APPLICATION NOTES

A Practical Guide to MPO Patchcords and Fan-out Assemblies

MPO to MPO Patchcords and MPO–LC / SC / ST Fan-outs

This application note provides a comprehensive overview of MPO patchcords and MPO-to-duplex fan-out assemblies, focusing on the critical design variables that impact performance and compatibility in high-speed fiber optic networks.

The key technical factors include fiber count, polarity type (A, B, C), connector gender (pinned vs. non-pinned), polarity method, fiber type (OM3/OM4/OM5/OS2), and key orientation. Among these, polarity is the most critical, as it ensures proper alignment between transmit (Tx) and receive (Rx) signals across multiple fibers.

MPO-to-MPO patchcords are widely used in data center environments such as spine-leaf architectures, hyperscale cloud infrastructure, and high-performance computing. MPO fan-out assemblies (also called breakout or hydra cables) convert multi-fiber MPO connections into duplex connectors like LC, SC, or ST, enabling compatibility with standard transceivers.

The document also outlines common deployment scenarios, such as direct MPO connections (typically Type B), structured cabling with cassettes (typically Type A), and breakout configurations (typically Type B with internal mapping). It highlights design considerations like Base-8 vs. Base-12 architectures, where Base-8 is optimized for modern parallel optics and Base-12 offers greater flexibility for mixed or legacy systems.

Finally, the note identifies common polarity mistakes—such as mixing trunk types, incorrect connector gender pairing, and improper fiber mapping—and provides a quick selection guide to help match cable types to specific applications, ensuring reliable and efficient network performance.

Introduction

This application note is intended to provide a practical reference for selecting and deploying MPO-based fiber optic assemblies in modern network environments. It outlines the key design considerations required to ensure interoperability, including polarity management, connector configuration, and fiber mapping. The goal is to support accurate system design and minimize common implementation errors in high-density, high-speed optical infrastructures.

Fiber Optic Cable Assemblies

MPO Patchcords and Fan-out Assemblies

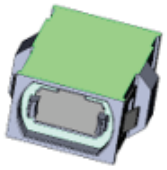
MPO–MPO Patchcords and MPO–LC / SC / ST Fanouts

1.0 Key Technical Variables

Parameter	Options	Impact
Fiber Count	8F, 12F, 16F, 24F, 32F	Determines optics compatibility
Polarity	Type A, Type B, Type C	Determines Tx/Rx alignment
Gender	Pinned / non-pinned	Must mate properly
Polarity Method	Method A, B, C	System-level polarity design
Fiber Type	OM3, OM4, OM5, OS2	Distance & bandwidth
Key Orientation	Key-Up / Key-Down	Determines mapping orientation

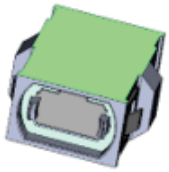
1.1 MPO Adapters & Polarity

Type A



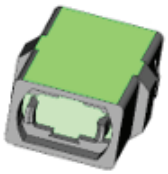
Key Up-
Key Down

Type B



Key Up-
Key Up

Type A or B



Adjustable Key allowing a switch between A or B

Examples: FOA-993A FOA-992A FOA-MPO

For full range of MPO adapters: click here

1.2 Understanding MPO Polarity

Polarity ensures:

Transmit (Tx) on one end connects to Receive (Rx) on the other end.

In duplex LC, this is simple (A to B).
In MPO (8–24 fibers), polarity must manage multiple Tx/Rx lanes simultaneously.

1.3 MPO Polarity Types (Connector Mapping)

Type A (Straight Through) Illustration 1.31

- Key-up to key-down
- Fiber 1 → Fiber 1
- Fiber 12 → Fiber 12

Used in: Method A systems
Requires: Polarity flipped in cassette

End A (Key Up) End B (Key Down)
1 2 3 ... 12 → 1 2 3 ... 12

Type B (Reversed) Illustration 1.31

- Key-up to key-up
- Fiber 1 → Fiber 12
- Fiber 12 → Fiber 1

Most common in data centers

End A (Key Up) End B (Key Up)
1 2 3 ... 12 → 12 11 10 ... 1

Used for:

- 40G SR4
- 100G SR4
- 400G SR8
- Direct optic-to-optic connections

This is the most common trunk type in modern parallel optics.

- **Type C (Pair Flipped)** Illustration 1.33
  - Key-up to key-down
  - Adjacent fibers flipped in pairs

1↔2
3↔4
5↔6

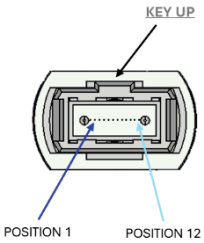
Used in legacy duplex breakout systems.
Less common in modern high-speed data centers.

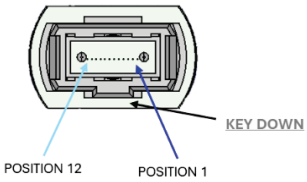
1.4 MPO Polarity Types & Configurations

KEY UP, with PINS, (MALE) (FEMALE)

KEY DOWN, without PINS

Positions 1, 2, 3, etc., will always be the same, relative to the Key as shown





12 FIBER →

	WIRING MAP	
	TYPE A	
J1		J2
1	BLUE	1
2	ORANGE	2
3	GREEN	3
4	BROWN	4
5	GRAY	5
6	WHITE	6
7	RED	7
8	BLACK	8
9	YELLOW	9
10	PURPLE	10
11	ROSE	11
12	AQUA	12

TYPE A: STRAIT THROUGH

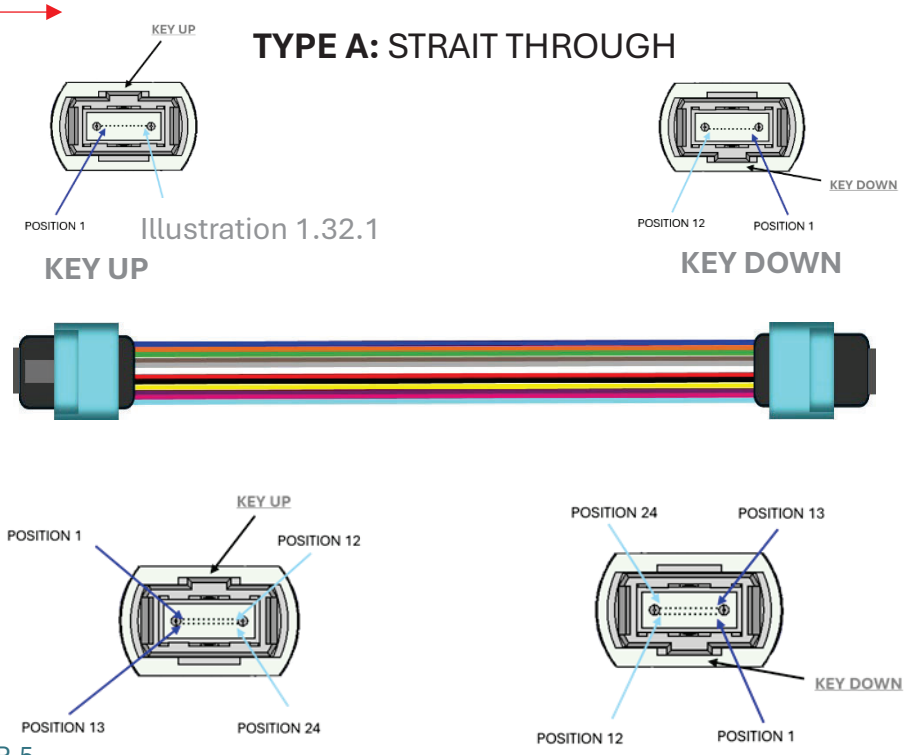


Illustration 1.32.1

24 FIBER

	WIRING MAP	
	TYPE A	
J1		J2
1	BLUE	13
2	ORANGE	14
3	GREEN	15
4	BROWN	16
5	GRAY	17
6	WHITE	18
7	RED	19
8	BLACK	20
9	YELLOW	21
10	PURPLE	22
11	ROSE	23
12	AQUA	24
13	BLUE/BLACK	1
14	ORANGE/BLACK	2
15	GREEN/BLACK	3
16	BROWN/BLACK	4
17	GRAY/BLACK	5
18	WHITE/BLACK	6
19	RED/BLACK	7
20	BLACK/BLACK	8
21	YELLOW/BLACK	9
22	PURPLE/BLACK	10
23	ROSE/BLACK	11
24	AQUA/BLACK	12

Examples: MPFF12OM4AP-5
MPMF24OM2AZ-3

Illustration 1.31

← **24 FIBER**

12 FIBER →

	WIRING MAP	
	TYPE B	
J1		J2
1	BLUE	12
2	ORANGE	11
3	GREEN	10
4	BROWN	9
5	GRAY	8
6	WHITE	7
7	RED	6
8	BLACK	5
9	YELLOW	4
10	PURPLE	3
11	ROSE	2
12	AQUA	1

TYPE B: CROSSED

(Reversed)

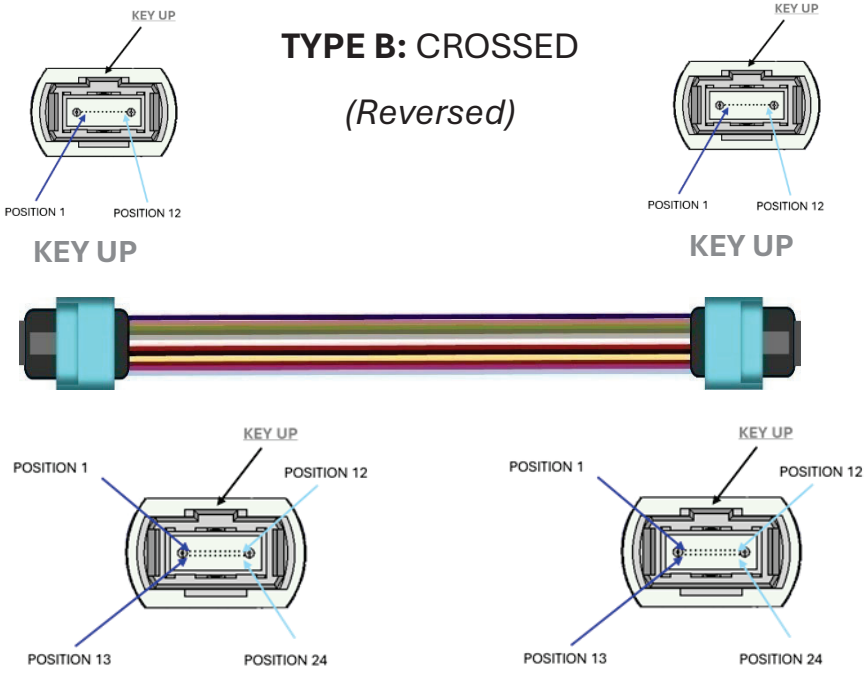


Illustration 1.32

24 FIBER

	WIRING MAP	
	TYPE B	
J1		J2
1	BLUE	12
2	ORANGE	11
3	GREEN	10
4	BROWN	9
5	GRAY	8
6	WHITE	7
7	RED	6
8	BLACK	5
9	YELLOW	4
10	PURPLE	3
11	ROSE	2
12	AQUA	1
13	BLUE/BLACK	24
14	ORANGE/BLACK	23
15	GREEN/BLACK	22
16	BROWN/BLACK	21
17	GRAY/BLACK	20
18	WHITE/BLACK	19
19	RED/BLACK	18
20	BLACK/BLACK	17
21	YELLOW/BLACK	16
22	PURPLE/BLACK	15
23	ROSE/BLACK	14
24	AQUA/BLACK	13

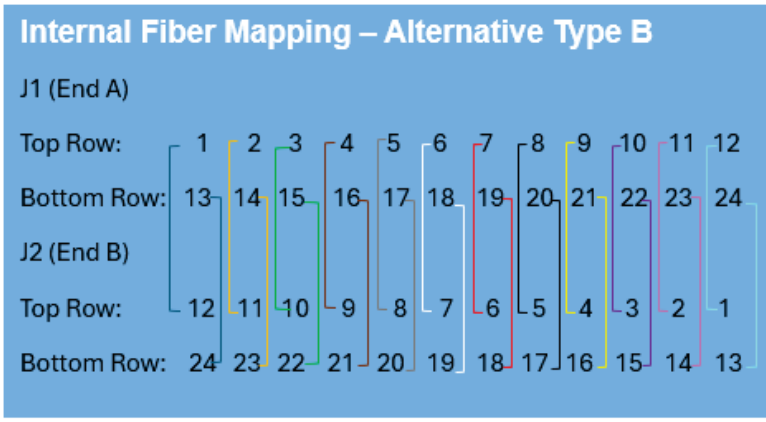
Examples: MPMM12OM4BR-10
MPMM24SMBR-10

A True TYPE B crossed, performs a complete mirror of all 24 fibers. Top Rows (1-2) will land in the bottom row on the other side and Bottom row fibers will land in the top row on the other side.

This is essential so that parallel optics transmit lanes meet receive lanes (Rx-Tx) when used in high-speed links like 40G SR4, 100G SR4, and 200G / 400G SR8 infrastructures.

Key Take away, 24 Fiber TYPE B reverses the entire fiber stack, not just each row individually also crossing from top to bottom. This is critical for parallel optics.

NOTE: The 24F fiber mapping in Illustration 1.32 is internal fiber mapping, as this is Type B, it is not a True type B where Fibers 1-12 on the top row of End A cross over completely to the bottom row of end B (positions 24 to 13). Both are illustrated below in 1.32.1



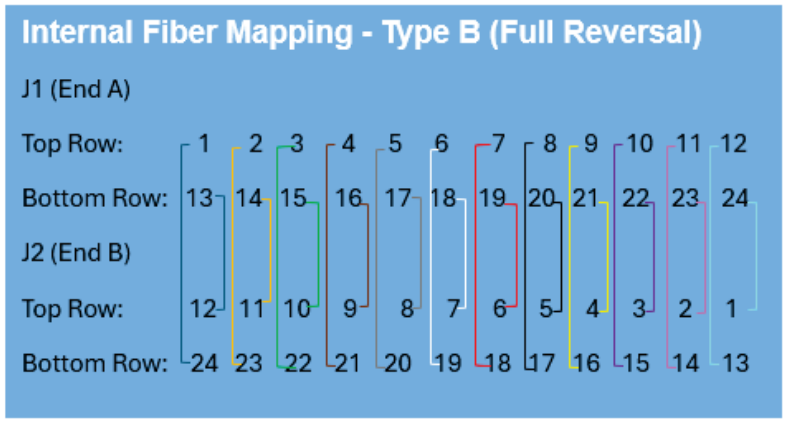


Illustration 1.32.1

Even though it isn't a "True TIA-Standard Type B" for a 24-fiber trunk, there are two major reasons to utilize this type of 24 Fiber polarity.

1. Direct Transceiver-to-Transceiver Links (100GBASE-SR10)

This is the most common use case. Older 100G transceivers (like CXP or CFP modules) use **100GBASE-SR10**, which requires a 24-fiber MPO connector.

The optics in these transceivers are laid out horizontally in rows:

- **Top Row (1–12):** Used exclusively for Transmitting (Tx 1 to 10, with 2 unused fibers).
- **Bottom Row (13–24):** Used exclusively for Receiving (Rx 1 to 10, with 2 unused fibers).

2. Proprietary Patch Panel & Cassette Ecosystems

Many major fiber routing manufacturers (like Corning, CommScope, or Panduit) design their own proprietary architectures to solve the "polarity headache" for their customers.

Instead of making technicians buy different Type A and Type B patch cords, these manufacturers use specialized internal wiring inside their cassettes. To make their cassettes plug-and-play, they often require a custom 24-fiber trunk that keeps the rows separate:

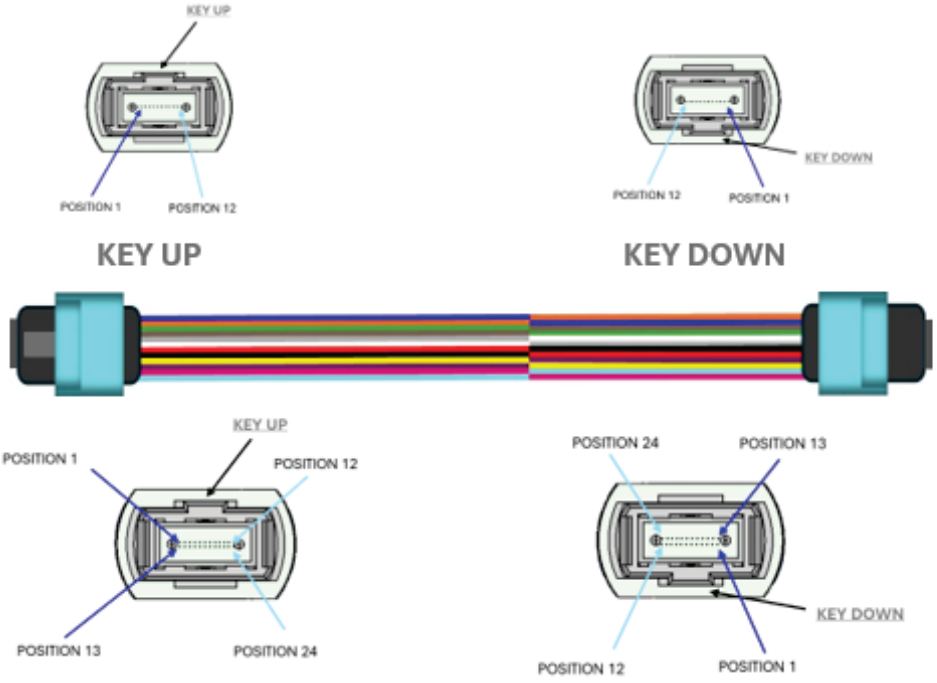
- Row 1 handles the left side of a patch panel.
- Row 2 handles the right side of a patch panel.

A true TIA Type B trunk in these systems, the rows cross, and half of their patch panel ports suddenly go dark because the signals got routed to the wrong cassettes.

TYPE C: CROSS PAIR

12 FIBER →

	WIRING MAP	
	TYPE C	
J1		J2
1	BLUE	2
2	ORANGE	1
3	GREEN	4
4	BROWN	3
5	GRAY	6
6	WHITE	5
7	RED	8
8	BLACK	7
9	YELLOW	10
10	PURPLE	9
11	ROSE	12
12	AQUA	11



	WIRING MAP TYPE C	
J1		J2
1	BLUE	14
2	ORANGE	13
3	GREEN	16
4	BROWN	15
5	GRAY	18
6	WHITE	17
7	RED	20
8	BLACK	19
9	YELLOW	22
10	PURPLE	21
11	ROSE	24
12	AQUA	23
13	BLUE/BLACK	2
14	ORANGE/BLACK	1
15	GREEN/BLACK	4
16	BROWN/BLACK	3
17	GRAY/BLACK	6
18	WHITE/BLACK	5
19	RED/BLACK	8
20	BLACK/BLACK	7
21	YELLOW/BLACK	10
22	PURPLE/BLACK	9
23	ROSE/BLACK	12
24	AQUA/BLACK	11

Illustration 1.33

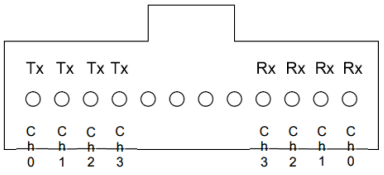
← **24 FIBER**

1.5 MPO Fiber Mapping for Parallel Optics

Example: 100G SR4 (8-Fiber Active)

Uses fibers:

- 4 Tx
- 4 Rx
- Middle fibers unused (in 12F)



Typical mapping (Type B trunk):

Fiber Position	Function
1–4	Tx
9–12	Rx
5–8	Unused

Type B ensures Tx lanes hit Rx lanes on opposite device.

Example: 400G SR8 (16-Fiber)

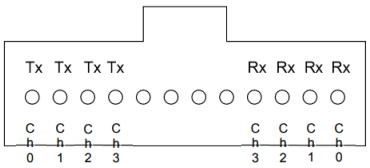
Fiber Position	Function
1–8	Tx
9–16	Rx

Requires:

- 16F MPO
- Type B polarity

Example: 400G DR4 (8-Fiber Singlemode)

Fiber Position	Function
1–4	Tx
9–12	Rx



Typically, OS2 with Type B mapping.

1.6 Applications – MPO to MPO

Primary Applications

- Data center spine-leaf networks
- Hyperscale cloud infrastructure
- AI / HPC clusters
- Core switch interconnect
- SAN backbone

Markets

- Cloud providers
- Enterprise data centers
- Colocation facilities
- Telecom central offices
- Government & defense networks

1.7 MPO to LC / SC / ST Fan-out Assemblies

Also called:

- Breakout assemblies
- Hydras
- Fan-out harnesses

These assemblies transition multi-fiber MPO trunks into duplex connectors.

1.8 Two Main Categories

1 Breakout (Conversion Harness)

- Splits MPO into duplex LC pairs
- Used to connect parallel trunk to duplex optics

Examples:

MPFA8OM4-20LCUZ-1

MPFB8OM3-20LCUZ-5

MPFB8OS2-20LCUZ-10

2 Fanout (Direct 250µm or 900µm legs)

- Individual fibers terminated directly
- Often used in panels or legacy integration
- (also referred to as patch cords due to direct termination)

FCA-MMS112D00P

FCA-MMS108A90P

FCA-MMS224600P

1.9 Polarity in MPO to LC Breakouts

Polarity becomes more complex because:

- MPO side may be Type A or B
- LC duplex side must present correct A-B orientation

The harness must account for:

- Lane assignment
- Cassette elimination
- Optics lane configuration

2.0 Example: 12F MPO to 6×LC Duplex

With Type B MPO Input:

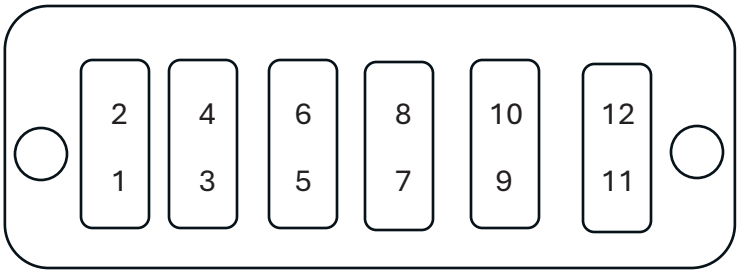
MPO (Type B) mapping:

1→12
2→11
3→10
4→9
5→8
6→7

Harness internally maps fibers to duplex LC pairs:

MPO Fibers	LC Pair
1–2	LC #1
3–4	LC #2
5–6	LC #3
7–8	LC #4
9–10	LC #5
11–12	LC #6

IE. MPO cassette module, Type B (fiber sequence)



Each LC duplex must flip A/B internally to ensure:

- Tx → Rx
- Rx → Tx

☑ It's important to note: MPO fiber positions are only physical positions. The optics define which positions are Tx/Rx.

IE. MPO positions 1-4 are Tx, MPO positions 9-12 are Rx (8 fiber MPO, 5-8 are unused) A type B trunk reverses: 1-12, 2-11, etc. If switch A transmits on fiber 1, it lands on fiber 12 at the end, Tx Rx is achieved.

The MPO fanout is now added, the harness groups positions:

MPO Positions	LC Duplex
1–2	LC #1
3–4	LC #2
5–6	LC #3
7–8	LC #4
9–10	LC #5
11–12	LC #6

The MPO assignment looks like this:

MPO Fiber	25G Port
1	Port 1 Tx
12	Port 1 Rx
2	Port 2 Tx
11	Port 2 Rx
3	Port 3 Tx
10	Port 3 Rx
4	Port 4 Tx
9	Port 4 Rx

2.1 Breakout for 100G to 4×25G

Common in TOR switch environments.

100G SR4 → 4× SFP28 Fiber mapping example:

MPO Fiber	SFP Channel
1–12 LC Pair	Port 1
2–11 LC Pair	Port 2
3–10 LC Pair	Port 3
4–9 LC Pair	Port 4

WIRING MAP TYPE B		
MPO FIBER #	LC COLOR	LC FIBER #
1	BLUE	12
2	ORANGE	11
3	GREEN	10
4	BROWN	9
5	-	8
6	-	7
7	-	6
8	-	5
9	YELLOW	4
10	VIOLET	3
11	PINK	2
12	AQUA	1

Requires:

- Type B MPO input
- Correct lane breakout alignment

2.2 Base-8 vs Base-12 Considerations

Base Type	Best For	Benefit
Base-8	40G/100G/400G SR8	No unused fibers
Base-12	Legacy & mixed duplex	Maximum flexibility
Base-24	High-density	Aggregation systems

2.3 Common Polarity Design Scenarios

Scenario 1 – Direct Optic to Optic (Parallel)

✓ Use Type B MPO trunk
✓ No cassette
✓ No additional polarity correction

Scenario 2 – MPO Trunk + Cassette + LC Patch

✓ Usually Type A trunk
✓ Cassette handles flip
✓ LC patch cords standard A-B

Scenario 3 – MPO to LC Breakout (No Cassette)

✓ Typically Type B input
✓ Harness handles mapping internally

2.4 SC and ST Fanout Considerations

SC and ST are used primarily in:

- Telecom central office
- Industrial environments
- Legacy campus fiber
- Government networks

Polarity rules are identical to LC, but:

- SC is push-pull duplex
- ST is bayonet (often simplex)

When using ST simplex, polarity must be managed at patch panel level.

2.5. Common Polarity Mistakes

❌ Mixing Type A and Type B trunks
❌ Using pinned connectors on both ends
❌ Breaking out Base-12 into Base-8 optics without planning
❌ Not verifying optic lane assignment
❌ Assuming all MPO harnesses are wired the same

2.6. Quick Selection Guide

Application	Recommended Assembly
100G SR4 switch-to-switch	12F or 8F MPO Type B
100G to 4×25G	MPO to 4×LC breakout (Type B input)
400G SR8	16F MPO Type B
400G DR4	12F OS2 Type B
Structured cabling w/ cassettes	Type A trunk
Legacy duplex migration	MPO to LC fanout