



Layer 1 Optical Tapping

Some considerations & points to remember

January 2022

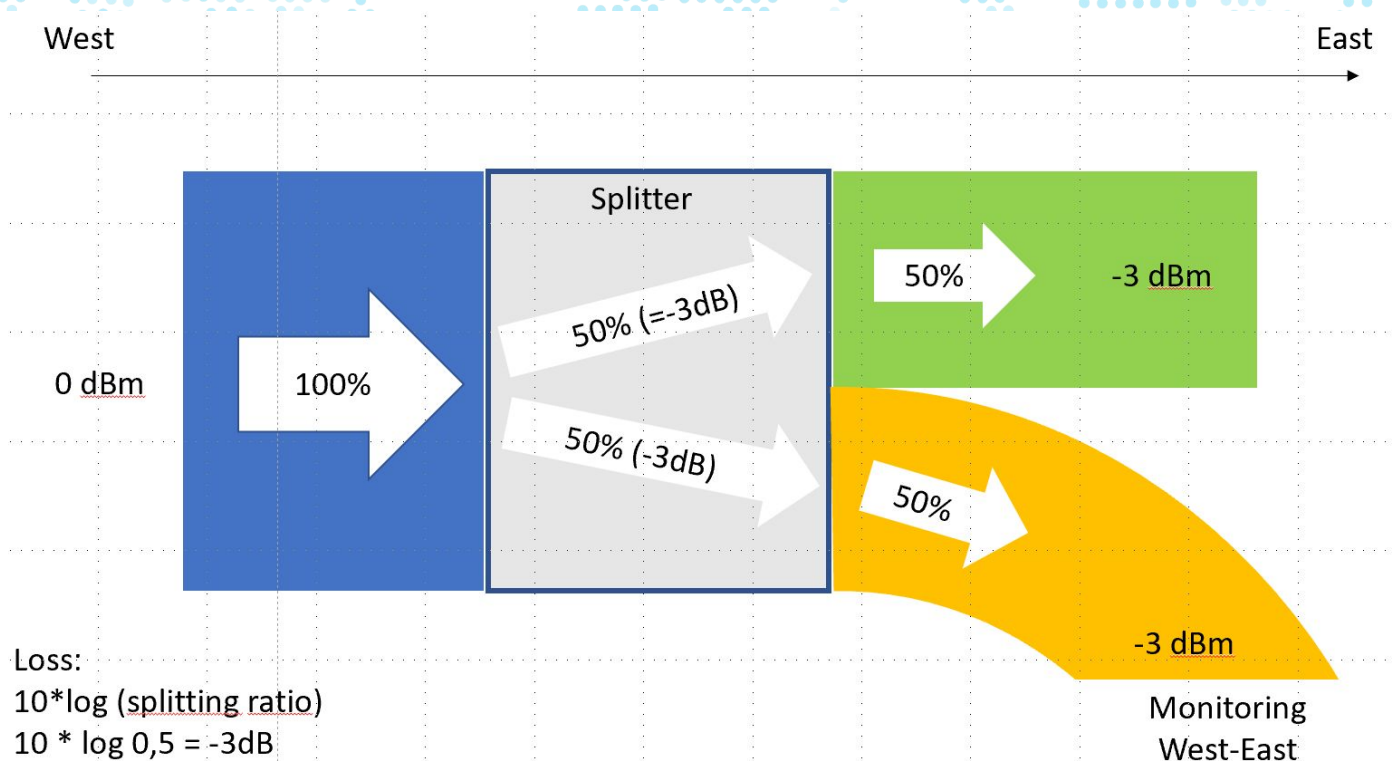
Contents



- Some Basics
- Optical Power Budget
- Tapping 10Gbit/s links
- Tapping 100Gbit/s links
- Additional important information

Some Basics

50:50 Splitter

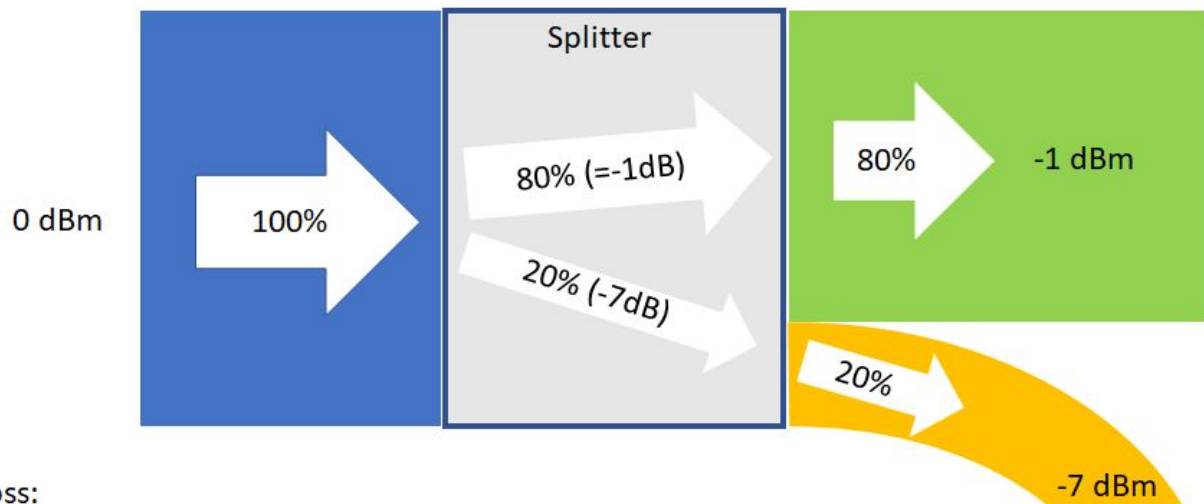


- Fully transparent and passive
- But insertion loss is introduced

80: 20 Splitter

West

East



Loss:

$10 \cdot \log(\text{splitting ratio})$

$10 \cdot \log 0,8 = -1\text{dB}$

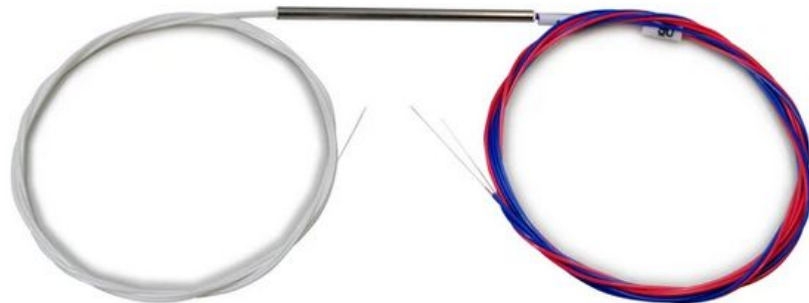
$10 \cdot \log 0,2 = -7\text{dB}$

- Fully transparent and passive
- But insertion loss is introduced

Splitter vs. TAP



- Splitter
 - Component inside a TAP
 - Insertion Loss can be calculated
 - E.g. **50%** = $10\text{dB} \cdot \log(0,5) = -3\text{dB}$
 - Insertion Loss: 3dB



- TAP
 - Usually for multiple full duplex links - includes connectors
 - Total Insertion Loss (IL) is more than just splitter

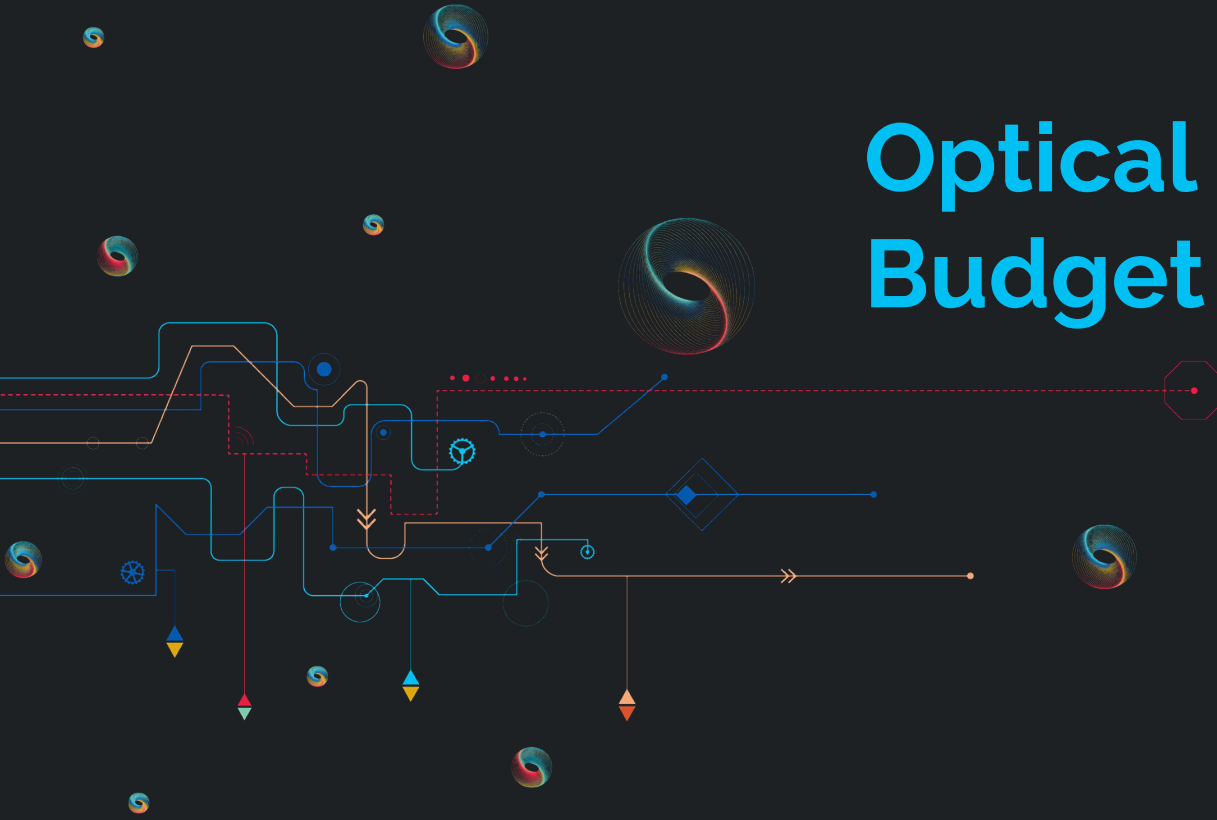


Insertion loss (IL) of Splitter and TAP



Splitting Ratio	Splitter only		TAP MAX. value (incl. connectors acc. ANSI_TIA_EIA-568-B.3)		TAP typical value (Cubro)		Cubro internal Limit	
	IL Live Link in dB	IL Monitoring in dB	IL Live Link in dB	IL Monitoring in dB	IL Live Link in dB	IL Monitoring in dB	IL Live Link in dB	IL Monitoring in dB
90 : 10	0,5	10	2,5	12	1	10,7	2	11,6
80 : 20	1	7	3	9	1,7	7,8	2,6	8,6
70 : 30	1,5	5,2	3,5	7,2	2,2	6	3,1	6,8
50 : 50	3	3	5	5	3,5	3,5	4,6	4,6

Optical Power Budget



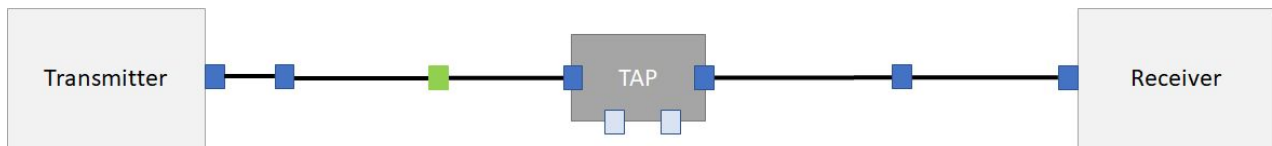
Optical power budget



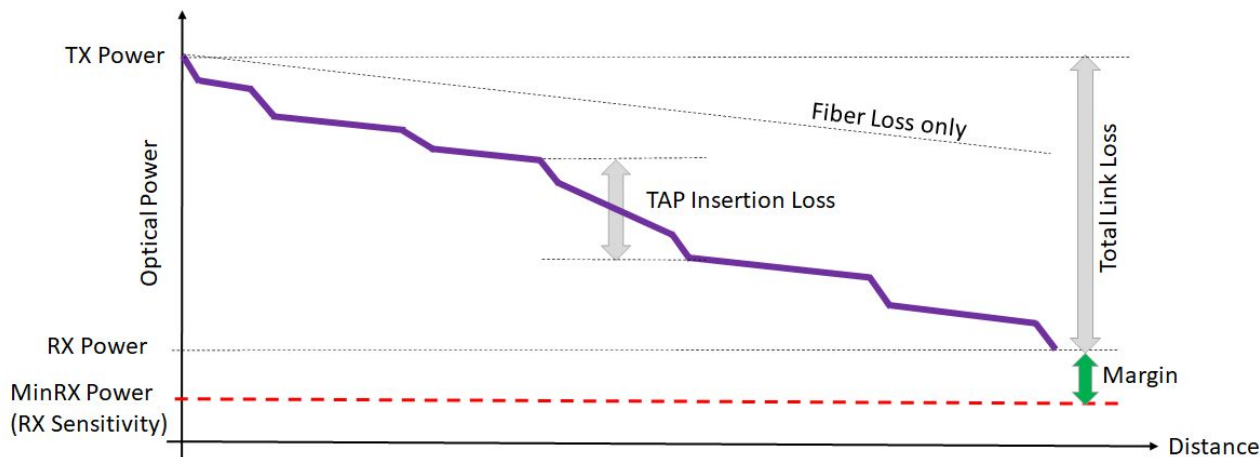
— Optical fibre

■ Optical connector

■ Optical splice



For a link budget analysis, both the passive & active components of the link have to be included in the calculation.



ANSI TIA_EIA-568-B (max. values)

- Connector Loss: 0,75dB
- Splice Loss: 0,3dB
- Fiber Loss
 - MM 850nm: 3,5dB/km
 - MM 1300nm: 1,5dB/km
 - SM 1310nm: 0,4dB/km
 - SM 1550nm: 0,3dB/km

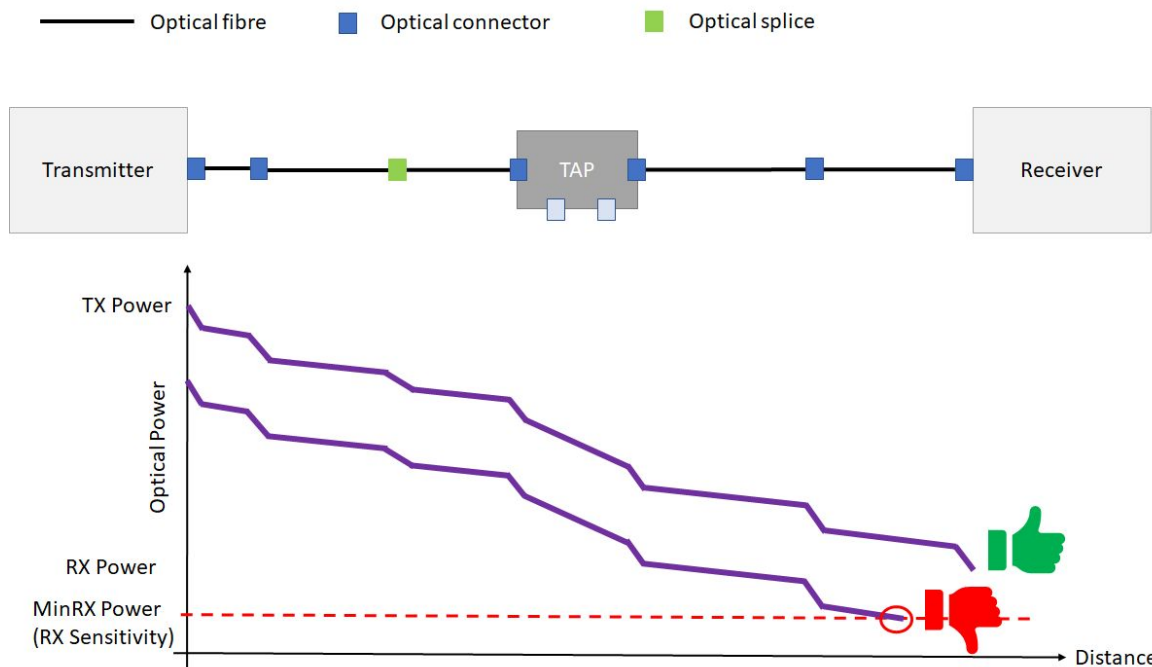
Receiver needs to get enough optical power to detect/decode the signal properly.

Active link elements - Transceivers



Transceivers have a main influence to the optical budget calculation as they define the starting point (= TX power) and also the end point (=min RX. Power/Sensitivity).

Problem is that optical transceivers are specified with a huge window of allowed TX power levels.



TX Power -8.2~0.5dBm

TX Power -7.3~-1dBm

TX Power -8.4~2.4dBm

Receivers connected to monitoring outputs of the TAP also need enough power to work.

IMPORTANT - Take care of optical connectors



Before shipment every delivered Cubro TAP is carefully cleaned, inspected with a microscope and is shipped with a test report.

More than 90% of claims are a result of in-proper handling. **The major source of error is dirt.** Cubro TAPs will arrive with clean connectors but dirty patchcords will influence the optical budget calculation and in some cases even the front connectors of the TAP will get damaged! **Such cases are not covered by warranty.**



Optical Budget Summary



- Know your available optical budget and plan accordingly.
- Don't forget that monitoring equipment connected to TAPs also needs enough optical power to work.
- Never forget to leave a margin.
- Keep in mind the wide windows of transceiver TX power and that TX power of Transceiver might change over time.
- Proper handling is mandatory - always use dust caps and cleaning tools. Even new patch-cords can be very dirty.

Cubro offers a wide range of high quality optical Layer 1 solutions/products.

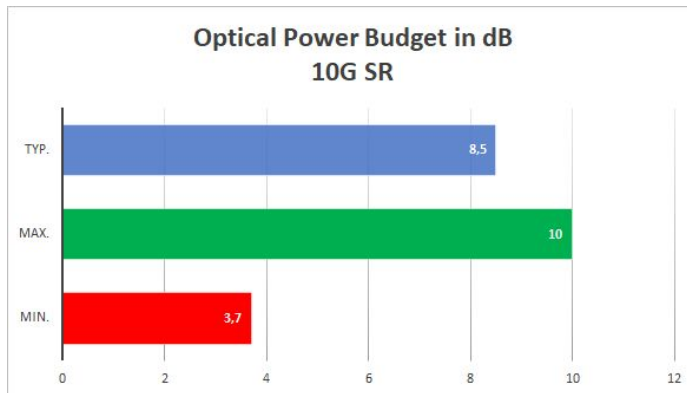
Tapping 10G

10G SFP+ Specifications and their optical budget



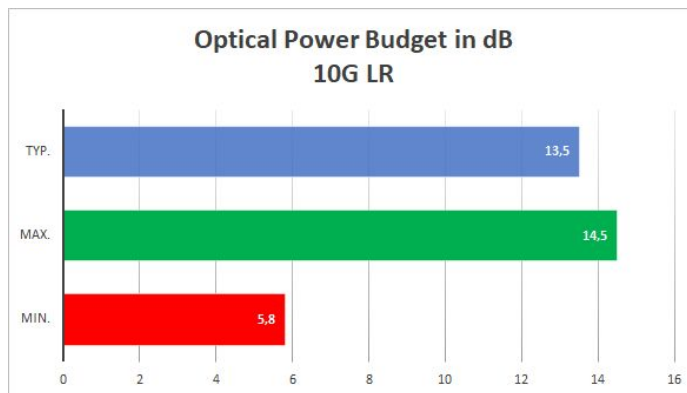
- 10G SFP+ SR Specifications

- TX Power max: -1dBm
- TX Power min.: -7,3dBm
- [TX Power typ.: -2,5dBm]
- RX Sensitivity: -11dBm



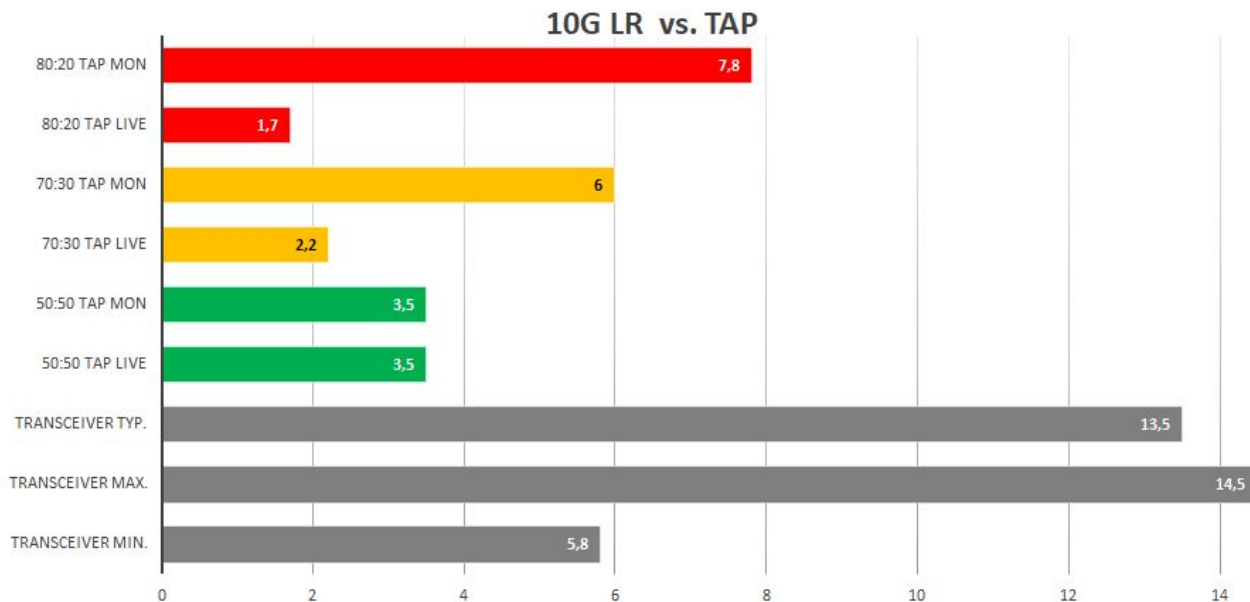
- 10G SFP+ LR Specifications

- TX Power max: 0,5dBm
- TX Power min.: -8,2Bm
- [TX Power typ.: -0,5dBm]
- RX Sensitivity: -14dBm



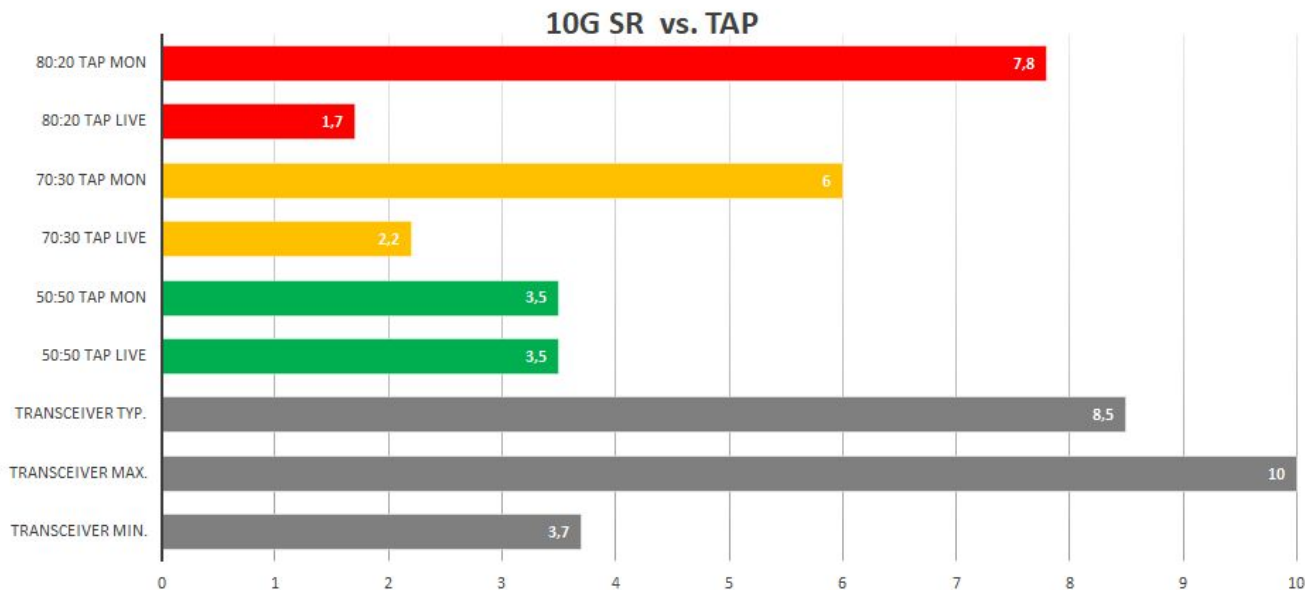
Transceiver only!
No other loss included!

Split Ratio for 10G LR Singlemode



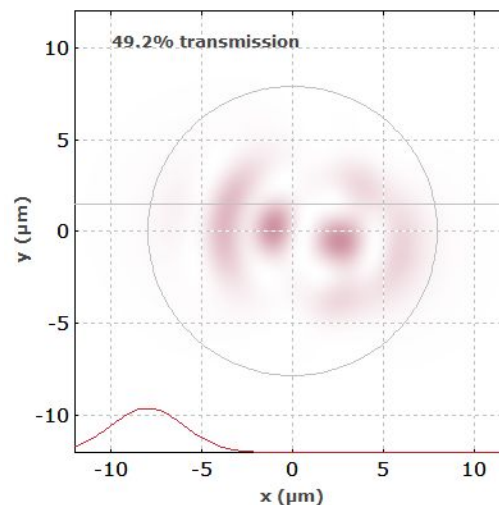
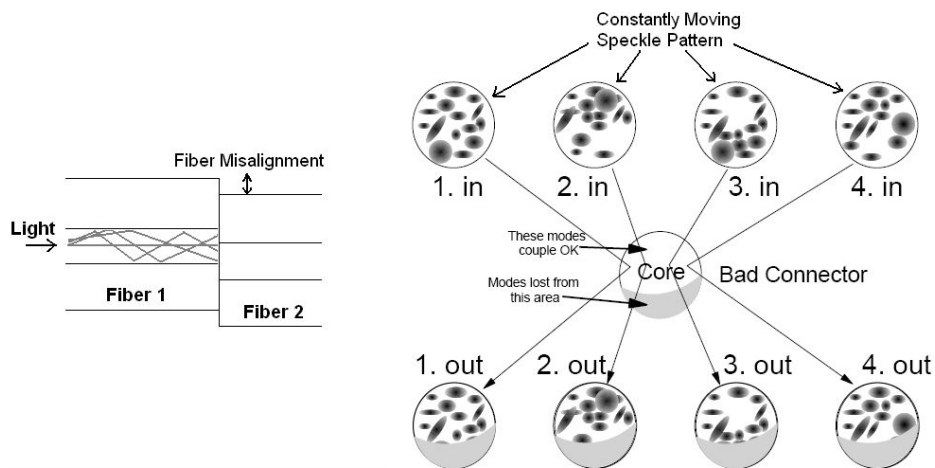
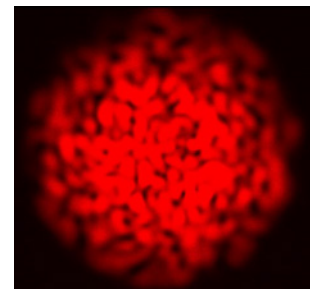
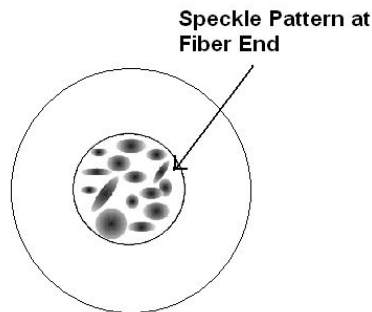
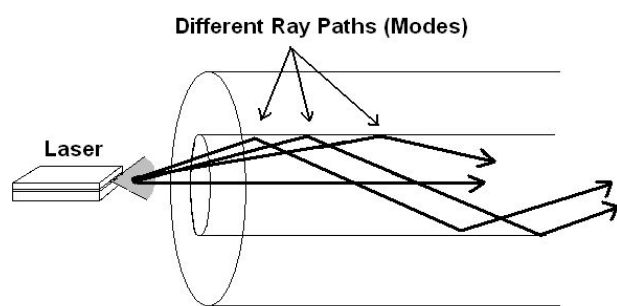
- Usually 10G Singlemode is tapped with **80:20**.
 - Of course also **70:30** and **50:50** ratio is fine.
 - **For upgradeability to 100G a ratio of 50:50 is recommended** - see later.
- **90:10** ratio is not recommended - as it features about 10,7dB insertion loss on monitoring ports.

Split Ratio for 10G SR Multimode



- Best option for Multimode is **50:50** ratio.
- From the figures **70:30** split ratio looks to be o.k. but margin is very low.
- **About 1% to 2% of 70:30 tapped links cause problems at monitoring outputs.**

Mode distribution problem in MMF



Up to 2,5dB
insertion loss
has been seen.
→ 70:30
splitting ratio
is not
recommended
for MM

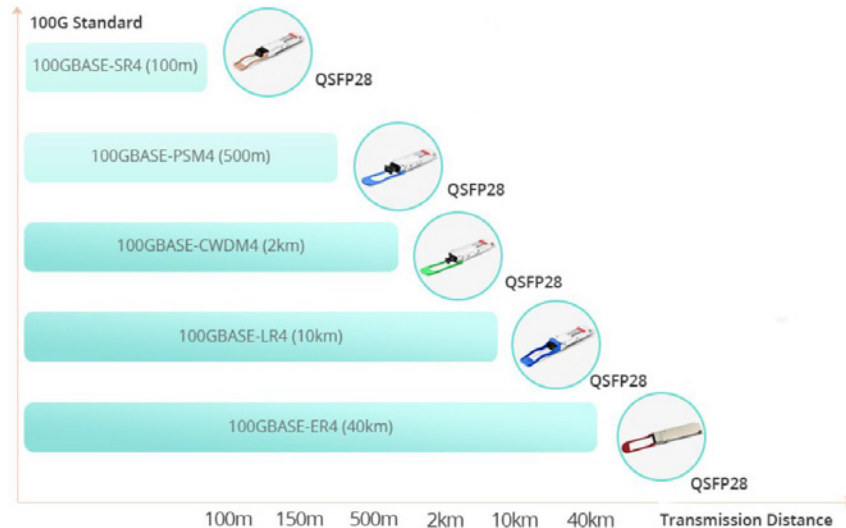
Tapping 100G

Types of 100G

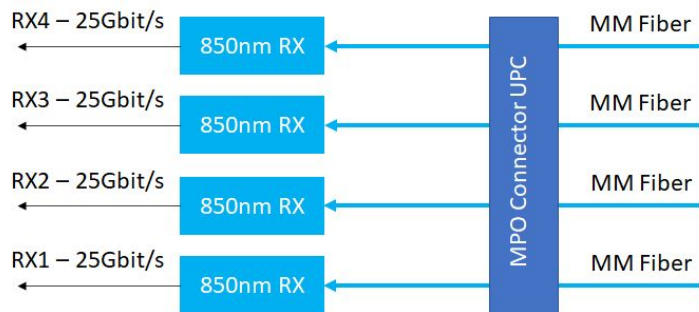
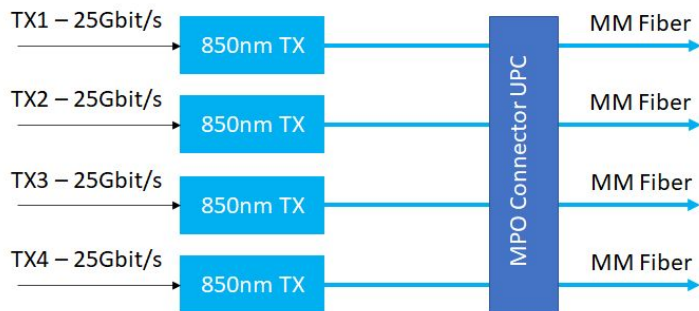


Basically 100G comes in 4 different options and can be divided into 2 groups

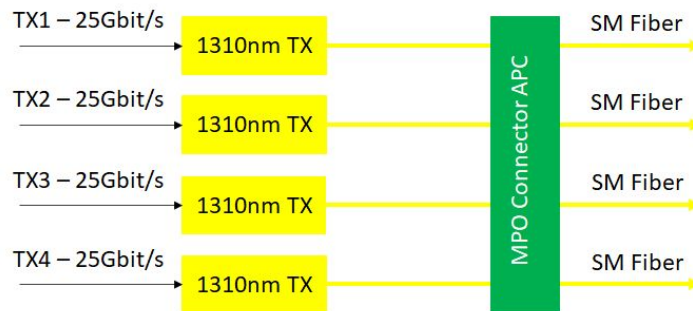
- Multifiber transmission such as 100G SR4 and 100G PSM4
- Single fiber transmission using WDM such as 100G CDWM4, 100G LR4 and 100G ER4



100G SR4 and 100G PSM4

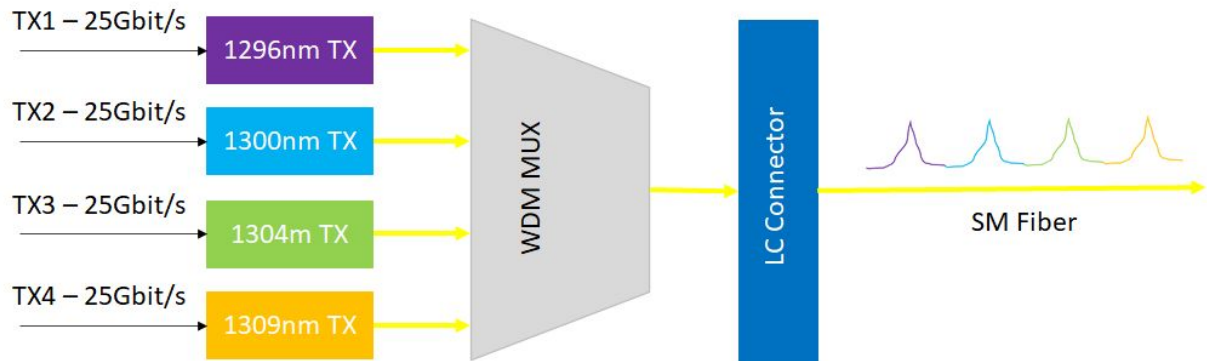


100G SR4



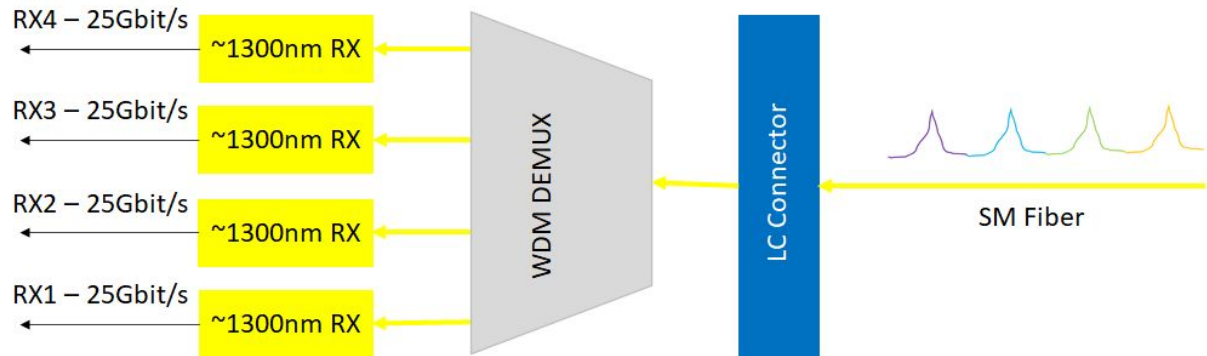
100G PSM4

100G LR4



100G CWDM4 uses different wavelengths than LR4

- 1271nm
- 1291nm
- 1311nm
- 1331nm



100G transceivers



	QSFP28 SR4	QSFP28 PSM4	QSFP28 CDWM 4	QSFP 28 LR4
Connector	MPO (UPC)	MPO (APC)	LC (UPC)	LC (UPC)
Fiber	Multimode	Singlemode	Singlemode	Singlemode
Transmission type	transmission on different fibers		WDM on single fiber	
Wavelength Lane 1 in nm	850	1310	1291	1296
Wavelength Lane 2 in nm	850	1310	1271	1300
Wavelength Lane 3 in nm	850	1310	1311	1304
Wavelength Lane 4 in nm	850	1310	1331	1309
TX Power per Lane max. in dBm	2,4	2	2,5	4,5
TX Power per Lane min. in dBm	-8,4	-9	-6,5	-1,4
TX Power per Lane typ. In dBm	0	0,5	0,5	3
Min. RX Power per Lane in dBm	-10,3	-12,5	-11,5	-7,7
Max. optical power budget in dB	12,7	14,5	14	12,2
Min. optical power budget in dB	1,9	3,5	5	6,3
Typ. optical power budget in dB	10,3	13	12	10,7
Max. Distance in km	0,1	0,5	2	10

100G Splitting Ratio



- 1000B-SX / 10G SR



- Multimode, typ. transceiver budget 17dB / 8dB
- 50:50 splitting ratio

- 1000B-LX / 10G LR



- Singlemode, typ. transceiver budget 21dB / 13dB
- 80:20 or **50:50** splitting ratio

- **For any 100G application** (100G SR4, 100G PSM4, 100G CWDM4 and 100G LR4)

ALWAYS use 50:50 splitting ratio



MPO MM TAP - 4 links, 50:50, 1/3U for 100G SR4



MPO SM TAP - 4 links, 50:50, 1/3U for 100G PSM4



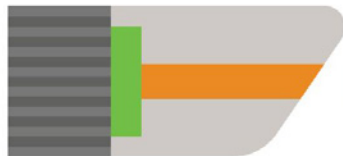
LC SM TAP - 8 links, 50:50, 1/3U for 100G CWDM4 and 100G LR4

Additional points to remember

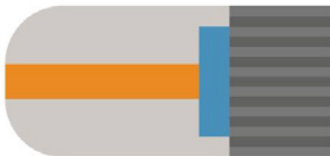
Don't mix up connector types



APC



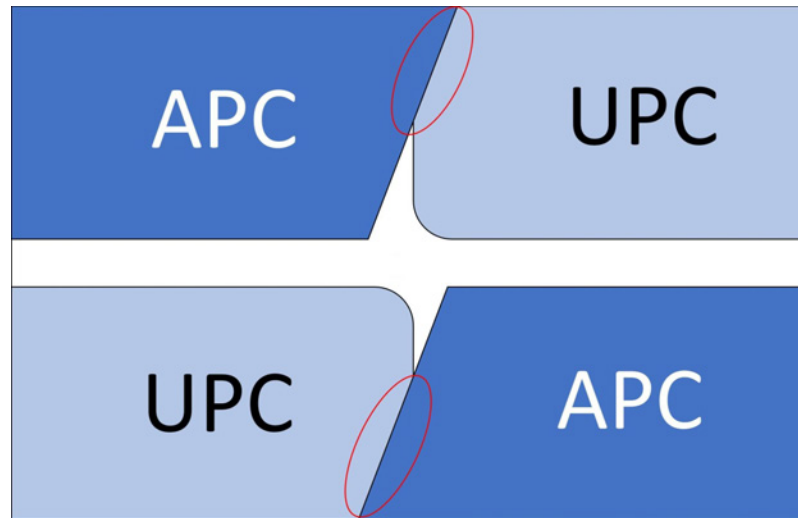
UPC



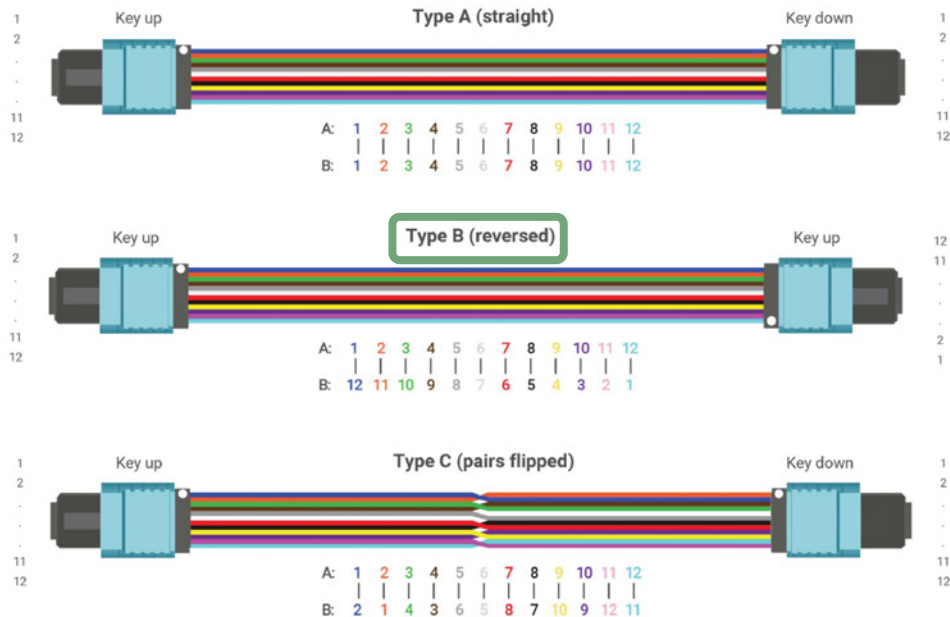
100G PSM4



100G SR4



Use the right (MPO) cables



Equipment like Switches are connected via Type B cables (TX - RX connection).

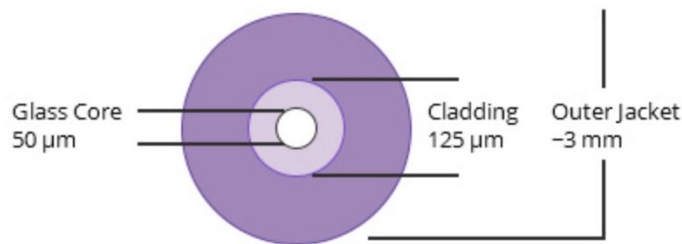
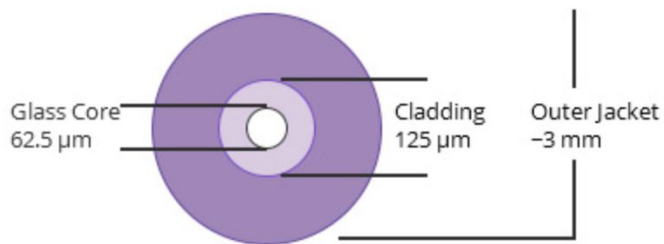
The same cable is also needed to make following connections.

- Live Equipment West to TAP
- TAP to Live Equipment East
- Monitoring West to NPB
- Monitoring East to NPB

Multimode fibers - 50μm vs 62,5μm



Normally, multimode fiber can be divided into OM1 fiber, OM2 fiber, OM3 fiber, OM4 fiber and OM5 fiber determined by the ISO 11801 standard. Among these fibers, only OM1 fiber is 62.5/125μm fiber, the other four are 50/125μm fibers.



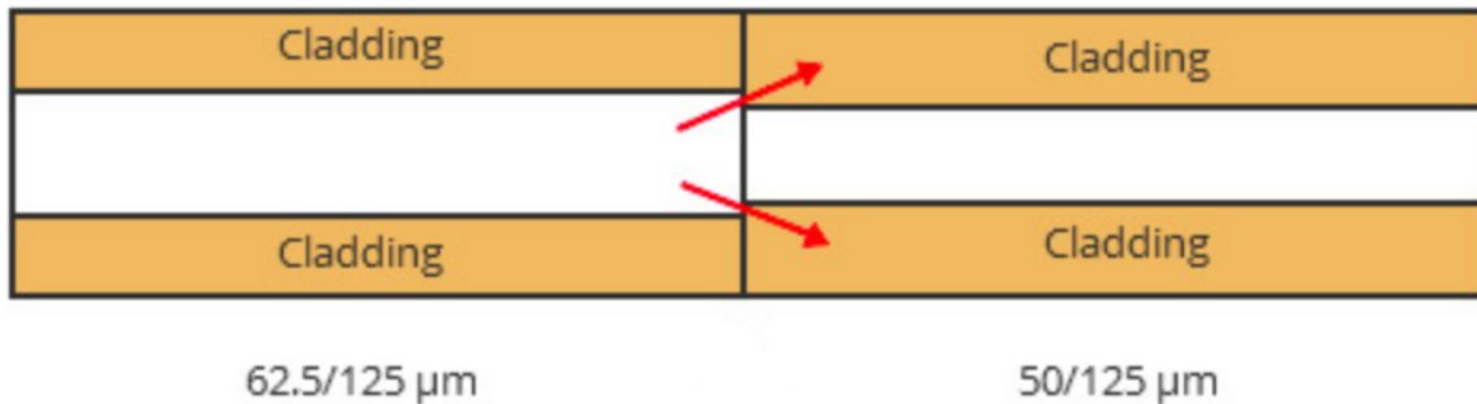
Name	100MB	1000BASE-SX	10GBASE-S	40GBASE-SR4	100GBASE-SR10
OM1	2000m	275m	33m	Not specified	Not specified
OM2	2000m	550m	82m	Not specified	Not specified
OM3	2000m	550m	300m	100m	100m
OM4	2000m	1000m	550m	150m	150m

Name	Diameter	Jacket Colors	Optical Source	Bandwidth
OM1	62.5/125 μm	Orange	LED	200MHz*km
OM2	50/125 μm	Orange	LED	500MHz*km
OM3	50/125 μm	Aqua	VCSEL	2000MHz*km
OM4	50/125 μm	Aqua	VCSEL	4700MHz*km

Cubro Optical MM TAPs are available in 50μm and 62,5μm version.

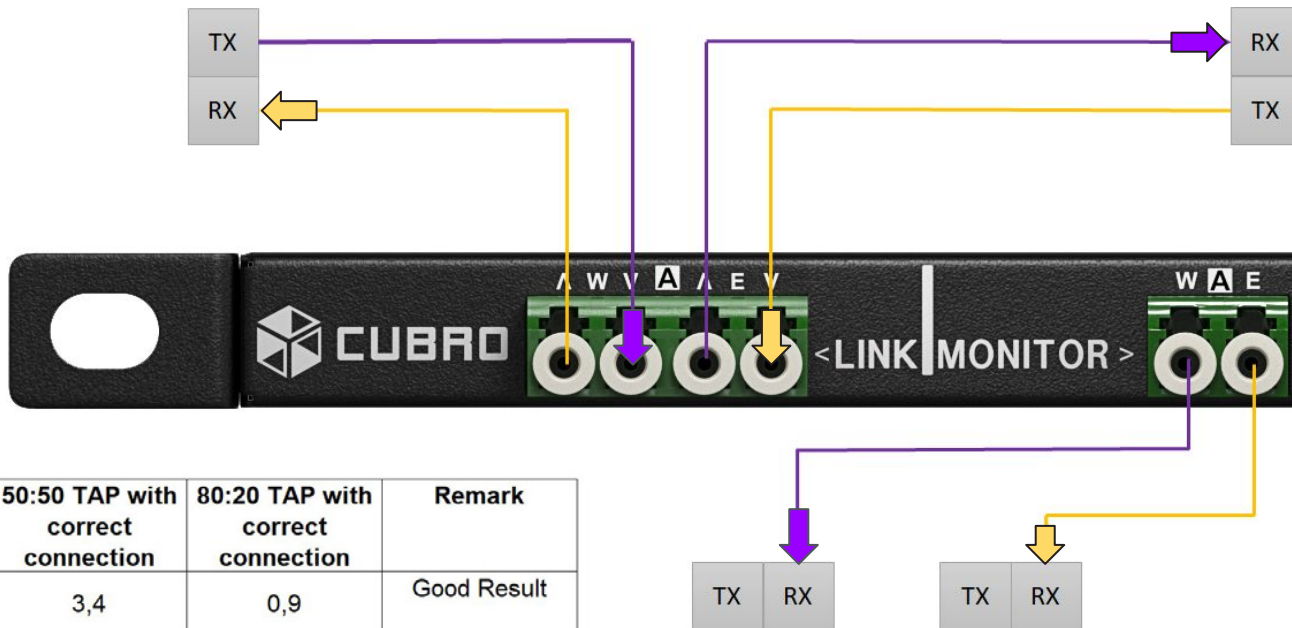
Mixing 50 μ m and 62,5 μ m

- Light travelling from 50 μ m to 62,5 μ m: not ideal but not so much of a problem
- Light travelling from 62,5 μ m to 50 μ m: **2 to 6dB insertion loss**



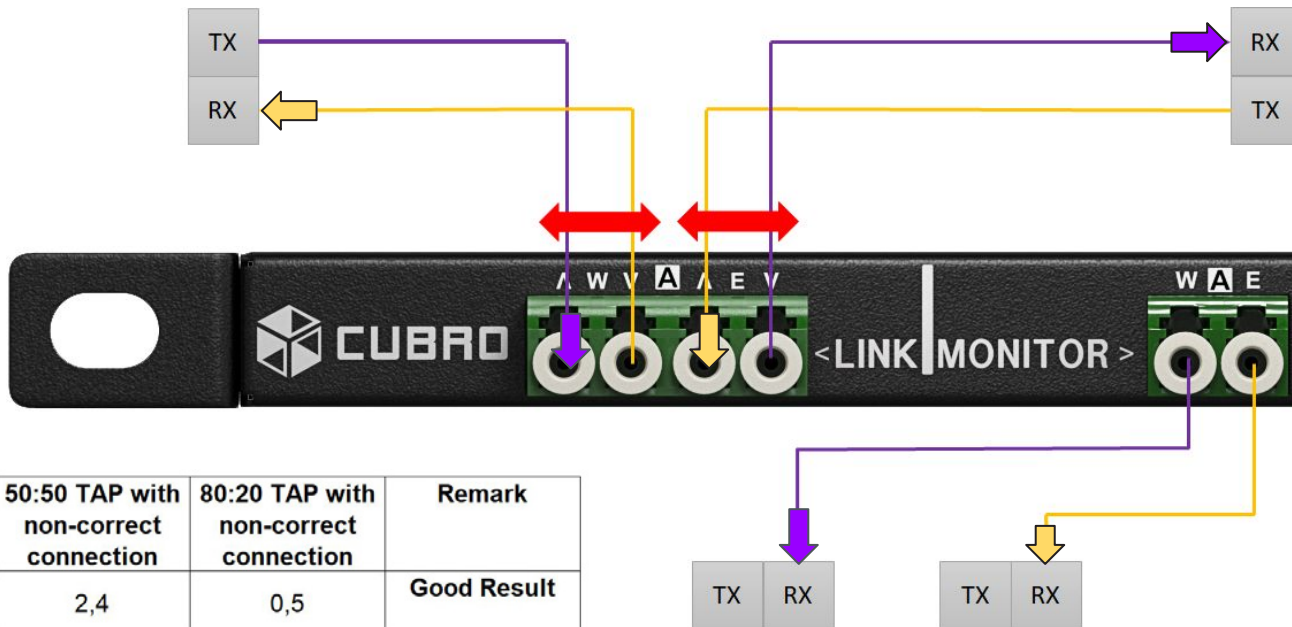
Mixing Multimode with Singlemode gives about 20dB insertion loss.

TX and RX - correct connection



	50:50 TAP with correct connection	80:20 TAP with correct connection	Remark
Insertion Loss West-East in dB	3,4	0,9	Good Result
Insertion Loss East-West in dB	3,5	1	Good Result
Insertion Loss Monitoring West in dB	3,5	7,1	Good Result
Insertion Loss Monitoring East in dB	3,6	7,2	Good Result

TX and RX - reversed (WRONG) connection



	50:50 TAP with non-correct connection	80:20 TAP with non-correct connection	Remark
Insertion Loss West-East in dB	2,4	0,5	Good Result
Insertion Loss East-West in dB	2,7	0,9	Good Result
Insertion Loss Monitoring West in dB	38	37	Bad Result
Insertion Loss Monitoring East in dB	39	38	Bad Result

Live Link is working but not the monitoring!

Reporting problems to us



Please use our Support Portal -
<https://support.cubro.com> for reporting problems.

Provide as much as possible details:

- Information like “Link is not going up is simply not enough” to help.
- Before contacting us, make sure to do
 - cleaning (and inspect connectors with microscope)
 - verify power levels (all equipment involved)

The screenshot shows a web browser window with the address bar displaying 'support.cubro.com/support/login'. The page has a black header with the CUBRO logo. Below the header, the text 'Welcome to the Cubro Support Platform!' is followed by instructions to login with a username and password. There are two input fields: 'Your e-mail address' and 'Password'. A checkbox labeled 'Remember me on this computer' is checked. Below the fields is a link for 'Forgot your password?'. At the bottom is a blue 'LOGIN' button.

Summary



Layer 1 optical tapping is basic requirement for network visibility. Cubro offers innovative and high quality Layer 1 network visibility solutions and expertise.

Customer Support



Technical Capabilities



Value Money



Reliability



Flexibility



Customer First



Collaboration



@Cubro

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THANK YOU

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