ports in the illustration here. The remaining eight to ten fibers from the incoming 12-fiber strand cable proceed unsplit, and are terminated on an MFOC adapter port, together with the fibers coming from the reverse port. The forward-feed MFOC adapter port is colored green and indicated with an A on the terminal, while the reverse MFOC port is colored red and indicated with an R.

The 3- and 4-fiber variants follow the same cabling concept—dropping fibers 3 and 4 from the incoming 12-fiber strand in addition to fibers 1 and 2, while the extra fibers made available from the outgoing MFOC adapter port are routed to the reverse-feed MFOC port. This way, the 3-fiber variant would have incoming fibers 1 through 3 terminated in the single drop ports, (the black ports); fibers 4 through 12 indexed into 1 through 9 at the outgoing MFOC port; and fibers 10 through 12 of the outgoing MFOC port terminated as fibers 1 through 3 in the reverse MFOC port.

The 4-fiber variant would have incoming fibers 1 through 4 terminated in the single drop ports (the black ports); fibers 5 through 12 indexed into 1 through 8 at the outgoing MFOC port; and fibers 9 through 12 of the outgoing MFOC port terminated as fibers 1 through 4 in the reverse MFOC port.

2-fiber variant



E 12-fiber multi-use indexing terminal with integrated splitter, pass-through fibers, and reverse port

Multi-use fiber terminals are designed to deliver splitter-based services or traditional “unsplit” services, or both. If present, the splitter is always connected to the first fiber of the incoming 12-fiber stand. In the illustration here, the outputs of the splitter are indicated with a black port. Adapters with an orange port indicate a straight pass-through fiber: a fiber dropped off from the incoming 12-fiber chain, but unsplit as it is a regular fiber coming from the hub.

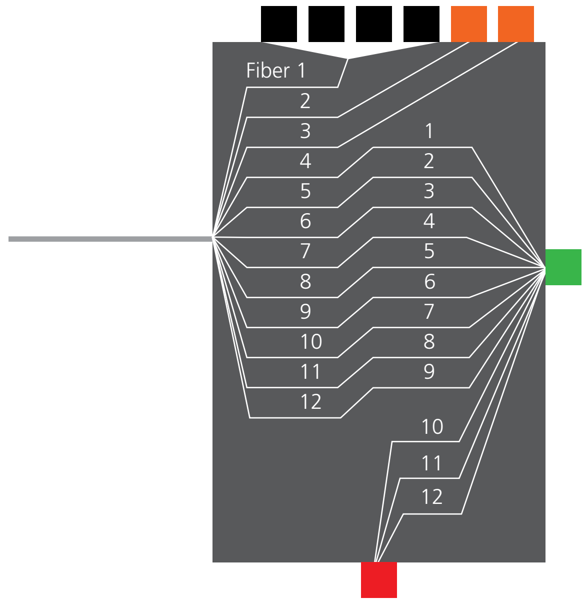
The illustration here shows fiber 1 dropped off and routed to an integrated 1:4 splitter, and fibers 2 and 3 dropped off and directly routed to the adapter port. The other nine fibers from the incoming 12-fiber strand continue via the green MFOC adapter port where fiber 4 of the incoming strand will take in position 1 in the adapter port. Three fibers from the red reverse port will take in positions 10, 11, and 12 in the green MFOC port. In this case the reverse port is also an MFOC adapter port.

The 3- and 4-fiber variants follow the same cabling concept. Fibers 4 and 5 are dropped from the incoming 12-fiber strand in addition to fibers 1 through 3, and the extra fibers made available from the outgoing MFOC adapter port are routed to the reverse-feed MFOC port. This way, the 3-fiber variant would have fiber 1 with an integrated 1:4 splitter with single-fiber drop ports, and incoming fibers 2 through 4 terminated in single drop ports (the black ports). Fibers 5 through 12 are indexed into 1 through 8 at the outgoing MFOC port, and fibers 9 through 12 of the outgoing MFOC port are terminated as fibers 1 though 4 in the reverse MFOC port.

The 4-fiber variant would have fiber 1 with an integrated 1:4 splitter with single-fiber drop ports, and incoming fibers 2 through 5 terminated in single drop ports (the black ports). Fibers 6 through 12 are indexed into 1 through 7 at the outgoing MFOC port, and fibers 8 through 12 of the outgoing MFOC port are terminated as fibers 1 through 5 in the reverse MFOC port.

There is also a final 2-fiber variant with integrated 1:8 splitter. This terminal will drop fiber 1 with an integrated 1:8 splitter with single-fiber drop ports, and incoming fibers 2 through 3 terminated in single drop ports (the black ports). Fibers 4 through 12 are indexed into 1 through 9 at the outgoing MFOC port, and fibers 10 through 12 of the outgoing MFOC port are terminated as fibers 1 through 3 in the reverse MFOC port.

2-fiber with 1:4 splitter variant



F 24-fiber multi-use indexing terminal with reverse port

24-fiber indexing terminals are designed to deliver bulk fiber into a distribution area where split and unsplit services are needed. On-board splitters have been removed in favor of external splitters. Fibers are allocated into two groups: fibers 1 through 12 are configured to the standard indexing model, and fibers 13 through 24 are configured as pure pass-through without indexing. This segregation allows for the express delivery of fibers independent of indexing architectures when necessary, and replenishment of fiber when the indexing string becomes exhausted.

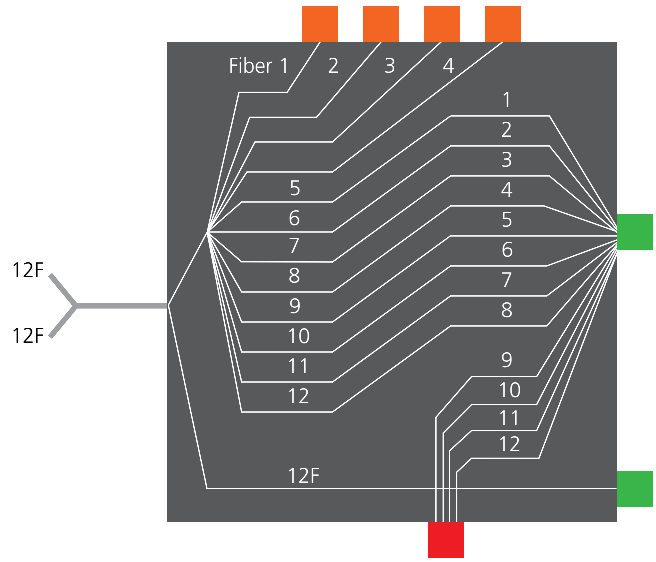
The illustration here shows the first four fibers dropped off. The signal is unsplit. The fiber in each of these drop-off ports is a straight pass-through fiber, and the port is orange. Fiber 5 of the incoming 12-fiber strand takes position 1 of the outgoing MFOC adapter port, A1. Four fibers of the reverse port take positions 8 through 12 in that adapter port.

Indexing terminals exhaust themselves once 12 fibers have been allocated. This may happen in as few as three links or as many as 12 links, depending upon how the fibers are distributed along the way. 24-fiber terminals have the capacity to replenish an indexing string by harnessing the express group on the A2 port, by attaching the next indexing terminal to this port. If the next terminal is a 24-fiber terminal, then the tail connectors will be swapped; for example: the A1 tail connector to the A2 port and the a2 tail connector to the A1 port.

The 3- and 4-fiber variants follow the same cabling concept, dropping fibers 3 and 4 from the incoming dual 12-fiber strand in addition to fibers 1 and 2, and the extra fibers made available from the outgoing MFOC adapter ports are routed to the reverse-feed MFOC port. This way, the 3-fiber variant would have incoming fibers 1 through 3 terminated in single drop ports, the black ports; fibers 4-24 are indexed into 1 through 21 at the outgoing MFOC ports; and fibers 22 through 24 of the outgoing MFOC ports are terminated as fibers 1 through 3 in the reverse MFOC port.

The 4-fiber variant would have incoming fibers 1through 4 terminated in single drop ports, the black ports; fibers 5 through 24 indexed into 1 through 20 at the outgoing MFOC ports; and fibers 21 through 24 of the outgoing MFOC ports terminated as fibers 1 through 4 in the reverse MFOC port.

4-fiber variant



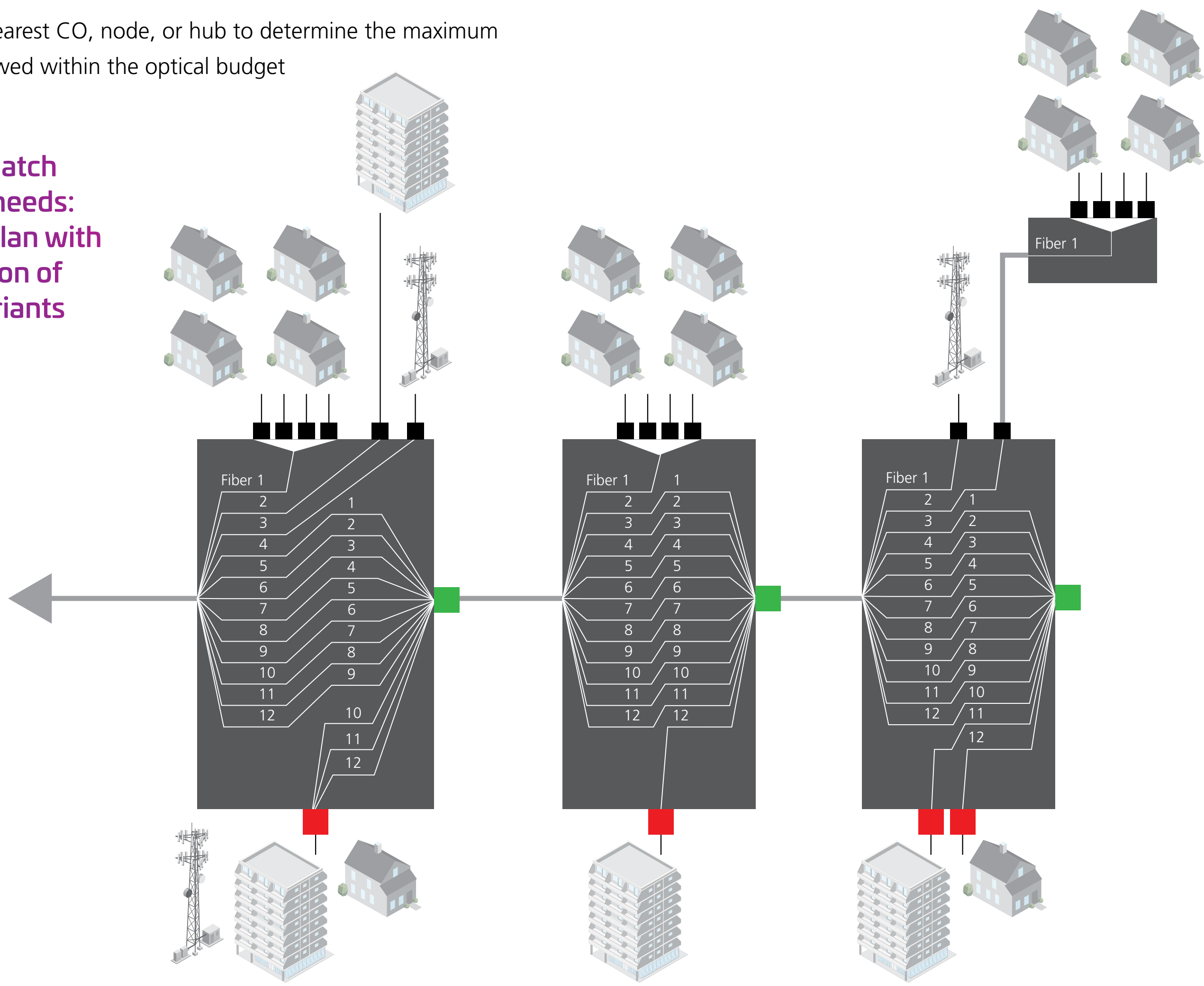
Designing a flexible network design with indexing terminals

Different configurations of indexing terminals can be combined to maximize the flexibility and capacity of the distribution network. Terminal selection will be determined by the services and market penetration needed for the specific area of the deployment. Combining different terminal designs can create a more flexible network, and allow the convergence of different services such as single-family units, multiple dwelling units, businesses, and cell towers. To build an optimized network utilizing indexing terminals, consider the following before beginning the network design:

- For an overview of the deployment area, locate and identify all customers
- Clarify all drawing nomenclature such as hand holes, poles, ducts, terminals, etc.
- Identify the availability of feeder fiber cables, and define their fiber count and type
- Locate the nearest CO, node, or hub to determine the maximum distance allowed within the optical budget
- Consider drop cable distances and routes
- Identify any network deployment restriction such as poles, aerial capacity, underground ducts, etc.
- Discuss the best locations for indexing terminals (for example, aerial, pole, wall, manhole, etc.)
- Consider the maximum number of services per indexing terminal
- Identify the split ratio specified by the project

In a typical daisy-chain configuration, the first splitting level occurs in a fiber distribution hub, and the second splitting level occurs within the indexing terminals. Indexing chains always start with terminal 1, and build outward in procession to a value no greater than 12. Indexing chains always provide the next fiber to the next terminal; for example, terminal 1 will use fiber 1 within the "chained" assembly.

Design to match real-world needs: a network plan with a combination of terminal variants



Link loss calculations

To determine the overall link loss for a network design, consider the following:

Physical

- Quality and quantity of splice points
- Connectors
- Split ratios
- Fiber make-up (SMF 28 = 9 micron fiber)

Optics power

- Class of PON
- Receiver sensitivity

Link budget

- Transceiver power budget
- Losses from multiplexing and demultiplexing
- Fiber losses
- Splice losses
- Patch panel and connector losses

The physical elements will determine the added losses in the link, while the optics power will determine the total optical budget available for the link. The first step in calculating the link loss is to determine the typical losses for each element.

Once these elements are determined, identify the events in the link from the headend or central office downstream to the distribution hub. This value will be added to each indexing terminal. For the indexed distribution network, follow the same addition process.

LOSS TABLES

Splitter loss table

Values do not include connectors.

Split ratio	Typical loss (dB)	Connector type
1:2	3.4	SC/APC
1:4	6.7	SC/APC
1:8	9.9	SC/APC

Event loss table

Event	Typical loss (dB)
Fusion splice	0.05
SC/APC	0.2
Hardened single fiber	0.2
Multi-fiber connector	0.2
Hardened mult-fiber connector	0.2

Fiber loss table

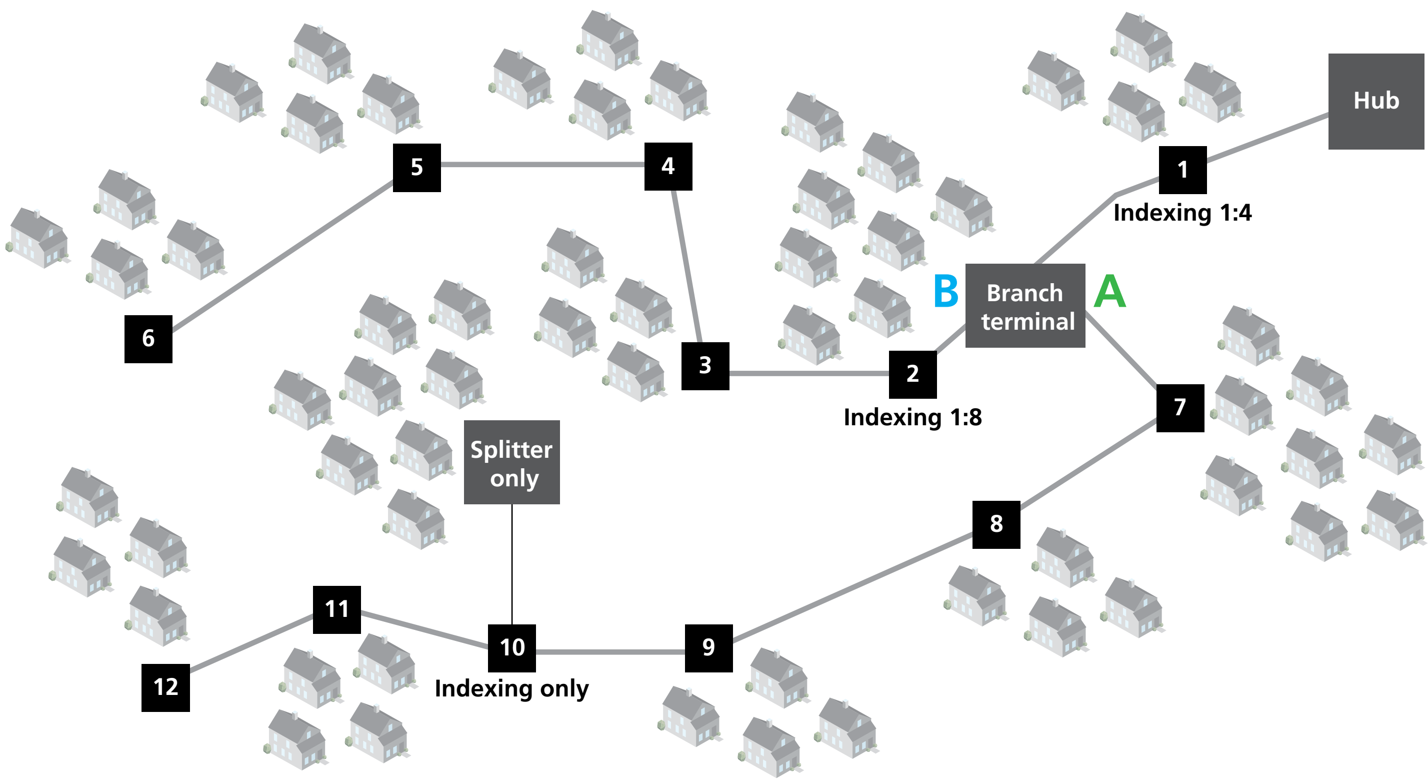
Wavelength (nm)	Loss/km (dB)	Loss/mi (dB)	Band
1550	0.25	0.4	C*
1490	0.28	0.48	S*
1310	0.4	0.64	O*

*Wavelengths used in BPON, EPON, GPON

Network design example

Premise: Using a 1x32 split ratio with 1x4 splitters at the hub and 1x8 at the indexing terminals. Individual events considered:

- 1x4 splitter = 6.7 dB (hub)
- 1x8 splitter = 9.9 dB (indexing terminal)
- SC/APC connector = 0.2 dB (splitters, hub and indexing terminals)
- MFOC connector = 0.2 dB



First indexing terminal

6.7 dB (hub 1x4 splitter) + 0.2 dB (hub SC/APC connectors) + 0.2 dB (indexing first MFOC connector) + 9.9 dB (terminal 1x8 splitter) + 0.2 dB (indexing SC/APC connector) = 17.2 dB

Second indexing terminal

6.7 dB (hub 1x4 splitter) + 0.2 dB (hub SC/APC connectors) + 0.2 dB (indexing first MFOC) + 0.2 dB (second MFOC) + 9.9 dB (terminal 1x8 splitter) + 0.2 dB (indexing SC/APC connector) = 17.4 dB

Third indexing terminal

6.7 dB (hub 1x4 splitter) + 0.2 dB (hub SC/APC connectors) + 0.2 dB (indexing first MFOC) + 0.2 dB (second MFOC) + 0.2 dB (third MFOC) + 9.9 dB (indexing 1.8 splitter) + 0.2 dB (indexing SC/APC connector) = 17.6 dB

Repeat for every terminal in the chain and add the link losses, including upstream value from hub to CO/HE. Make sure it's within the optical budget determined by the optics used.

For support in evaluating application of an indexed solution in your network please contact your local CommScope representative.

Partner with a proven innovator to build your network

With a 40-year record of industry leadership, innovation, and customer success, CommScope can help you create the fiber infrastructure you need.

Leveraging our network expertise and diverse FTTX solutions—of which fiber indexing is one of many—we collaborate with our customers to ensure the single best design and blend of technologies for each specific application. From solution architects to field application engineers, we're there with best-practice advice and real-world information on technology pros and cons to help you get the most from your FTTX deployment. More than a supplier, CommScope is a partner and trusted advisor.

CommScope pushes the boundaries of communications technology with game-changing ideas and ground-breaking discoveries that spark profound human achievement. We collaborate with our customers and partners to design, create and build the world's most advanced networks. It is our passion and commitment to identify the next opportunity and realize a better tomorrow. Discover more at commscope.com.

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