



# Shelf Configuration Rules

The design of the Cisco ONS 15540 requires that a set of rules be followed during physical configuration of the shelf. These rules, along with examples, are provided in this chapter. This chapter contains the following major sections:

- [Per Shelf Rules Using Add/Drop Mux/Demux Modules, page 3-1](#)
- [Per Shelf Rules Using Terminal Mux/Demux Modules, page 3-10](#)
- [Per Shelf Rules for 2.5-Gbps Line Card Motherboards, page 3-12](#)
- [General Rules for Ring Topologies, page 3-13](#)



**Note**

Applying the shelf configuration rules requires an understanding of the Cisco ONS 15540 system components and protection schemes, including the optical backplane. See especially the “[System Components](#)” section on page 1-3 and the “[Protection Against Fiber and System Failures](#)” section on page 2-1.

## Per Shelf Rules Using Add/Drop Mux/Demux Modules

In an unprotected configuration, a shelf can have only one add/drop mux/demux module with a given channel band transmitting and receiving in a given direction (either west or east). [Table 3-1](#) lists the conflicting bands 4-channel and 8-channel add/drop mux/demux modules. If an add/drop mux/demux module that supports a band in a particular row of column 1 in [Table 3-1](#) is installed on a shelf in an unprotected configuration, that shelf cannot also have a module that supports any of the conflicting bands in column 2 transmitting and receiving in the same direction. For example, modules for band A and band AB both cannot transmit to and receive from the west.

*Table 3-1 Conflicting Bands for Add/Drop Mux/Demux Module*

| Band | Conflicting Bands           |
|------|-----------------------------|
| A    | A with OSC, AB, AB with OSC |
| B    | B with OSC, AB, AB with OSC |
| C    | C with OSC, CD, CD with OSC |
| D    | D with OSC, CD, CD with OSC |
| E    | E with OSC, EF, EF with OSC |
| F    | F with OSC, EF, EF with OSC |

*Table 3-1 Conflicting Bands for Add/Drop Mux/Demux Module (continued)*

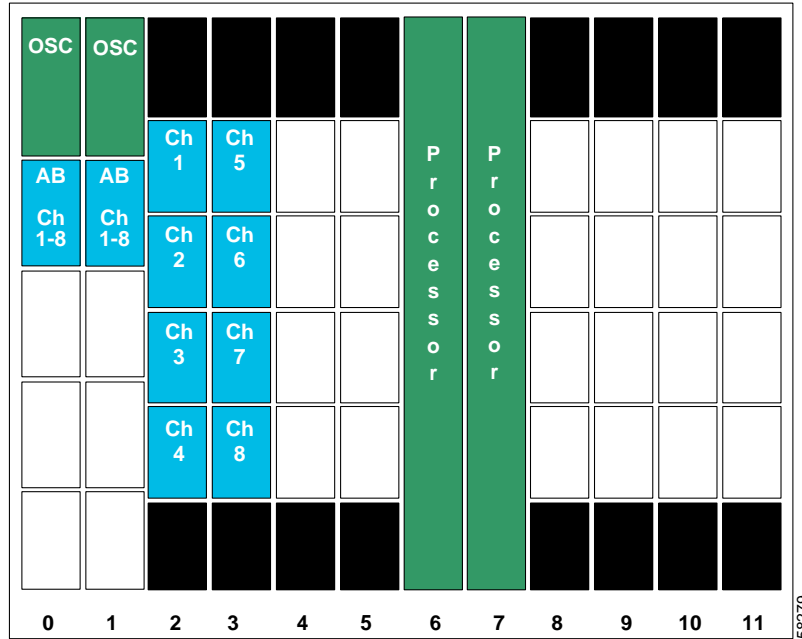
| Band        | Conflicting Bands                             |
|-------------|---|
| G           | G with OSC, GH, GH with OSC                   |
| H           | H with OSC, GH, GH with OSC                   |
| A with OSC  | A, AB, any band with OSC                      |
| B with OSC  | B, AB, any band with OSC                      |
| C with OSC  | C, CD, any band with OSC                      |
| D with OSC  | D, CD, any band with OSC                      |
| E with OSC  | E, EF, any band with OSC                      |
| F with OSC  | F, EF, any band with OSC                      |
| G with OSC  | G, GH, any band with OSC                      |
| H with OSC  | H, GH, any band with OSC                      |
| AB          | A, A with OSC, B, B with OSC, AB, AB with OSC |
| CD          | C, C with OSC, D, D with OSC, CD, CD with OSC |
| EF          | E, E with OSC, F, F with OSC, EF, EF with OSC |
| GH          | G, G with OSC, H, H with OSC, GH, GH with OSC |
| AB with OSC | A, B, AB, any band with OSC                   |
| CD with OSC | C, D, CD, any band with OSC                   |
| EF with OSC | E, F, EF, any band with OSC                   |
| GH with OSC | G, H, GH, any band with OSC                   |

## Add/Drop Mux/Demux Modules with Splitter Protection

When configuring channels to use splitter protection, add/drop mux/demux modules with the same channels must be present in the same positions in both slots 0 and 1. During migration, one of the modules might not be present, or one of the modules might contain only a subset of the channels present on the other module. The latter is only possible if the add/drop mux/demux modules map the common channels to the same optical backplane traces.

[Figure 3-1](#) shows an example shelf configuration for splitter protection with add/drop mux/demux modules for band AB in positions 0/0 and 1/0.

Figure 3-1 Example Installation of Add/Drop Mux/Demux Modules with Splitter Protection



## Add/Drop Mux/Demux Modules Without Splitter Protection

If not using splitter protection, when an add/drop mux/demux module is present in slot 0, there must be no mux/demux module in the corresponding position in slot 1 that picks up the same channels. Conversely, when an add/drop mux/demux module is present in slot 1, there must be no mux/demux module in the corresponding position in slot 0 that picks up the same channels.



Note

These rules apply to unprotected or line card protected (y-cable or client) configurations.

## 4-Channel Mux/Demux Modules Without Splitter Protection

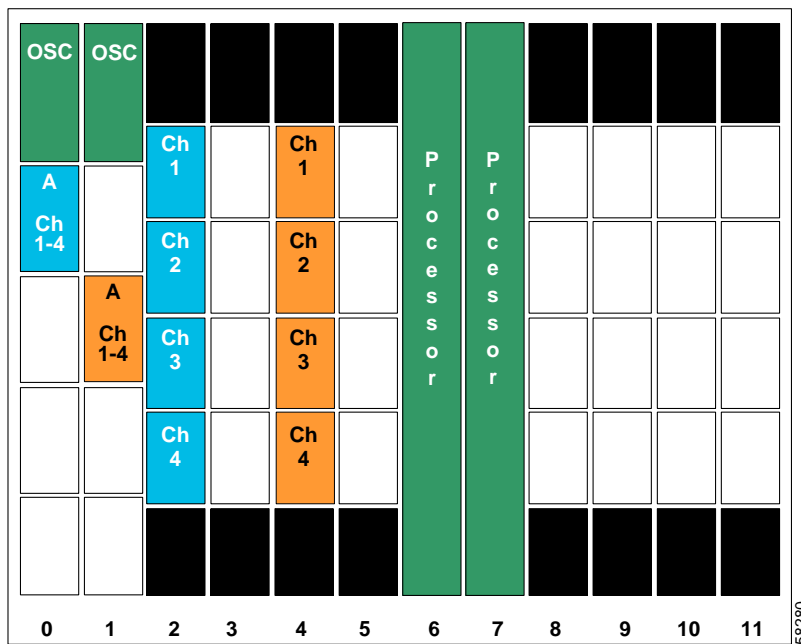
The rules for the 4-channel mux/demux modules are as follows (see [Table 3-2](#)):

- If a 4-channel mux/demux module from group X (the lower 4 channels of an 8-channel range) is present in slot 0, then the corresponding position in slot 1 must either be empty, or have a 4-channel mux/demux module from group Y (the upper 4 channels of an 8-channel range).
- If a 4-channel mux/demux module from group Y is present in slot 0, then the corresponding position in slot 1 must either be empty, or have a 4-channel mux/demux module from group X.
- If a 4-channel mux/demux module from group X is present in slot 1, then the corresponding position in slot 0 must either be empty, or have a 4-channel mux/demux module from group Y.
- If a 4-channel mux/demux module from group Y is present in slot 1, then the corresponding position in slot 0 must either be empty, or have a 4-channel mux/demux module from group X.

**Table 3-2 Band Pairings for 4-Channel Mux/Demux Modules Without Splitter Protection**

| Group X 4-Channel Mux/Demux Module Band | Group Y 4-Channel Mux/Demux Module Band |
|---|---|
| A                                       | B                                       |
| A with OSC                              | B with OSC                              |
| C                                       | D                                       |
| C with OSC                              | D with OSC                              |
| E                                       | F                                       |
| E with OSC                              | F with OSC                              |
| G                                       | H                                       |
| G with OSC                              | H with OSC                              |

Figure 3-2 shows an example shelf configuration for line card protection with add/drop mux/demux modules for band A in positions 0/0 and 1/1.

**Figure 3-2 Example Installation of Add/Drop Mux/Demux Modules with Line Card Protection**

## 8-Channel Mux/Demux Modules Without Splitter Protection

The rules for 8-channel mux/demux modules are as follows:

- If an 8-channel mux/demux module is present in slot 0, the corresponding position in slot 1 must be empty.
- If an 8-channel mux/demux module is present in slot 1, the corresponding position in slot 0 must be empty.

## Transponder Module Placement When Using Add/Drop Mux/Demux Modules

The fixed optical backplane maps the transponder (or ITU direct insertion module) subslots to connectors at specific positions on the mux/demux motherboards (see [Figure 2-2 on page 2-4](#)). Thus, for all the channels present on the optical mux/demux modules, transponders must be present in the corresponding transponder subslots. Specifically, for all channels present on the add/drop mux/demux modules in positions  $0/x$  or  $1/x$  in [Table 3-3](#), transponder modules should be present in slots  $y, y+1$ .

**Table 3-3** Add/Drop Mux/Demux Module to Transponder Slot Mapping

| Mux/Demux Module Slot/Subslot $0/x$ or $1/x$ | Transponder Slots $y, y+1$ |
|--|----------------------------|
| 0  | 2, 3                       |
| 1  | 4, 5                       |
| 2  | 8, 9                       |
| 3  | 10, 11                     |

For example, if there is an add/drop mux/demux module in position  $0/2$  or  $1/2$ , you must use slots 8 and 9 for the transponder modules with the corresponding channels.



### Note

When using y-cable protection, ensure that both transponder modules are of the same type (single-mode, multimode, or extended range) for a given client signal. For example, if client signal A connects by a y-cable to transponders in positions  $2/0$  and  $8/0$ , then both of those transponder must either be single-mode, multimode, or extended range. Also, if using extended range transponder modules, the transceivers must be the same type.

## Transponder Modules with 4-Channel Mux/Demux Modules

For the 4-channel mux/demux modules from group X in [Table 3-2](#), transponder modules supporting channels  $w+0$  to  $w+3$  must be present in the positions shown in [Table 3-4](#), where  $w$  is the first channel in the 4-channel band and  $y$  is the first transponder slot number in column 2 of [Table 3-3](#).

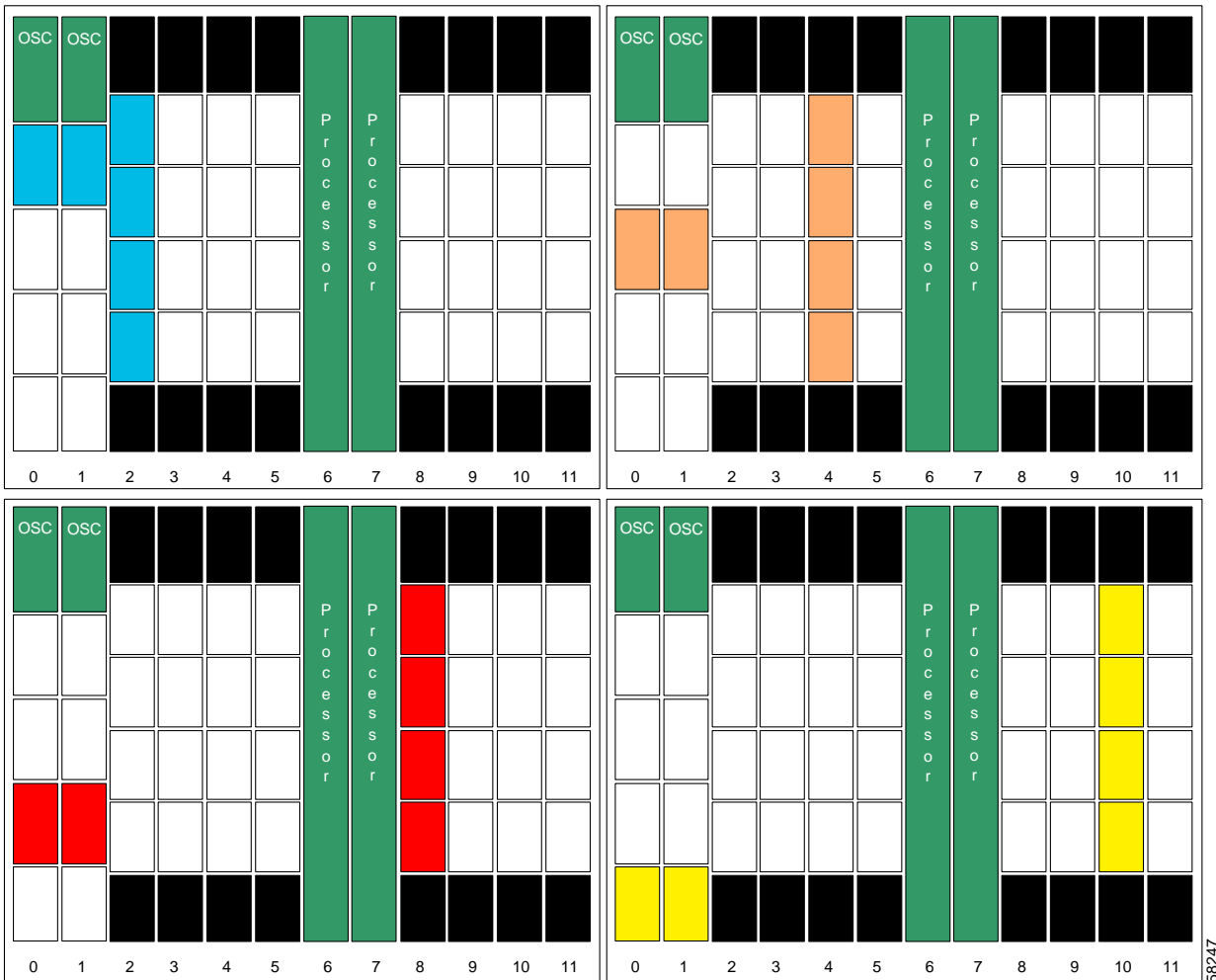
**Table 3-4** Transponder Module Placement for Lower Channels When Using 4-Channel Mux/Demux Modules

| Channel | Transponder Slot/Subslot |
|---------|--------------------------|
| $w+0$   | $y/0$                    |
| $w+1$   | $y/1$                    |
| $w+2$   | $y/2$                    |
| $w+3$   | $y/3$                    |

For example, if a band A module (channels 1–4) is present in mux/demux subslot 0, the four transponder modules supporting those channels must be installed in slot/subslots  $2/0$  through  $2/3$ .

Figure 3-3 provides a graphic representation of the rule in Table 3-4. The figure shows the four possible arrangements of transponder modules and add/drop mux/demux modules that can support the lower 4 channels (bands A, C, E, G) of an 8-channel range. These examples assume splitter protection; if the east or west line card motherboard were used, one of the mux/demux slots would remain empty.

Figure 3-3 Transponder Placement with Add/Drop Mux/Demux Modules for Bands A, C, E, G



For the 4-channel mux/demux modules from group Y in Table 3-2, transponder modules supporting channels  $w+0$  to  $w+3$  must be present in the positions shown in Table 3-5, where  $w$  is the first channel in the 4-channel band and  $y+1$  is the second transponder slot number in column 2 of Table 3-3.

Table 3-5 Transponder Module Placement for Upper Channels When Using 4-Channel Mux/Demux Modules

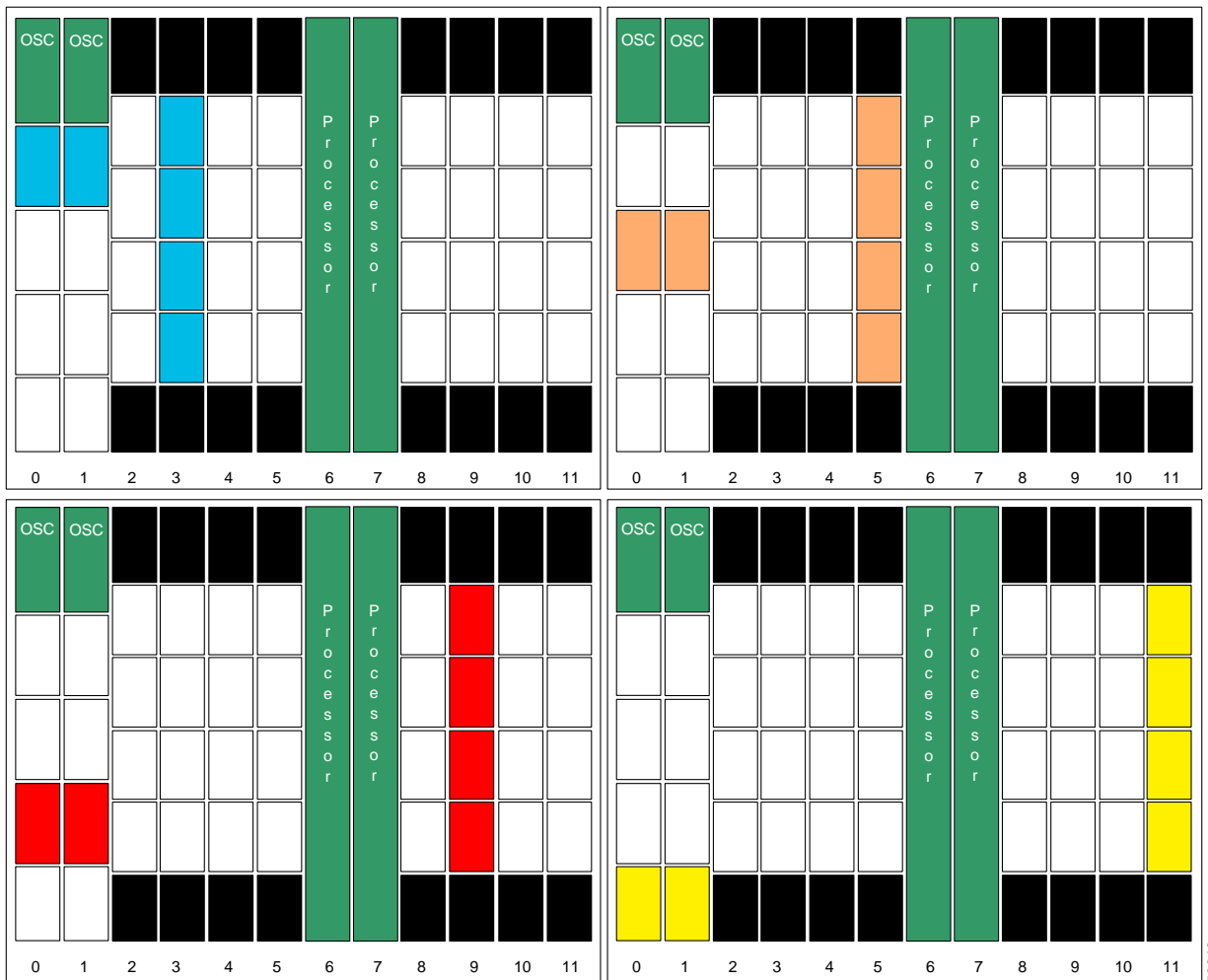
| Channel | Transponder Slot/Subslot |
|---------|--------------------------|
| $w+0$   | $y+1/0$                  |
| $w+1$   | $y+1/1$                  |
| $w+2$   | $y+1/2$                  |
| $w+3$   | $y+1/3$                  |

In other words, if you think of the 32 channels as comprising four ranges of eight channels, you must install the transponder modules for the first four channels of a range of eight in either slot 2, 4, 8, or 10, and the transponder modules for the last four channels of the range in the next higher adjoining slot. The transponder modules must be installed in ascending order based on channel number.

For example, if a band B module (channels 5–8) is present in mux/demux subslot 0, the four transponder modules supporting those channels must be installed in slot/subslots 3/0 through 3/3.

Figure 3-4 provides a graphic representation of the rule in Table 3-5. The figure shows the four possible arrangements of transponder modules and add/drop mux/demux modules that can support the upper 4 channels (bands B, D, F, and H) of an 8-channel range. These examples assume splitter protection; if the east or west line card motherboard were used, one of the mux/demux slots would remain empty.

Figure 3-4 Transponder Placement with Add/Drop Mux/Demux Modules for Bands B, D, F, H



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## Transponder Modules with 8-Channel Mux/Demux Modules

For 8-channel mux/demux modules containing channels  $w+0$  to  $w+7$ , the transponder modules supporting these channels must be present in the positions shown in [Table 3-6](#), where  $w$  is the first channel in an 8-channel band and  $y$  is the first transponder slot number in column 2 of [Table 3-3](#).

**Table 3-6** *Transponder Module Placement When Using 8-Channel Mux/Demux Modules*

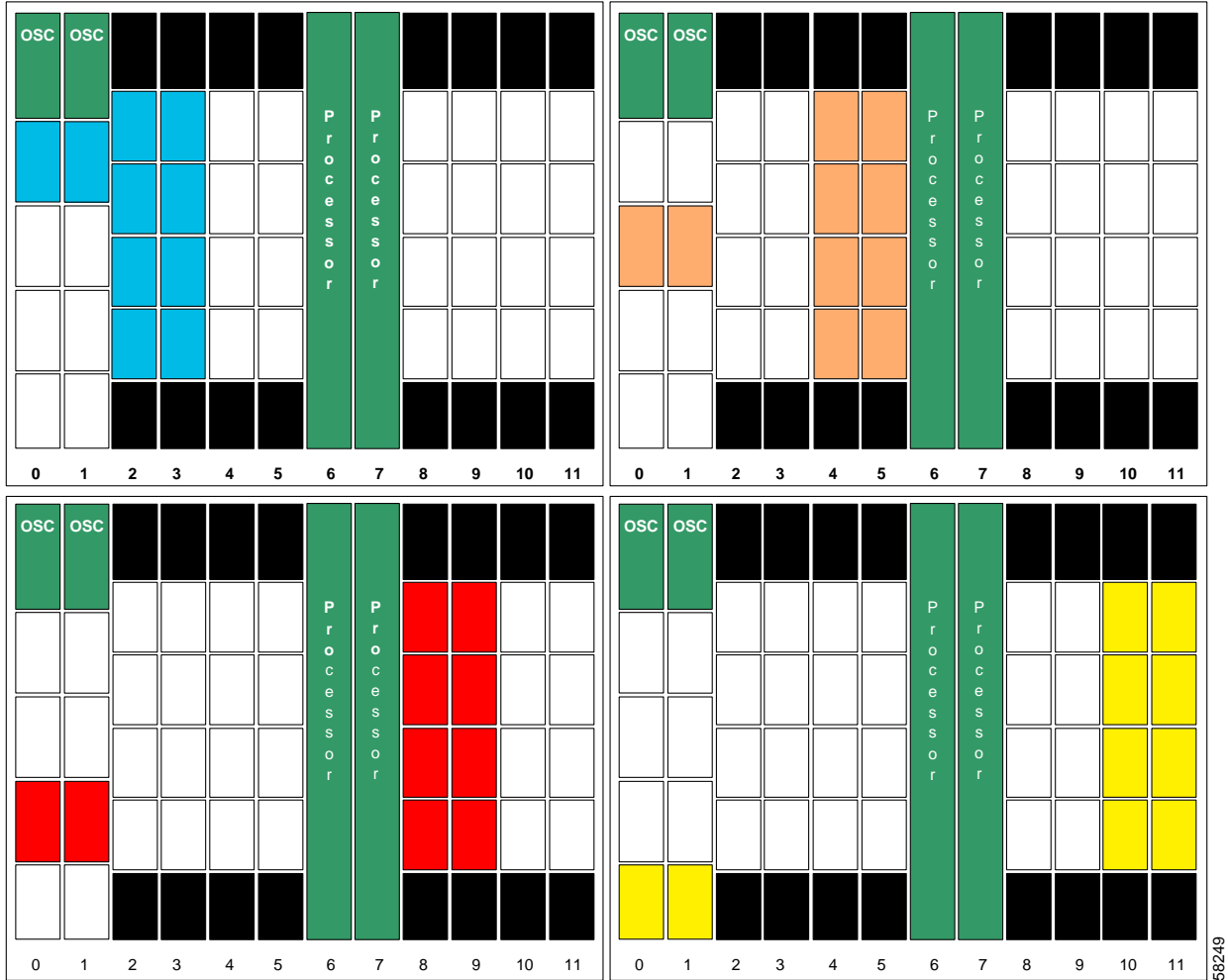
| Channel | Transponder Slot/Subslot |
|---------|--------------------------|
| $w+0$   | $y/0$                    |
| $w+1$   | $y/1$                    |
| $w+2$   | $y/2$                    |
| $w+3$   | $y/3$                    |
| $w+4$   | $y+1/0$                  |
| $w+5$   | $y+1/1$                  |
| $w+6$   | $y+1/2$                  |
| $w+7$   | $y+1/3$                  |

For example, if a band AB module (channels 1–8) is present in mux/demux subslot 0, the four transponder modules supporting channels 1–4 must be installed in slot/subslots 2/0 through 2/3, and the four transponder modules supporting channels 5–8 must be installed in slot/subslots 3/0 through 3/3.

[Figure 3-5](#) provides a graphic representation of the rule in [Table 3-6](#). The figure shows the four possible arrangements of transponder modules and add/drop mux/demux modules that can support an 8-channel range (bands AB, CD, EF, GH). These examples assume splitter protection; if the east or west line card motherboard were used, one of the mux/demux slots would remain empty.



Figure 3-5 Transponder Placement with Add/Drop Mux/Demux Modules for Bands AB, CD, EF, GH



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## Cabling of Add/Drop Mux/Demux Modules

The following rules apply when cabling the 4- and 8-channel add/drop mux/demux modules:

- Use fiber optical cables with MU connectors to cable the add/drop mux/demux modules.
- Cable the OSC from the mux/demux motherboard only to the add/drop mux/demux module that connects to the trunk (east and west sides). Connect the OSC IN on the mux/demux module to OSC OUT on the mux/demux motherboard; connect the OSC OUT on the mux/demux module to OSC IN on the mux/demux motherboard.
- Connect west to east, never west to west or east to east, between nodes in a ring.
- Connect the trunk receive direction to TI (trunk interface) IN, and trunk transmit direction to TI OUT (east and west sides).
- Connect Thru OUT to TI IN, and OUT to TI IN between add/drop mux/demux modules on the same side.
- Connect Thru OUT to Thru IN between add/drop mux/demux modules on west and east sides.

For examples of add/drop mux/demux module cabling in a protected ring configuration, see [Figure 1-1 on page 1-2](#) and [Figure 1-6 on page 1-15](#).

## Per Shelf Rules Using Terminal Mux/Demux Modules

There are two types of terminal (16-channel) mux/demux modules: one for band AD with OSC, and one for band EH without OSC. The band EH terminal mux/demux module can only be used in conjunction with the band AD module. The following sections describe additional rules for using the 16-channel terminal mux/demux module.

### Terminal Mux/Demux Modules with Splitter Protection

When using splitter protection, terminal mux/demux modules that support the same channels should be present in the same position in both slot 0 and slot 1. During migration, it is possible that a module will not be present in one of the slots, or that one of the modules contains a subset of the channels present on the other module. The latter is only possible if the terminal mux/demux modules map the common wavelengths to the same optical backplane traces.

### Terminal Mux/Demux Modules Without Splitter Protection

When splitter protection is not used, if a terminal mux/demux module is present in slot 0, the corresponding position in slot 1 must be empty, and vice versa.

## Transponder Module Placement When Using Terminal Mux/Demux Modules

For all the channels present on the terminal mux/demux modules in positions 0/x and 1/x, transponder modules should be present in the slots shown in [Table 3-7](#).

*Table 3-7 Terminal Mux/Demux Module to Transponder Slot Mapping*

| Mux/Demux Slot/Subslot 0/x or 1/x | Transponder Slots y to y+3 |
|-----------------------------------|----------------------------|
| 0-1                               | 2, 3, 4, 5                 |
| 2-3                               | 8, 9, 10, 11               |



#### Note

It is possible for some transponder line cards or modules to be missing. This might happen in cases where not all 16 channels are needed, or during migration.



#### Note

When using y-cable protection, ensure that both transponder modules are of the same type (single-mode, multimode, or extended range) for a given client signal. For example, if client signal A connects by a y-cable to transponders in positions 2/0 and 8/0, then both of those transponder must either be single-mode, multimode, or extended range. Also, if using extended range transponder modules, the transceivers must be the same type.

For the 16-channel mux/demux modules containing channels  $w+0$  to  $w+15$ , transponder modules supporting these channels must be present in the positions shown in [Table 3-8](#), where  $y$  is the first transponder slot number in column 2 of [Table 3-7](#).

**Table 3-8** *Transponder Module Placement When Using 16-Channel Mux/Demux Modules*

| Channel | Transponder Slot/Subslot |
|---------|--------------------------|
| $w+0$   | $y/0$                    |
| $w+1$   | $y/1$                    |
| $w+2$   | $y/2$                    |
| $w+3$   | $y/3$                    |
| $w+4$   | $y+1/0$                  |
| $w+5$   | $y+1/1$                  |
| $w+6$   | $y+1/2$                  |
| $w+7$   | $y+1/3$                  |
| $w+8$   | $y+2/0$                  |
| $w+9$   | $y+2/1$                  |
| $w+10$  | $y+2/2$                  |
| $w+11$  | $y+2/3$                  |
| $w+12$  | $y+3/0$                  |
| $w+13$  | $y+3/1$                  |
| $w+14$  | $y+3/2$                  |
| $w+15$  | $y+3/3$                  |

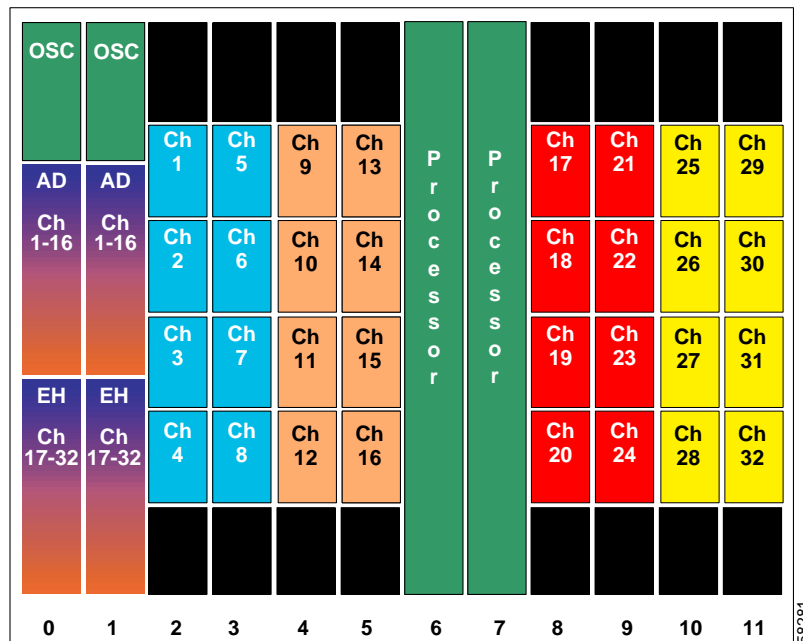


**Note**

With the 16-channel mux/demux modules, if channels 17–32 are present, channels 1–16 must also be present.

Figure 3-6 provides a graphic representation of the rule in Table 3-8. The example shows a 32-channel splitter protected shelf configuration.

Figure 3-6 Transponder Module Placement Using 16-Channel Mux/Demux Modules for Bands AD and EH



## Cabling of Terminal Mux/Demux Modules

The following rules apply when cabling the 16-channel terminal mux/demux modules:

- Cable the OSC from the mux/demux motherboard to the OA and OD connectors on the band AD terminal mux/demux module. Connect OSC OUT to OA and OSC IN to OD.
- Connect the trunk receive direction to I and the trunk transmit direction to O on the band AD terminal mux/demux module.
- Connect 2AD to 2BD and 2AM to 2BM when using the band EH module with the band AD module.

## Per Shelf Rules for 2.5-Gbps Line Card Motherboards

If splitter protection is used, the corresponding transponder slots must use the splitter protected line card motherboards.

If line card protection is used, the following rules apply:

- The transponder slots corresponding to the optical mux/demux modules in slot 0 should use the west line card motherboards, which are wired only to the backplane traces to slot 0. This is to avoid sending four copies of the signal as a result of duplication in the y-cable (or redundant client signals) and reduplication in the splitter on the line card motherboard. Alternatively, splitter protected line card motherboards can be used. When splitter protected line card motherboards are used, all wavepatch y/z/0 interfaces in the slot should be configured as “shutdown.”

- The transponder slots corresponding to the optical mux/demux modules in slot 1 should use the east line card motherboards, which are wired only to the backplane traces to slot 1. Alternatively, splitter motherboards can be used. When splitter protected line card motherboards are used, all wavepatch y/z/1 interfaces in the slot should be configured as “shutdown.”

**Note**

When configuring a system for line card protection, the east and west line card motherboards offer the additional advantage of having lower optical power loss.

## General Rules for Ring Topologies

The following network rules apply to ring topologies:

- A channel must be present on only two nodes in the ring when using splitter protection.
- All channels added by a node on an east add/drop mux/demux modules must be dropped on a west add/drop mux/demux module of one or more other nodes on the ring. All channels added by a node on a west add/drop mux/demux module must be dropped by an east add/drop mux/demux module of one or more other nodes on the ring. This rule may be violated during migration.
- A node cannot add a channel that is already present in the same direction until it has dropped that channel.

In addition, we recommend that if there are plans to migrate from a hubbed ring to a logical mesh, the 4-channel or 8-channel add/drop mux/demux modules should be considered for deployment at the terminal node. This strategy avoids the necessity of discarding a terminal mux/demux module when migrating.

