



## CHAPTER 5

# Multiplexer and Demultiplexer Cards

This chapter describes legacy multiplexer and demultiplexer cards used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, see the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, see the *Cisco Optical Transport Products Safety and Compliance Information* document.



### Note

Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- [5.1 Card Overview, page 5-1](#)
- [5.2 Safety Labels, page 5-8](#)
- [5.3 32MUX-O Card, page 5-13](#)
- [5.4 32DMX-O Card, page 5-17](#)
- [5.5 4MD-xx.x Card, page 5-21](#)



### Note

For a description of the 32DMX, 32DMX-L, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-WSS-C, 40-WSS-CE, and 40-WXC-C cards, see [Chapter 9, “Reconfigurable Optical Add/Drop Cards.”](#)

## 5.1 Card Overview

The card overview section contains card summary, compatibility, interface class, and channel allocation plan information for legacy multiplexer and demultiplexer cards.



### Note

Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. For a list of slots and symbols, see the “Card Slot Requirements” section in the *Cisco ONS 15454 Hardware Installation Guide*.

## 5.1.1 Card Summary

Table 5-1 lists and summarizes the functions of the 32MUX-O, 32DMX-O, and 4MD-xx.x cards.

**Table 5-1 Multiplexer and Demultiplexer Cards**

| Card            | Port Description                                                                                             | For Additional Information                                        |
|-----------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| <b>32MUX-O</b>  | The 32MUX-O has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.       | See the <a href="#">“5.3 32MUX-O Card” section on page 5-13.</a>  |
| <b>32DMX-O</b>  | The 32DMX-O has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.       | <a href="#">“5.4 32DMX-O Card” section on page 5-17</a>           |
| <b>4MD-xx.x</b> | The 4MD-xx.x card has five sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17. | See the <a href="#">“5.5 4MD-xx.x Card” section on page 5-21.</a> |

## 5.1.2 Card Compatibility

Table 5-2 lists the CTC software compatibility for the legacy cards.

**Table 5-2 Software Compatibility for Legacy Multiplexer and Demultiplexer Cards**

| Release     | Cards   |         |          |
|-------------|---------|---------|----------|
|             | 32MUX-O | 32DMX-O | 4MD-xx.x |
| <b>R4.5</b> | Yes     | Yes     | Yes      |
| <b>R4.6</b> | Yes     | Yes     | Yes      |
| <b>R4.7</b> | Yes     | Yes     | Yes      |
| <b>R5.0</b> | Yes     | Yes     | Yes      |
| <b>R6.0</b> | Yes     | Yes     | Yes      |
| <b>R7.0</b> | Yes     | Yes     | Yes      |
| <b>R7.2</b> | Yes     | Yes     | Yes      |
| <b>R8.0</b> | Yes     | Yes     | Yes      |
| <b>R8.5</b> | Yes     | Yes     | Yes      |
| <b>R9.0</b> | Yes     | Yes     | Yes      |
| <b>R9.1</b> | Yes     | Yes     | Yes      |
| <b>R9.2</b> | Yes     | Yes     | Yes      |

## 5.1.3 Interface Classes

The 32MUX-O, 32DMX-O, and 4MD-xx.x cards have different input and output optical channel signals depending on the interface card where the input signal originates. The input interface cards have been grouped in classes listed in Table 5-3. The subsequent tables list the optical performance and output power of each interface class.

**Table 5-3 ONS 15454 Card Interfaces Assigned to Input Power Classes**

| Input Power Class | Card                                                                                                                                                                                                                                                                                                                        |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A                 | 10-Gbps multirate transponder cards (TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) with forward error correction (FEC) enabled, 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_2.5G_10E_C, and MXP_2.5G_10E_L) with FEC enabled, and 40-Gbps muxponder card (40G-MXP-C) |
| B                 | 10-Gbps multirate transponder card (TXP_MR_10G) without FEC, 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_MR_10DME_C, MXP_MR_10DME_L), 40-Gbps muxponder card (40G-MXP-C), and ADM-10G cards with FEC disabled                                                                                                                |
| C                 | OC-192 LR ITU cards (TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) without FEC                                                                                                                                                                                                                                                |
| D                 | 2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC enabled                                                                                                                                                                                                                         |
| E                 | OC-48 100-GHz DWDM muxponder card (MXP_MR_2.5G) and 2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected, with FEC disabled and retime, reshape, and regenerate (3R) mode enabled                                                                                                                    |
| F                 | 2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected, in regenerate and reshape (2R) mode                                                                                                                                                                                                            |
| G                 | OC-48 ELR 100 GHz card                                                                                                                                                                                                                                                                                                      |
| H                 | 2/4 port GbE transponder (GBIC WDM 100GHz)                                                                                                                                                                                                                                                                                  |
| I                 | TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards with enhanced FEC (E-FEC) and the MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, MXP_MR_10DME_L, and 40G-MXP-C cards with E-FEC enabled                                                                                                                     |

Table 5-5 lists the optical performance parameters for 40-Gbps cards that provide signal input to multiplexer and demultiplexer cards.

**Table 5-4 40-Gbps Interface Optical Performance**

| Parameter                     | Class A           |                           | Class B           |              | Class I           |              |
|-------------------------------|-------------------|---------------------------|-------------------|--------------|-------------------|--------------|
| Type                          | Power Limited     | OSNR <sup>1</sup> Limited | Power Limited     | OSNR Limited | Power Limited     | OSNR Limited |
| Maximum bit rate              | 40 Gbps           |                           | 40 Gbps           |              | 40 Gbps           |              |
| Regeneration                  | 3R                |                           | 3R                |              | 3R                |              |
| FEC                           | Yes               |                           | No                |              | Yes (E-FEC)       |              |
| Threshold                     | Optimum           |                           | Average           |              | Optimum           |              |
| Maximum BER <sup>2</sup>      | 10 <sup>-15</sup> |                           | 10 <sup>-12</sup> |              | 10 <sup>-15</sup> |              |
| OSNR <sup>1</sup> sensitivity | 23 dB             | 9 dB                      | 23 dB             | 19 dB        | 20 dB             | 8 dB         |
| Power sensitivity             | -24 dBm           | -18 dBm                   | -21 dBm           | -20 dBm      | -26 dBm           | -18 dBm      |
| Power overload                | -8 dBm            |                           | -8 dBm            |              | -8 dBm            |              |

**Table 5-4 40-Gbps Interface Optical Performance (continued)**

| Parameter                            | Class A       |                           | Class B        |              | Class I       |              |
|--------------------------------------|---------------|---------------------------|----------------|--------------|---------------|--------------|
| Type                                 | Power Limited | OSNR <sup>1</sup> Limited | Power Limited  | OSNR Limited | Power Limited | OSNR Limited |
| Transmitted Power Range <sup>3</sup> |               |                           |                |              |               |              |
| OC-192 LR ITU                        | —             |                           | —              |              | —             |              |
| Dispersion compensation tolerance    | +/-800 ps/nm  |                           | +/-1,000 ps/nm |              | +/-800 ps/nm  |              |

1. OSNR = optical signal-to-noise ratio

2. BER = bit error rate

3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

Table 5-5 lists the optical performance parameters that provide signal input for the 40-Gbps multiplexer and demultiplexer cards.

**Table 5-5 10-Gbps Interface Optical Performance Parameters**

| Parameter                                                          | Class A           |                           | Class B           |              | Class C           | Class I           |              |
|--------------------------------------------------------------------|-------------------|---------------------------|-------------------|--------------|-------------------|-------------------|--------------|
| Type                                                               | Power Limited     | OSNR <sup>1</sup> Limited | Power Limited     | OSNR Limited | OSNR Limited      | Power Limited     | OSNR Limited |
| Maximum bit rate                                                   | 10 Gbps           |                           | 10 Gbps           |              | 10 Gbps           | 10 Gbps           |              |
| Regeneration                                                       | 3R                |                           | 3R                |              | 3R                | 3R                |              |
| FEC                                                                | Yes               |                           | No                |              | No                | Yes (E-FEC)       |              |
| Threshold                                                          | Optimum           |                           | Average           |              | Average           | Optimum           |              |
| Maximum BER <sup>2</sup>                                           | 10 <sup>-15</sup> |                           | 10 <sup>-12</sup> |              | 10 <sup>-12</sup> | 10 <sup>-15</sup> |              |
| OSNR <sup>1</sup> sensitivity                                      | 23 dB             | 9 dB                      | 23 dB             | 19 dB        | 19 dB             | 20 dB             | 8 dB         |
| Power sensitivity                                                  | -24 dBm           | -18 dBm                   | -21 dBm           | -20 dBm      | -22 dBm           | -26 dBm           | -18 dBm      |
| Power overload                                                     | -8 dBm            |                           | -8 dBm            |              | -9 dBm            | -8 dBm            |              |
| Transmitted Power Range <sup>3</sup>                               |                   |                           |                   |              |                   |                   |              |
| 10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10G) | +2.5 to 3.5 dBm   |                           | +2.5 to 3.5 dBm   |              | —                 | —                 |              |
| OC-192 LR ITU                                                      | —                 |                           | —                 |              | +3.0 to 6.0 dBm   | —                 |              |
| 10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10E) | +3.0 to 6.0 dBm   |                           | +3.0 to 6.0 dBm   |              | —                 | +3.0 to 6.0 dBm   |              |
| Dispersion compensation tolerance                                  | +/-800 ps/nm      |                           | +/-1,000 ps/nm    |              | +/-1,000 ps/nm    | +/-800 ps/nm      |              |

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

Table 5-6 lists the optical interface performance parameters for 2.5-Gbps cards that provide signal input to multiplexer and demultiplexer cards.

**Table 5-6 2.5-Gbps Interface Optical Performance**

| Parameter                                 | Class D              |              | Class E              |              | Class F              | Class G              |              | Class H              |              | Class J              |
|-------------------------------------------|----------------------|--------------|----------------------|--------------|----------------------|----------------------|--------------|----------------------|--------------|----------------------|
| Type                                      | Power Limited        | OSNR Limited | Power Limited        | OSNR Limited | OSNR Limited         | Power Limited        | OSNR Limited | Power Limited        | OSNR Limited | Power Limited        |
| Maximum bit rate                          | 2.5 Gbps             |              | 2.5 Gbps             |              | 2.5 Gbps             | 2.5 Gbps             |              | 1.25 Gbps            |              | 2.5 Gbps             |
| Regeneration                              | 3R                   |              | 3R                   |              | 2R                   | 3R                   |              | 3R                   |              | 3R                   |
| FEC                                       | Yes                  |              | No                   |              | No                   | No                   |              | No                   |              | No                   |
| Threshold                                 | Average              |              | Average              |              | Average              | Average              |              | Average              |              | Average              |
| Maximum BER                               | 10 <sup>-15</sup>    |              | 10 <sup>-12</sup>    |              | 10 <sup>-12</sup>    | 10 <sup>-12</sup>    |              | 10 <sup>-12</sup>    |              | 10 <sup>-12</sup>    |
| OSNR sensitivity                          | 14 dB                | 6 dB         | 14 dB                | 10 dB        | 15 dB                | 14 dB                | 11 dB        | 13 dB                | 8 dB         | 12 dB                |
| Power sensitivity                         | -31 dBm              | -25 dBm      | -30 dBm              | -23 dBm      | -24 dBm              | -27 dBm              | -33 dBm      | -28 dBm              | -18 dBm      | -26 dBm              |
| Power overload                            | -9 dBm               |              | -9 dBm               |              | -9 dBm               | -9 dBm               |              | -7 dBm               |              | -17dBm               |
| Transmitted Power Range <sup>1</sup>      |                      |              |                      |              |                      |                      |              |                      |              |                      |
| TXP_MR_2.5G                               | -1.0 to 1.0 dBm      |              | -1.0 to 1.0 dBm      |              | -1.0 to 1.0 dBm      | -2.0 to 0 dBm        |              |                      |              |                      |
| TXPP_MR_2.5G                              | -4.5 to -2.5 dBm     |              | -4.5 to -2.5 dBm     |              | -4.5 to -2.5 dBm     |                      |              |                      |              |                      |
| MXP_MR_2.5G                               | —                    |              | +2.0 to +4.0 dBm     |              | —                    |                      |              |                      |              |                      |
| MXPP_MR_2.5G                              | —                    |              | -1.5 to +0.5 dBm     |              | —                    |                      |              |                      |              |                      |
| 2/4 port GbE Transponder(GBIC WDM 100GHz) |                      |              |                      |              |                      |                      |              | +2.5 to 3.5 dBm      |              | —                    |
| Dispersion compensation tolerance         | -1200 to +5400 ps/nm |              | -1200 to +5400 ps/nm |              | -1200 to +3300 ps/nm | -1200 to +3300 ps/nm |              | -1000 to +3600 ps/nm |              | -1000 to +3200 ps/nm |

1. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

## 5.1.4 Channel Allocation Plan

ONS 15454 DWDM multiplexer and demultiplexer cards are designed for use with specific channels in the C band and L band. In most cases, the channels for these cards are either numbered (for example, 1 to 32 or 1 to 40) or delimited (odd or even). Client interfaces must comply with these channel assignments to be compatible with the ONS 15454 system.

Table 5-7 lists the channel IDs and wavelengths assigned to the C-band DWDM channels.

**Note**

In some cases, a card uses only one of the bands (C band or L band) and some or all of the channels listed in a band. Also, some cards use channels on the 100-GHz ITU grid while others use channels on the 50-GHz ITU grid. See the specific card description or [Appendix A, “Hardware Specifications”](#) for more details.

**Table 5-7 DWDM Channel Allocation Plan (C Band)**

| Channel Number | Frequency (THz) | Wavelength (nm) | Channel Number | Frequency (THz) | Wavelength (nm) |
|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| 1              | 196.00          | 1529.55         | 42             | 193.95          | 1545.72         |
| 2              | 195.95          | 1529.94         | 43             | 193.90          | 1546.119        |
| 3              | 195.90          | 1530.334        | 44             | 193.85          | 1546.518        |
| 4              | 195.85          | 1530.725        | 45             | 193.80          | 1546.917        |
| 5              | 195.80          | 1531.116        | 46             | 193.75          | 1547.316        |
| 6              | 195.75          | 1531.507        | 47             | 193.70          | 1547.715        |
| 7              | 195.70          | 1531.898        | 48             | 193.65          | 1548.115        |
| 8              | 195.65          | 1532.290        | 49             | 193.60          | 1548.515        |
| 9              | 195.60          | 1532.681        | 50             | 193.55          | 1548.915        |
| 10             | 195.55          | 1533.073        | 51             | 193.50          | 1549.32         |
| 11             | 195.50          | 1533.47         | 52             | 193.45          | 1549.71         |
| 12             | 195.45          | 1533.86         | 53             | 193.40          | 1550.116        |
| 13             | 195.40          | 1534.250        | 54             | 193.35          | 1550.517        |
| 14             | 195.35          | 1534.643        | 55             | 193.30          | 1550.918        |
| 15             | 195.30          | 1535.036        | 56             | 193.25          | 1551.319        |
| 16             | 195.25          | 1535.429        | 57             | 193.20          | 1551.721        |
| 17             | 195.20          | 1535.822        | 58             | 193.15          | 1552.122        |
| 18             | 195.15          | 1536.216        | 59             | 193.10          | 1552.524        |
| 19             | 195.10          | 1536.609        | 60             | 193.05          | 1552.926        |
| 20             | 195.05          | 1537.003        | 61             | 193.00          | 1553.33         |
| 21             | 195.00          | 1537.40         | 62             | 192.95          | 1553.73         |
| 22             | 194.95          | 1537.79         | 63             | 192.90          | 1554.134        |
| 23             | 194.90          | 1538.186        | 64             | 192.85          | 1554.537        |
| 24             | 194.85          | 1538.581        | 65             | 192.80          | 1554.940        |
| 25             | 194.80          | 1538.976        | 66             | 192.75          | 1555.343        |
| 26             | 194.75          | 1539.371        | 67             | 192.70          | 1555.747        |
| 27             | 194.70          | 1539.766        | 68             | 192.65          | 1556.151        |
| 28             | 194.65          | 1540.162        | 69             | 192.60          | 1556.555        |
| 29             | 194.60          | 1540.557        | 70             | 192.55          | 1556.959        |
| 30             | 194.55          | 1540.953        | 71             | 192.50          | 1557.36         |

**Table 5-7 DWDM Channel Allocation Plan (C Band) (continued)**

| Channel Number | Frequency (THz) | Wavelength (nm) | Channel Number | Frequency (THz) | Wavelength (nm) |
|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| 31             | 194.50          | 1541.35         | 72             | 192.45          | 1557.77         |
| 32             | 194.45          | 1541.75         | 73             | 192.40          | 1558.173        |
| 33             | 194.40          | 1542.142        | 74             | 192.35          | 1558.578        |
| 34             | 194.35          | 1542.539        | 75             | 192.30          | 1558.983        |
| 35             | 194.30          | 1542.936        | 76             | 192.25          | 1559.389        |
| 36             | 194.25          | 1543.333        | 77             | 192.20          | 1559.794        |
| 37             | 194.20          | 1543.730        | 78             | 192.15          | 1560.200        |
| 38             | 194.15          | 1544.128        | 79             | 192.10          | 1560.606        |
| 39             | 194.10          | 1544.526        | 80             | 192.05          | 1561.013        |
| 40             | 194.05          | 1544.924        | 81             | 192.00          | 1561.42         |
| 41             | 194.00          | 1545.32         | 82             | 191.95          | 1561.83         |

Table 5-8 lists the channel IDs and wavelengths assigned to the L-band channels.

**Table 5-8 DWDM Channel Allocation Plan (L Band)**

| Channel Number | Frequency (THz) | Wavelength (nm) | Channel Number | Frequency (THz) | Wavelength (nm) |
|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| 1              | 190.85          | 1570.83         | 41             | 188.85          | 1587.46         |
| 2              | 190.8           | 1571.24         | 42             | 188.8           | 1587.88         |
| 3              | 190.75          | 1571.65         | 43             | 188.75          | 1588.30         |
| 4              | 190.7           | 1572.06         | 44             | 188.7           | 1588.73         |
| 5              | 190.65          | 1572.48         | 45             | 188.65          | 1589.15         |
| 6              | 190.6           | 1572.89         | 46             | 188.6           | 1589.57         |
| 7              | 190.55          | 1573.30         | 47             | 188.55          | 1589.99         |
| 8              | 190.5           | 1573.71         | 48             | 188.5           | 1590.41         |
| 9              | 190.45          | 1574.13         | 49             | 188.45          | 1590.83         |
| 10             | 190.4           | 1574.54         | 50             | 188.4           | 1591.26         |
| 11             | 190.35          | 1574.95         | 51             | 188.35          | 1591.68         |
| 12             | 190.3           | 1575.37         | 52             | 188.3           | 1592.10         |
| 13             | 190.25          | 1575.78         | 53             | 188.25          | 1592.52         |
| 14             | 190.2           | 1576.20         | 54             | 188.2           | 1592.95         |
| 15             | 190.15          | 1576.61         | 55             | 188.15          | 1593.37         |
| 16             | 190.1           | 1577.03         | 56             | 188.1           | 1593.79         |
| 17             | 190.05          | 1577.44         | 57             | 188.05          | 1594.22         |
| 18             | 190             | 1577.86         | 58             | 188             | 1594.64         |
| 19             | 189.95          | 1578.27         | 59             | 187.95          | 1595.06         |

**Table 5-8 DWDM Channel Allocation Plan (L Band) (continued)**

| Channel Number | Frequency (THz) | Wavelength (nm) | Channel Number | Frequency (THz) | Wavelength (nm) |
|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
| 20             | 189.9           | 1578.69         | 60             | 187.9           | 1595.49         |
| 21             | 189.85          | 1579.10         | 61             | 187.85          | 1595.91         |
| 22             | 189.8           | 1579.52         | 62             | 187.8           | 1596.34         |
| 23             | 189.75          | 1579.93         | 63             | 187.75          | 1596.76         |
| 24             | 189.7           | 1580.35         | 64             | 187.7           | 1597.19         |
| 25             | 189.65          | 1580.77         | 65             | 187.65          | 1597.62         |
| 26             | 189.6           | 1581.18         | 66             | 187.6           | 1598.04         |
| 27             | 189.55          | 1581.60         | 67             | 187.55          | 1598.47         |
| 28             | 189.5           | 1582.02         | 68             | 187.5           | 1598.89         |
| 29             | 189.45          | 1582.44         | 69             | 187.45          | 1599.32         |
| 30             | 189.4           | 1582.85         | 70             | 187.4           | 1599.75         |
| 31             | 189.35          | 1583.27         | 71             | 187.35          | 1600.17         |
| 32             | 189.3           | 1583.69         | 72             | 187.3           | 1600.60         |
| 33             | 189.25          | 1584.11         | 73             | 187.25          | 1601.03         |
| 34             | 189.2           | 1584.53         | 74             | 187.2           | 1601.46         |
| 35             | 189.15          | 1584.95         | 75             | 187.15          | 1601.88         |
| 36             | 189.1           | 1585.36         | 76             | 187.1           | 1602.31         |
| 37             | 189.05          | 1585.78         | 77             | 187.05          | 1602.74         |
| 38             | 189             | 1586.20         | 78             | 187             | 1603.17         |
| 39             | 188.95          | 1586.62         | 79             | 186.95          | 1603.60         |
| 40             | 188.9           | 1587.04         | 80             | 186.9           | 1604.03         |

## 5.2 Safety Labels

This section explains the significance of the safety labels attached to some of the cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

### 5.2.1 Class 1 Laser Product Labels

The 32MUX-O card has a Class 1 laser. The labels that appear on the card are described in the following sections.

#### 5.2.1.1 Class 1 Laser Product Label

The Class 1 Laser Product label is shown in [Figure 5-1](#).

**Figure 5-1**      **Class 1 Laser Product Label**



Class 1 lasers are products whose irradiance does not exceed the Maximum Permissible Exposure (MPE) value. Therefore, for Class 1 laser products the output power is below the level at which it is believed eye damage will occur. Exposure to the beam of a Class 1 laser will not result in eye injury and may therefore be considered safe. However, some Class 1 laser products may contain laser systems of a higher class but there are adequate engineering control measures to ensure that access to the beam is not reasonably likely. Anyone who dismantles a Class 1 laser product that contains a higher Class laser system is potentially at risk of exposure to a hazardous laser beam

### 5.2.1.2 Hazard Level 1 Label

The Hazard Level 1 label is shown in [Figure 5-2](#). This label is displayed on the faceplate of the cards.

**Figure 5-2**      **Hazard Level Label**



The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

### 5.2.1.3 Laser Source Connector Label

The Laser Source Connector label is shown in [Figure 5-3](#).

**Figure 5-3**      **Laser Source Connector Label**

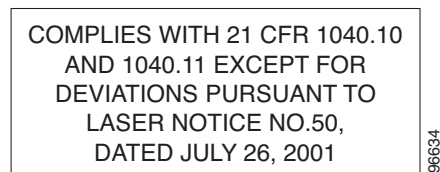


This label indicates that a laser source is present at the optical connector where the label has been placed.

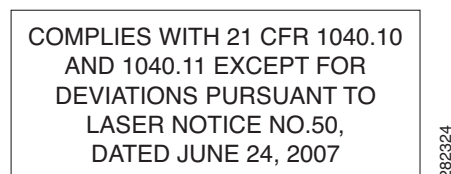
### 5.2.1.4 FDA Statement Label

The FDA Statement labels are shown in [Figure 5-4](#) and [Figure 5-5](#). These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

**Figure 5-4** *FDA Statement Label*



**Figure 5-5** *FDA Statement Label*



### 5.2.1.5 Shock Hazard Label

The Shock Hazard label is shown in [Figure 5-6](#).

**Figure 5-6** *Shock Hazard Label*



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

## 5.2.2 Class 1M Laser Product Cards

The 32DMX-O and 4MD-xx.x cards have Class IM lasers. The labels that appear on these cards are described in the following subsections.

### 5.2.2.1 Class 1M Laser Product Statement

The Class 1M Laser Product statement is shown in [Figure 5-7](#).

**Figure 5-7** *Class 1M Laser Product Statement*



Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

### 5.2.2.2 Hazard Level 1M Label

The Hazard Level 1M label is shown in [Figure 5-8](#).

**Figure 5-8** *Hazard Level Label*



The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2. This label is displayed on the faceplate of the cards.

### 5.2.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in [Figure 5-9](#).

**Figure 5-9** *Laser Source Connector Label*



This label indicates that a laser source is present at the optical connector where the label has been placed.

### 5.2.2.4 FDA Statement Label

The FDA Statement labels are shown in [Figure 5-10](#) and [Figure 5-11](#). These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

**Figure 5-10** *FDA Statement Label*

COMPLIES WITH 21 CFR 1040.10  
AND 1040.11 EXCEPT FOR  
DEVIATIONS PURSUANT TO  
LASER NOTICE NO.50,  
DATED JULY 26, 2001

96634

**Figure 5-11** *FDA Statement Label*

COMPLIES WITH 21 CFR 1040.10  
AND 1040.11 EXCEPT FOR  
DEVIATIONS PURSUANT TO  
LASER NOTICE NO.50,  
DATED JUNE 24, 2007

282324

### 5.2.2.5 Shock Hazard Label

The Shock Hazard label is shown in [Figure 5-6](#).

**Figure 5-12** *Shock Hazard Label*



65541

This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

## 5.3 32MUX-O Card

**Note**

See the [“A.7.1 32MUX-O Card Specifications” section on page A-20](#) for hardware specifications.

The 32-Channel Multiplexer (32MUX-O) card multiplexes 32 100-GHz-spaced channels identified in the channel plan. The 32MUX-O card takes up two slots in an ONS 15454 and can be installed in Slots 1 to 5 and 12 to 16.

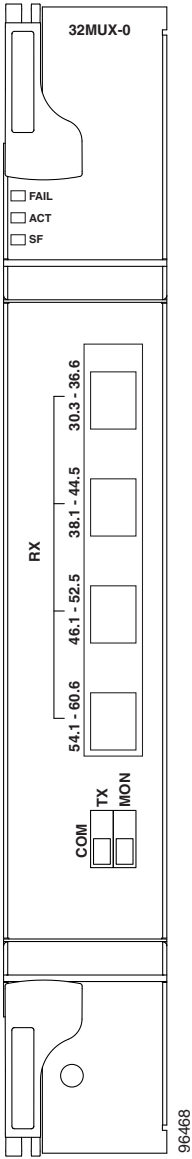
The 32MUX-O features include:

- Arrayed waveguide grating (AWG) device that enables full multiplexing functions for the channels.
- Each single-channel port is equipped with VOAs for automatic optical power regulation prior to multiplexing. In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.
- Each single-channel port is monitored using a photodiode to enable automatic power regulation.

An additional optical monitoring port with 1:99 splitting ratio is available.

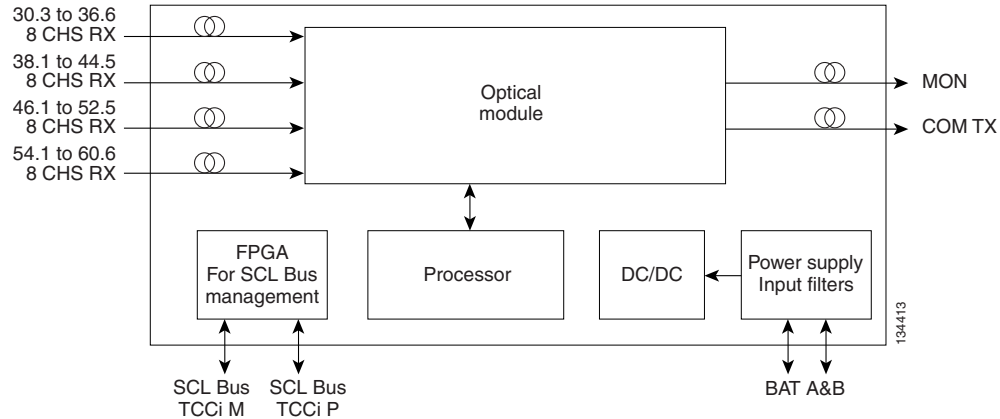
[Figure 5-13](#) shows the 32MUX-O faceplate.

Figure 5-13 32MUX-O Faceplate



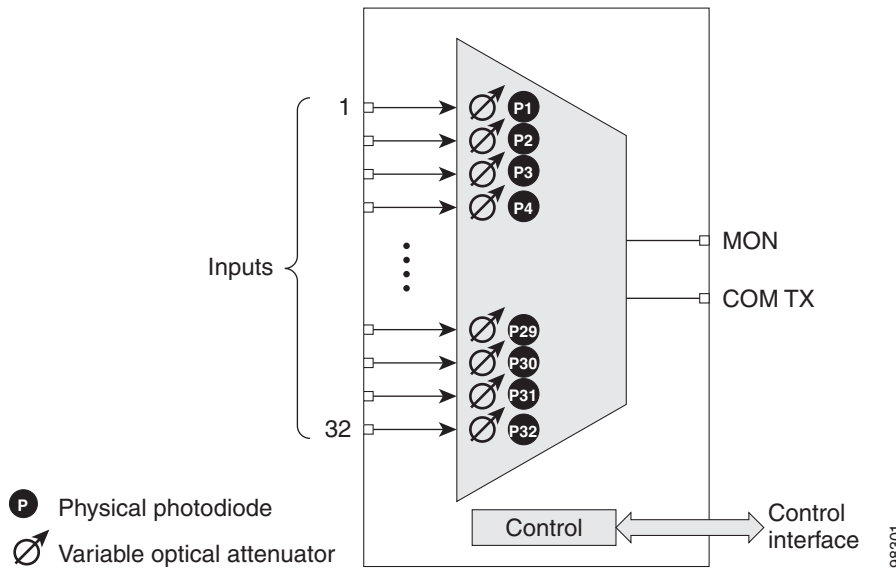
For information on safety labels for the card, see the [“5.2.1 Class 1 Laser Product Labels”](#) section on [page 5-8](#).

[Figure 5-14](#) shows a block diagram of the 32MUX-O card.

**Figure 5-14 32MUX-O Block Diagram**

The 32MUX-O card has four receive connectors that accept multifiber push-on (MPO) cables on its front panel for the client input interfaces. MPO cables break out into eight separate cables. The 32MUX-O card also has two LC-PC-II optical connectors, one for the main output and the other for the monitor port.

Figure 5-15 shows the 32MUX-O optical module functional block diagram.

**Figure 5-15 32MUX-O Optical Module Functional Block Diagram**

### 5.3.1 Channel Plan

The 32MUX-O is typically used in hub nodes and provides the multiplexing of 32 channels, spaced at 100 GHz, into one fiber before their amplification and transmission along the line. The channel plan is shown in Table 5-9.

**Table 5-9 32MUX-O Channel Plan**

| Channel Number <sup>1</sup> | Channel ID | Frequency (GHz) | Wavelength (nm) |
|-----------------------------|------------|-----------------|-----------------|
| 1                           | 30.3       | 195.9           | 1530.33         |
| 2                           | 31.2       | 195.8           | 1531.12         |
| 3                           | 31.9       | 195.7           | 1531.90         |
| 4                           | 32.6       | 195.6           | 1532.68         |
| 5                           | 34.2       | 195.4           | 1534.25         |
| 6                           | 35.0       | 195.3           | 1535.04         |
| 7                           | 35.8       | 195.2           | 1535.82         |
| 8                           | 36.6       | 195.1           | 1536.61         |
| 9                           | 38.1       | 194.9           | 1538.19         |
| 10                          | 38.9       | 194.8           | 1538.98         |
| 11                          | 39.7       | 194.7           | 1539.77         |
| 12                          | 40.5       | 194.6           | 1540.56         |
| 13                          | 42.1       | 194.4           | 1542.14         |
| 14                          | 42.9       | 194.3           | 1542.94         |
| 15                          | 43.7       | 194.2           | 1543.73         |
| 16                          | 44.5       | 194.1           | 1544.53         |
| 17                          | 46.1       | 193.9           | 1546.12         |
| 18                          | 46.9       | 193.8           | 1546.92         |
| 19                          | 47.7       | 193.7           | 1547.72         |
| 20                          | 48.5       | 193.6           | 1548.51         |
| 21                          | 50.1       | 193.4           | 1550.12         |
| 22                          | 50.9       | 193.3           | 1550.92         |
| 23                          | 51.7       | 193.2           | 1551.72         |
| 24                          | 52.5       | 193.1           | 1552.52         |
| 25                          | 54.1       | 192.9           | 1554.13         |
| 26                          | 54.9       | 192.8           | 1554.94         |
| 27                          | 55.7       | 192.7           | 1555.75         |
| 28                          | 56.5       | 192.6           | 1556.55         |
| 29                          | 58.1       | 192.4           | 1558.17         |
| 30                          | 58.9       | 192.3           | 1558.98         |
| 31                          | 59.7       | 192.2           | 1559.79         |
| 32                          | 60.6       | 192.1           | 1560.61         |

1. The Channel Number column is only for reference purposes. The channel ID is consistent with the ONS 15454 and is used in card identification.

## 5.3.2 Power Monitoring

Physical photodiodes P1 through P32 monitor the power for the 32MUX-O card. The returned power level values are calibrated to the ports as shown in [Table 5-10](#).

**Table 5-10 32MUX-O Port Calibration**

| Photodiode | CTC Type Name | Calibrated to Port |
|------------|---------------|--------------------|
| P1–P32     | ADD           | COM TX             |

For information on the associated TL1 AIDs for the optical power monitoring points, refer the “CTC Port Numbers and TL1 Aids” section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

## 5.3.3 32MUX-O Card-Level Indicators

The 32MUX-O card has three card-level LED indicators, described in [Table 5-11](#).

**Table 5-11 32MUX-O Card-Level Indicators**

| Card-Level Indicators | Description                                                                                                                                                                                                                                    |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Red FAIL LED          | The red FAIL LED indicates that the card’s processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.                                                                                |
| Green ACT LED         | The green ACT LED indicates that the 32MUX-O is carrying traffic or is traffic-ready.                                                                                                                                                          |
| Amber SF LED          | The amber SF LED indicates a signal failure on one or more of the card’s ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off. |

## 5.3.4 32MUX-O Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 32MUX-O card has five sets of ports located on the faceplate.

COM TX is the line output. COM MON is the optical monitoring port. The xx.x to yy.y RX ports represent the four groups of eight channels ranging from wavelength xx.x to wavelength yy.y, according to the channel plan.

## 5.4 32DMX-O Card



### Note

See the [“A.7.2 32DMX-O Card Specifications”](#) section on page A-20 for hardware specifications.

The 32-Channel Demultiplexer (32DMX-O) card demultiplexes 32 100-GHz-spaced channels identified in the channel plan. The 32DMX-O takes up two slots in an ONS 15454 and can be installed in Slots 1 to 5 and 12 to 16.

The 32DMX-O features include:

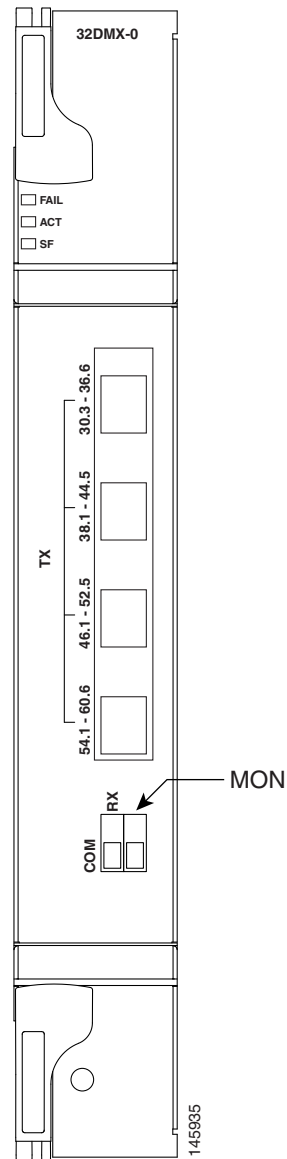
- AWG that enables channel demultiplexing functions.
- Each single-channel port is equipped with VOAs for automatic optical power regulation after demultiplexing. In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.
- The 32DXM-O has four physical receive connectors that accept MPO cables on its front panel for the client input interfaces. MPO cables break out into eight separate cables.

**Note**

In contrast, the single-slot 32DMX card does not have VOAs on each drop port for optical power regulation. The 32DMX optical demultiplexer module is used in conjunction with the 32WSS card in ONS 15454 Multiservice Transport Platform (MSTP) nodes.

- Each single-channel port is monitored using a photodiode to enable automatic power regulation.

[Figure 5-16](#) shows the 32DMX-O card faceplate.

**Figure 5-16 32DMX-O Faceplate**

For information on safety labels for the card, see the [“5.2.2 Class 1M Laser Product Cards”](#) section on [page 5-10](#).

[Figure 5-17](#) shows a block diagram of the 32DMX-O card.

**Figure 5-17 32DMX-O Block Diagram**

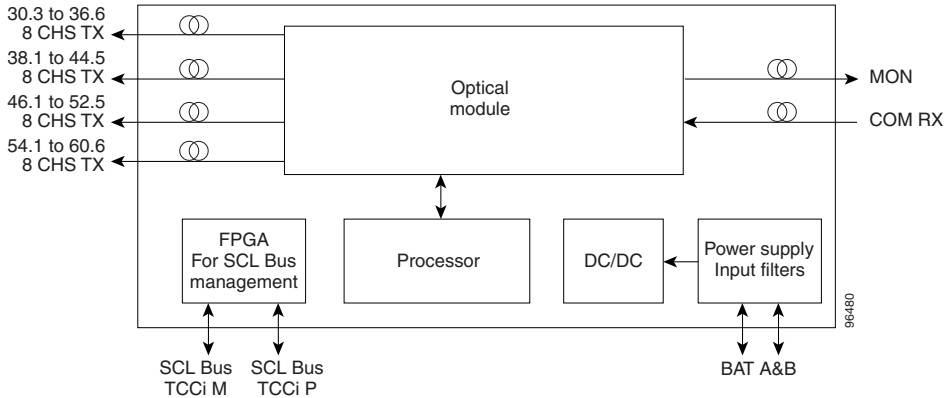
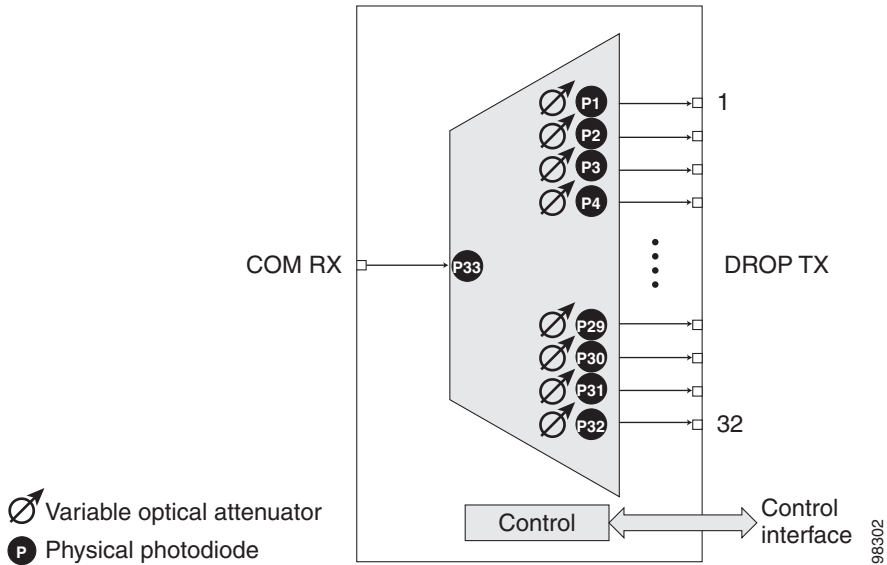


Figure 5-18 shows the 32DMX-O optical module functional block diagram.

**Figure 5-18 32DMX-O Optical Module Functional Block Diagram**



## 5.4.1 Power Monitoring

Physical photodiodes P1 through P33 monitor the power for the 32DMX-O card. The returned power level values are calibrated to the ports as shown in Table 5-12.

**Table 5-12 32DMX-O Port Calibration**

| Photodiode | CTC Type Name | Calibrated to Port |
|------------|---------------|--------------------|
| P1–P32     | DROP          | DROP TX            |
| P33        | INPUT COM     | COM RX             |

For information on the associated TL1 AIDs for the optical power monitoring points, refer the “CTC Port Numbers and TL1 Aids” section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

## 5.4.2 32DMX-O Card-Level Indicators

The 32DMX-O card has three card-level LED indicators, described in [Table 5-13](#).

**Table 5-13 32DMX-O Card-Level Indicators**

| Card-Level Indicators | Description                                                                                                                                                                                                                                    |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Red FAIL LED          | The red FAIL LED indicates that the card’s processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.                                                                                |
| Green ACT LED         | The green ACT LED indicates that the 32DMX-O is carrying traffic or is traffic-ready.                                                                                                                                                          |
| Amber SF LED          | The amber SF LED indicates a signal failure on one or more of the card’s ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off. |

## 5.4.3 32DMX-O Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 32DMX-O card has five sets of ports located on the faceplate. MON is the output monitor port. COM RX is the line input. The xx.x to yy.y TX ports represent the four groups of eight channels ranging from wavelength xx.x to wavelength yy.y according to the channel plan.

## 5.5 4MD-xx.x Card



### Note

See the [“A.7.3 4MD-xx.x Card Specifications”](#) section on [page A-21](#) for hardware specifications.

The 4-Channel Multiplexer/Demultiplexer (4MD-xx.x) card multiplexes and demultiplexes four 100-GHz-spaced channels identified in the channel plan. The 4MD-xx.x card is designed to be used with band OADMs (both AD-1B-xx.x and AD-4B-xx.x).

The card is bidirectional. The demultiplexer and multiplexer functions are implemented in two different sections of the same card. In this way, the same card can manage signals flowing in opposite directions.

There are eight versions of this card that correspond with the eight sub-bands specified in [Table 5-14 on page 5-24](#). The 4MD-xx.x can be installed in Slots 1 to 6 and 12 to 17.

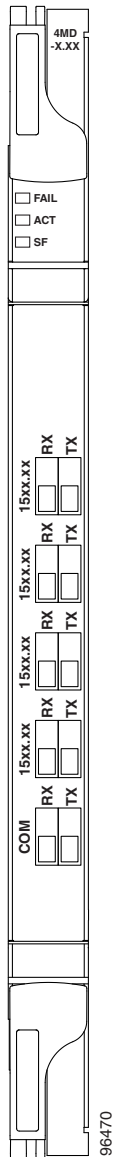
The 4MD-xx.x has the following features implemented inside a plug-in optical module:

- Passive cascade of interferential filters perform the channel multiplex/demultiplex function.
- Software-controlled VOAs at every port of the multiplex section regulate the optical power of each multiplexed channel.

- Software-monitored photodiodes at the input and output multiplexer and demultiplexer ports for power control and safety purposes.
- Software-monitored virtual photodiodes at the common DWDM output and input ports. A virtual photodiode is a firmware calculation of the optical power at that port. This calculation is based on the single channel photodiode reading and insertion losses of the appropriated paths.

Figure 5-19 shows the 4MD-xx.x faceplate.

**Figure 5-19 4MD-xx.x Faceplate**



For information on safety labels for the card, see the “[5.2.2 Class 1M Laser Product Cards](#)” section on [page 5-10](#).

Figure 5-20 shows a block diagram of the 4MD-xx.x card.

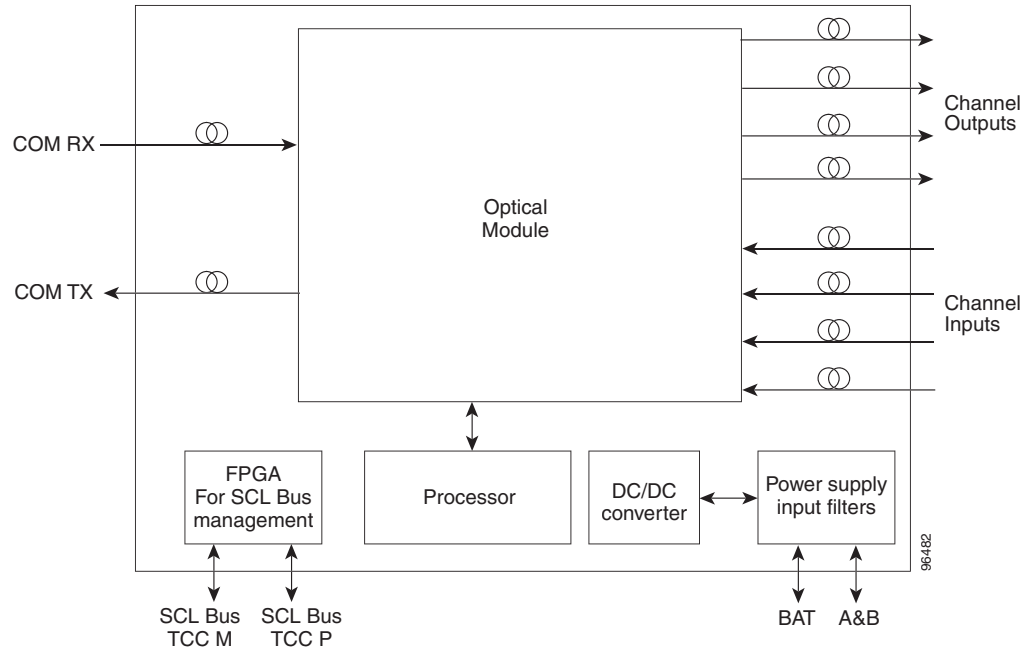
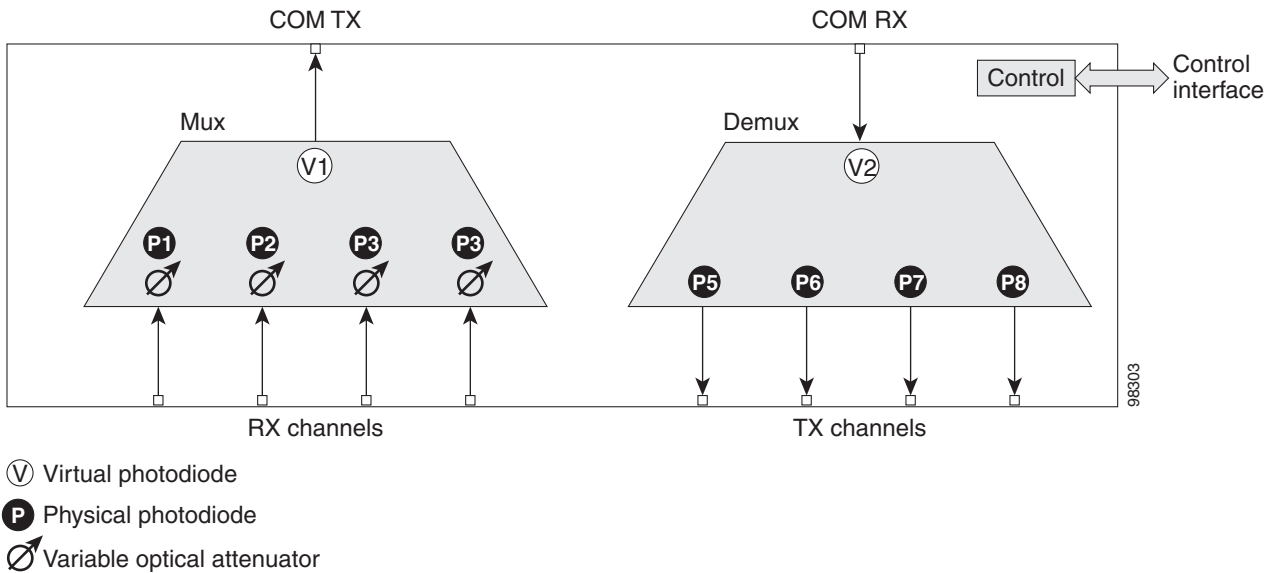
**Figure 5-20 4MD-xx.x Block Diagram**

Figure 5-21 shows the 4MD-xx.x optical module functional block diagram.

**Figure 5-21 4MD-xx.x Optical Module Functional Block Diagram**

The optical module shown in Figure 5-21 is optically passive and consists of a cascade of interferential filters that perform the channel multiplexing and demultiplexing functions.

VOAs are present in every input path of the multiplex section in order to regulate the optical power of each multiplexed channel. Some optical input and output ports are monitored by means of photodiodes implemented both for power control and for safety purposes. An internal control manages VOA settings and functionality as well as photodiode detection and alarm thresholds. The power at the main output

and input ports is monitored through the use of virtual photodiodes. A virtual photodiode is implemented in the firmware of the plug-in module. This firmware calculates the power on a port, summing the measured values from all single channel ports (and applying the proper path insertion loss) and then providing the TCC2/TCC2P/TCC3/TNC/TSC card with the obtained value.

## 5.5.1 Wavelength Pairs

Table 5-14 shows the band IDs and the add/drop channel IDs for the 4MD-xx.x card.

**Table 5-14 4MD-xx.x Channel Sets**

| Band ID       | Add/Drop Channel IDs   |
|---------------|------------------------|
| Band 30.3 (A) | 30.3, 31.2, 31.9, 32.6 |
| Band 34.2 (B) | 34.2, 35.0, 35.8, 36.6 |
| Band 38.1 (C) | 38.1, 38.9, 39.7, 40.5 |
| Band 42.1 (D) | 42.1, 42.9, 43.7, 44.5 |
| Band 46.1 (E) | 46.1, 46.9, 47.7, 48.5 |
| Band 50.1 (F) | 50.1, 50.9, 51.7, 52.5 |
| Band 54.1 (G) | 54.1, 54.9, 55.7, 56.5 |
| Band 58.1 (H) | 58.1, 58.9, 59.7, 60.6 |

## 5.5.2 Power Monitoring

Physical photodiodes P1 through P8 and virtual photodiodes V1 and V2 monitor the power for the 4MD-xx.x card. The returned power level values are calibrated to the ports as shown in Table 5-15.

**Table 5-15 4MD-xx.x Port Calibration**

| Photodiode | CTC Type Name | Calibrated to Port |
|------------|---------------|--------------------|
| P1–P4      | ADD           | COM TX             |
| P5–P8      | DROP          | DROP TX            |
| V1         | OUT COM       | COM TX             |
| V2         | IN COM        | COM RX             |

For information on the associated TL1 AIDs for the optical power monitoring points, refer the “CTC Port Numbers and TL1 Aids” section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

## 5.5.3 4MD-xx.x Card-Level Indicators

The 4MD-xx.x card has three card-level LED indicators, described in Table 5-16.

**Table 5-16** 4MD-xx.x Card-Level Indicators

| Card-Level Indicators | Description                                                                                                                                                                                                                                    |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Red FAIL LED          | The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.                                                                                |
| Green ACT LED         | The green ACT LED indicates that the 4MD-xx.x card is carrying traffic or is traffic-ready.                                                                                                                                                    |
| Amber SF LED          | The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off. |

## 5.5.4 4MD-xx.x Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 4MD-xx.x card has five sets of ports located on the faceplate. COM RX is the line input. COM TX is the line output. The 15xx.x TX ports represent demultiplexed channel outputs 1 to 4. The 15xx.x RX ports represent multiplexed channel inputs 1 to 4.

