ARTEL VIDEO SYSTEMS

MegaWav

Dense Wavelength Division Multiplexer System

Installation and Operation Guide

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Artel Video Systems, Inc.
237 Cedar Hill Street
Marlborough, MA 01752
(508) 303-8200

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About This Guide

This guide contains instructions for installing and configuring the MegaWav Dense Wavelength Division Multiplexer (DWDM) system.

Audience

This guide is intended for the following trained and qualified service personnel who are responsible for installing and operating the MegaWav DWDM system:

- System installer
- Hardware technician
- System operator

How to Use This Guide

The contents of each chapter in this guide include the following.

Section	Provides
Chapter 1, "Introduction"	An overview of the MegaWav DWDM system, including the chassis unit and modules.
Chapter 2, "Installation"	Procedures to unpack and install the MegaWav chassis unit and modules.
Chapter 3, "Broadband WDM Modules"	Detailed information on MegaWav broadband WDM modules, including cabling and sample applications.
Chapter 4, "DWDM Modules"	Detailed information on MegaWav DWDM modules, including cabling and sample applications.
Chapter 5, "Combiner/Splitter Modules"	Detailed information on MegaWav combiner/splitter modules, including cabling and sample applications.
Chapter 6, "Filter Modules"	Detailed information on MegaWav add/drop/pass filters, including cabling and sample applications.
Appendix A, "Specifications"	Specifications for the MegaWav chassis unit and the four module groups.
Appendix , "Fiber Optic Cables"	Information on fiber optic cables.
Appendix C, "Customer Service"	Information for contacting Artel's customer service department.
Index	An alphabetical index of topics.

Symbols and Conventions

This guide uses the following symbols and conventions to emphasize certain information.

Caution

A caution means that a specific action could cause harm to the equipment or to the data.

Warning

⚠ A warning describes an action that could cause physical harm or damage the equipment.

Note: Important related information, reminders, and recommendations.

Italics - Indicate the first occurrence of a new term, book title, and emphasized text.

1. Numbered list - When order is important.
   a. Alphabetical list - When the order of secondary items is important.

- Bulleted list - When the order of the items is unimportant.
  – Indented dashed list - When the order of subtopics is unimportant.

1

Introduction

This chapter provides an introduction to and general overview of Artel Video Systems' MegaWav product line.

This chapter contains the following sections:

Product Overview

The MegaWav product line efficiently manages and transports multiple video/data signals simultaneously over one common fiber optic cable. MegaWav products increase fiber capacity by providing optical multiplexing, demultiplexing, bidirectional communication, and add/drop/pass filtering of signals over a common fiber optic cable. Figure 1-1 compares a basic configuration before and after installing MegaWav.

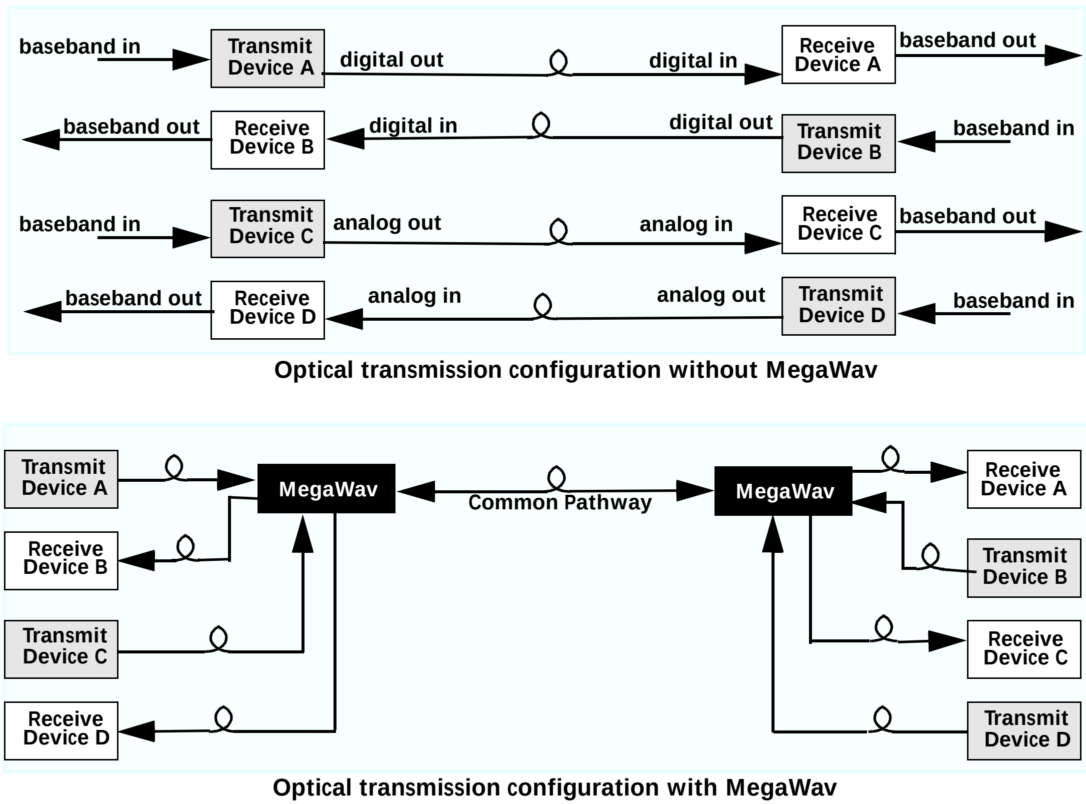

Figure 1-1. Sample MegaWav Configuration

The product line includes two chassis enclosures (Figure 1-2 on page 1-5 and Figure 1-3 on page 1-6) and several user-configurable functional modules (listed by model number on page 1-7). A chassis can house several functional modules, allowing you to customize the MegaWav to your specific needs.

The MegaWav modules enable multiple analog and digital video datastreams, audio signals, and data to be transported together over one singlemode fiber optic cable. They support applications such as:

- Multichannel broadcast video transport
- CATV supertrunking
- Multichannel interoffice trunking
- High density channel solutions
- Optical signal blending and extraction

Note: This product is designed for operation with singlemode fiber only. Refer to Appendix B for more information on selecting fiber optic cables.

The MegaWav uses ITU-standard wavelengths in its dense wavelength division multiplexing (DWDM) and add/drop/pass filtering modules. You can integrate the MegaWav with both Artel transmission products and other ITU-compliant third-party systems.

Features and Capabilities

The MegaWav product line offers the following features and capabilities:

- Optical multiplexing capabilities for transmitting as many as 16 optical signals on a single common fiber pathway
- Demultiplexing capabilities for extracting optical signals that have been blended on a common fiber pathway and sending them over separate fiber paths
- Bi-directional optical coupling over the common pathway
- Add/drop/pass filtering of optical wavelengths at mid-span distances along the common pathway
- Two single rack unit (1 RU) chassis, one that houses up to four functional modules and another specially designed to house one or two 16-channel DWDM modules
- ITU-standard notched laser wavelengths that are compatible with Artel's DigiLink, DL8000, MegaLink, and SL4000 products as well as other industry equipment
- High reliability resulting from a totally passive design
- NEBS, UL, CSA, CE, and FCC compliance

MegaWav Chassis Enclosures

Two types of chassis enclosures are available to house your MegaWav modules—an MW18204H four-slot chassis and an MW18202H two-slot chassis. Both chassis are 1 RU rack-mountable enclosures.

The MW18204H Four-slot Chassis

The MW18204H chassis is a single 19 inch rack unit (1 RU) enclosure that houses as many as four of any of the following MegaWav functional modules:

- The Broadband WDM Modules (page 1-8)
- Four- or eight-channel DWDM Modules (page 1-10)
- The Combiner/Splitter Modules (page 1-12)
- The Add/Drop/Pass Filter Modules (page 1-15)

The four-slot chassis come from the factory with 1 ... 4 modules pre-installed. Unpopulated slots contain removable blank panels. Blank panels can be field-upgraded with any of the above functional modules.

Figure 1-2 shows sample front and rear panel views of a four-slot chassis with eight-channel DWDM modules installed in slots 1 and 2. Slots 3 and 4 are unpopulated. The module connectors are accessible from the rear panel, and the model numbers of the installed modules show through windows in the front panel.

Front Panel

Figure 1-2. The MW18204H Four-slot Chassis Unit

The MW18202H Two-slot Chassis

The MW18202H chassis is a single-rack unit (1 RU) mountable enclosure that house one or two MW18216D 16-channel DWDM modules (page 1-10). The ability to install two DWDM modules in the chassis allows you to establish redundant multiplexer/demultiplexer capabilities at your sites. Redundancy can be used to structure counter-rotating, self-healing ring topologies in high-reliability applications.

The two-slot chassis come from the factory with one or both modules pre-installed. If a slot is unpopulated, the chassis will contain a removable blank panel. The blank panel can be field-upgraded with an additional functional module at a later time.

Figure 1-3 shows sample front and rear panel views of a two-slot chassis with a 16-channel DWDM module installed in slot 1. Slot 2 is not populated. The module connectors are accessible from the rear panel, and the model number of the installed module shows through a window in the front panel.

Front Panel

Rear Panel

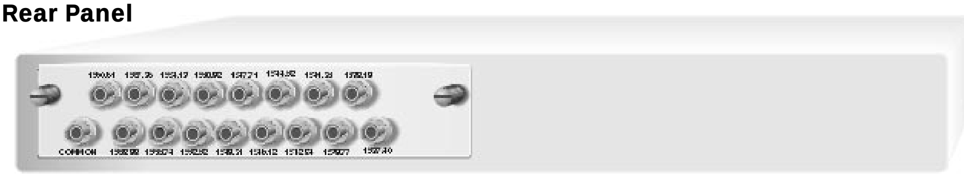

Figure 1-3. The MW18202H Two-slot Chassis Unit

MegaWav Module Models

MegaWav modules are available in four different functional types that enable you to construct flexible networks. All models are compatible with the Digilink1200/1220, DL8000, Megalink, and SL4000 products, as well as with ITU-compliant third-party equipment. The four groups are:

- *Broadband WDM*: Single- and dual-channel universal broadband wavelength division multiplexer/demultiplexer (WDM/WDD) modules (see page 1-8)
- *DWDM*: Four-, eight-, and 16-channel optical modules that uses dense wavelength division multiplexing (DWDM) to blend signals on a common fiber pathway and dense wavelength division demultiplexing (DWDD) to extract signals from the common fiber pathway (see page 1-10)
- *Combiner/splitters*: Two-, four-, and eight-way optical combiner/splitter modules for use in optical broadcast applications (see page 1-12)
- *Filters*: Sixteen different filter modules, each designed to perform an optical add/drop/pass operation on one of the 16 supported DWDM wavelengths (see page 1-15)

Each module is identified using the following alphanumeric numbering system:

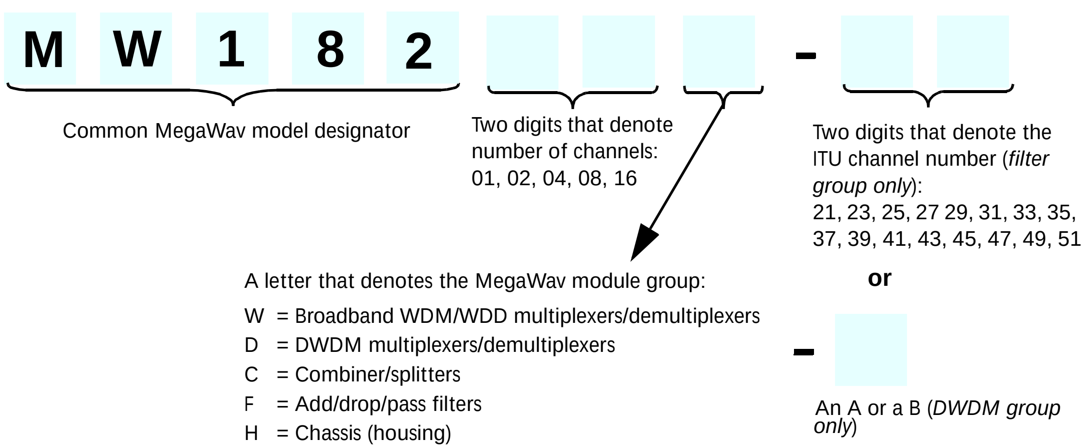

Figure 1-4. MegaWav Model Numbering Scheme

Broadband WDM Modules

The broadband wavelength division multiplexer (WDM) group includes the two models, described in Table 1-1.

Table 1-1. MegaWav Broadband Wavelength Division Multiplexer Models

Model	Description	Optical Paths Supported
MW18201W	Single broadband WDM/WDD	1310 nm or 1550 nm
MW18202W	Dual broadband WDM/WDD	1310 nm or 1550 nm

These units are bidirectional and can be used to:

- Blend (multiplex) two broadband optical signals (from 1310 nm and 1550 nm wavelengths) onto a common optical pathway—this operation is called WDM
- Extract (demultiplex) two broadband optical signals wavelengths) from a common pathway and transmit them on different 1310 nm and 1550 nm fiber pathways—this operation is called WDD
- Combine WDM and WDD operations such that one broadband optical signal is extracted from the common pathway while another is transmitted on the common pathway

Unidirectional and bidirectional operations

In the first two cases listed above, the operations are unidirectional—that is, the two signals both travel in the same direction on the common pathway. In the third case, the operation is bidirectional in that two signals travel in opposite directions on the common pathway.

Figure 1-5 illustrates the signal flow of these three operations.

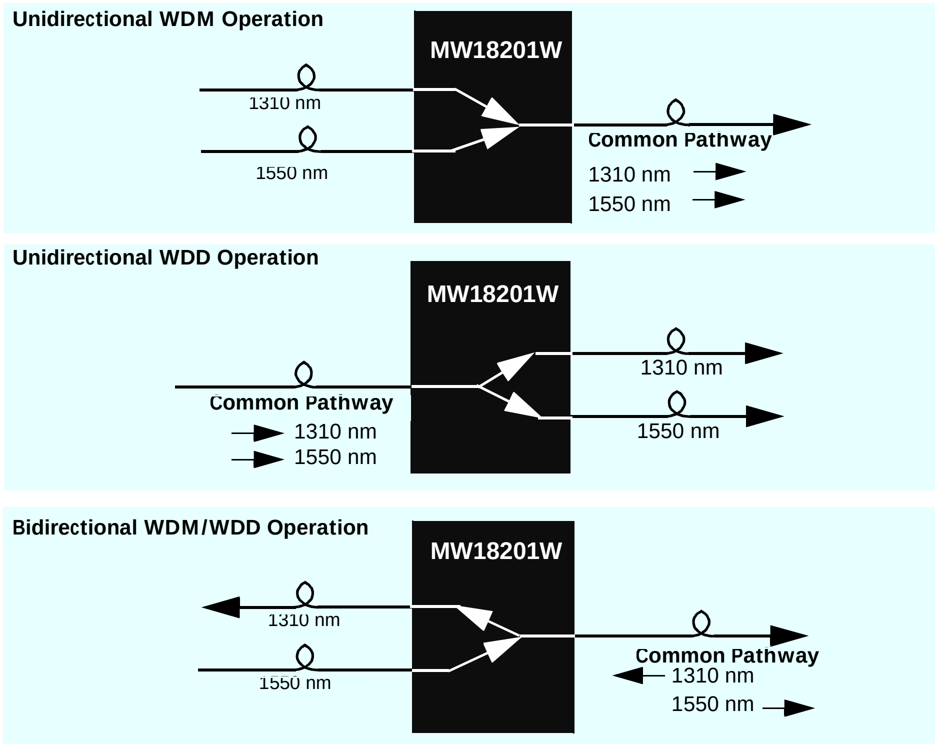

Figure 1-5. Signal Flows in a MegaWav Model MW18201W

The MW18202W model operates similarly, with two identical sets of broadband WDM/WDD portage—two 1310 nm I/O ports, two 1550 nm I/O ports, and two common pathway ports.

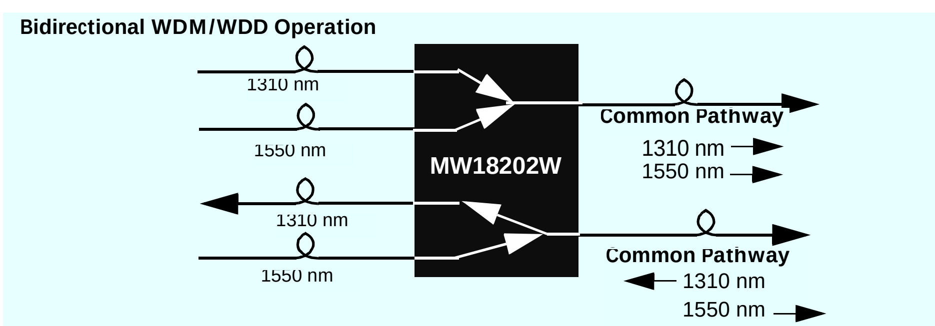

Figure 1-6. Signal Flow in a MegaWav Model MW18202W

DWDM Modules

The MegaWav dense wavelength division multiplexer/demultiplexer (DWDM/DWDD) group includes six bidirectional modules (Table 1-2).

Table 1-2. MegaWav Dense Wavelength Division Multiplexer Models

Model	Description	Wavelengths Supported (nm)
MW18204D-A MW18204D-B	Four-channel optical multiplexer/demultiplexer	1560.61, 1557.36, 1554.13, 1550.92
MW18208D-A MW18208D-B	Eight-channel optical multiplexer/demultiplexer	1560.61, 1557.36, 1554.13, 1550.92, 1547.71, 1544.52, 1541.35, 1538.19
MW18216D-A MW18216D-B	16-channel optical multiplexer/demultiplexers	1560.61,1558.98, 1557.36, 1555.74, 1554.13, 1552.52, 1550.92,1549.31, 1547.71, 1546.12, 1544.52, 1542.94, 1541.35, 1539.77, 1538.19, 1536.61

Note: -A and -B versions are provided for optimal performance. To minimize insertion loss, use a -A module on one end of the common pathway and a -B module on the opposite end of the common pathway.

Where insertion loss is not a major consideration, two -A modules or two -B modules may be paired at opposite ends of the common pathway.

For a detailed discussion of DWDM performance considerations, refer to Chapter 4. These modules are bidirectional and are used to:

- Blend (multiplex) up to 16 distinct notched wavelengths onto a common fiber pathway—this operation is called DWDM
- Extract (demultiplex) up to 16 distinct notched wavelengths from the common fiber pathway—this operation is called DWDD
- Combine DWDM and DWDD operations such that some optical signals are extracted from the common pathway while others are multiplexed onto the same common pathway

Unidirectional and bidirectional operations

Straight DWDM or DWDD operations are unidirectional—that is, all the signals travel in the same direction on the common pathway. In the case of combined DWDM/DWDD, the operation is bidirectional in that signals travel in opposite directions on the common pathway.

Figure 1-7 illustrates signal flow in a combined DWDM/DWDD operation using the four-channel MW18204D module.

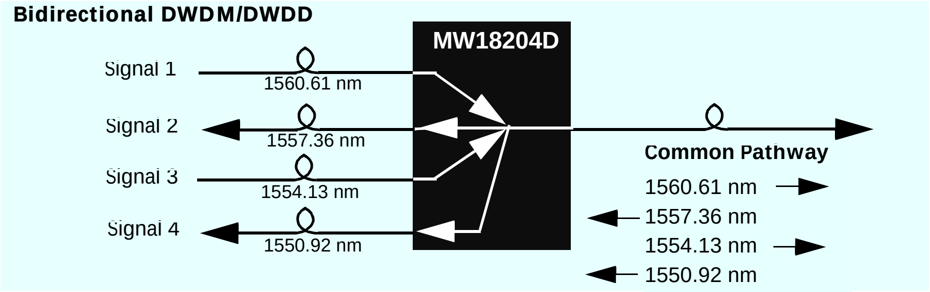

Figure 1-7. MegaWav Model MW18204D in a DWDM/DWDD Operation

In this example, the MW18204D module acts as a multiplexer for signals 1 and 3, accepting input signals on separate 1560.61 and 1554.13 nm paths, blending them, then transmitting them together on the common pathway. Simultaneously, it acts as a demultiplexer for signals 2 and 4, taking these two signals off the common fiber pathway, separating them, and transmitting them as outputs on separate 1557.36 and 1550.92 nm optical paths.

The MW18208D and MW18216D modules operate similarly, but can manage eight and 16 notched wavelengths, respectively, on the common pathway. The supported wavelengths are listed in Table 1-2.

Combiner/Splitter Modules

The MegaWav combiner/splitter group contains three modules, described in Table 1-3.

Table 1-3. Optical Combiner/Splitter Models

Model	Description	Optical Wavelengths Supported
MW18202C	Two-way optical combiner/splitter	Any combination of signals on 1560.61, 1558.98, 1557.36, 1555.74, 1554.13, 1552.52, 1550.92, 1549.31, 1547.71, 1546.12, 1544.52, 1542.94, 1541.35, 1538.19, or 1536.61 nm DWDM wavelengths in splitter or combiner mode 1310 and 1550 nm wavelengths can be supported in splitter mode; only the above DWDM wavelengths are supported in combiner mode.
MW18204C	Four-way optical combiner/splitter	
MW18208C	Eight-way optical combiner/splitter	

These modules are unidirectional and can function in either of two modes:

- As a combiner of multiple DWDM wavelengths on the common pathway
- As a splitter for signals on the common pathway composed of WDM or DWDM wavelengths

Combiner operations

Figure 1-8 illustrates a MegaWav MW18204C four-way module used as a combiner:

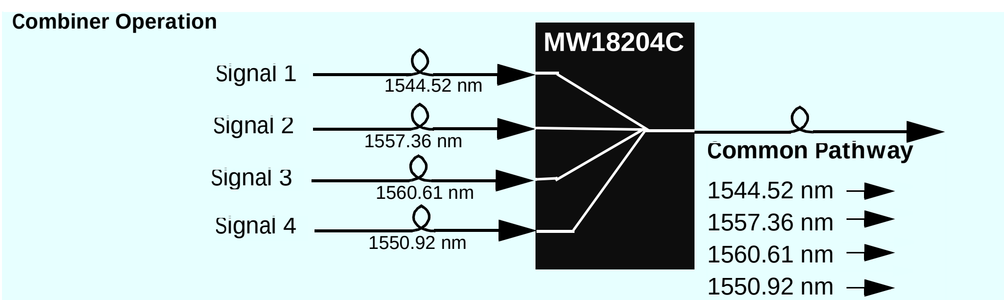

Figure 1-8. MegaWav Model MW18204C Used as a Combiner

The combiner function is similar to a multiplexer function, but is more limited in the following ways:

- It is unidirectional—that is, signals can travel in only one direction (as outputs) on the common pathway
- It can only combine signals—it cannot uncombine signals—a demultiplexer (or a series of drop filters) is required at the other end of the common pathway
- The combiner produces significantly more insertion loss (7.5 dB) than a DWDM multiplexer (worst case 4.5 dB); therefore the distance the signals can travel on the common pathway is reduced

Splitter operations

Figure 1-9 illustrates a MegaWav MW18204C four-way module used as a splitter:

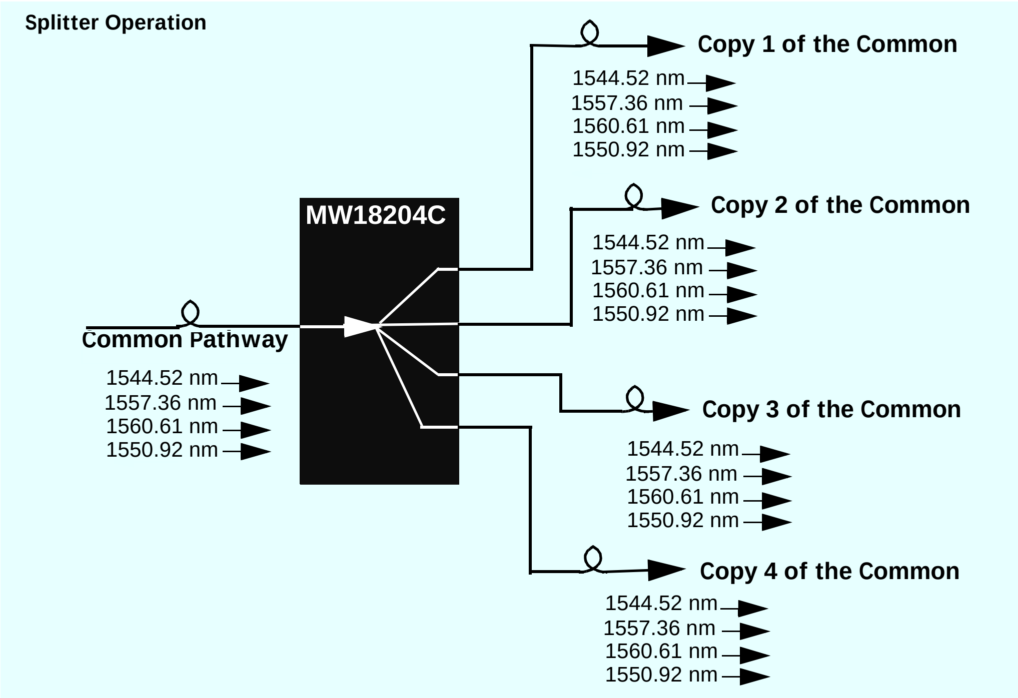

Figure 1-9. MegaWav Model MW18204C Used as a Splitter

The splitter does not demultiplex the input signal it receives on the common pathway. It simply replicates the signal combination on the common pathway and transmits copies of it over four different optical output paths.

Model MW18208C operates similarly to the MW18204C as both a combiner and a splitter, but with an eight-way capacity instead of a four-way capacity.

Add/Drop/Pass Filter Modules

The MegaWav filter group enables you to perform add/drop/pass operations in DWDM systems. These filters are bidirectional. They are usually placed mid-span in a DWDM application, and they are designed to either add a specific wavelength to the common pathway or drop a specific wavelength from the common pathway.

The filter group includes the models described in Table 1-4.

Table 1-4. Optical Add/Drop/Pass Filter Models

Model	Wavelength (nm)
MW18201F-21	1560.61
MW18201F-23	1558.98
MW18201F-25	1557.36
MW18201F-27	1555.74
MW18201F-29	1554.13
MW18201F-31	1552.52
MW18201F-33	1550.92
MW18201F-35	1549.31
MW18201F-37	1547.71
MW18201F-39	1546.12
MW18201F-41	1544.52
MW18201F-43	1542.94
MW18201F-45	1541.35
MW18201F-47	1539.77
MW18201F-49	1538.19
MW18201F-51	1536.61

Drop/pass operations

Figure 1-10 illustrates a drop/pass operation using an MW1821F-21 filter. This filter is tuned to operate on the 1560.61 nm optical path. The filter is positioned at location B, mid-span between locations A and C. There are eight signals on the common pathway traveling from location A, one of which is on the 1560.61 nm wavelength.

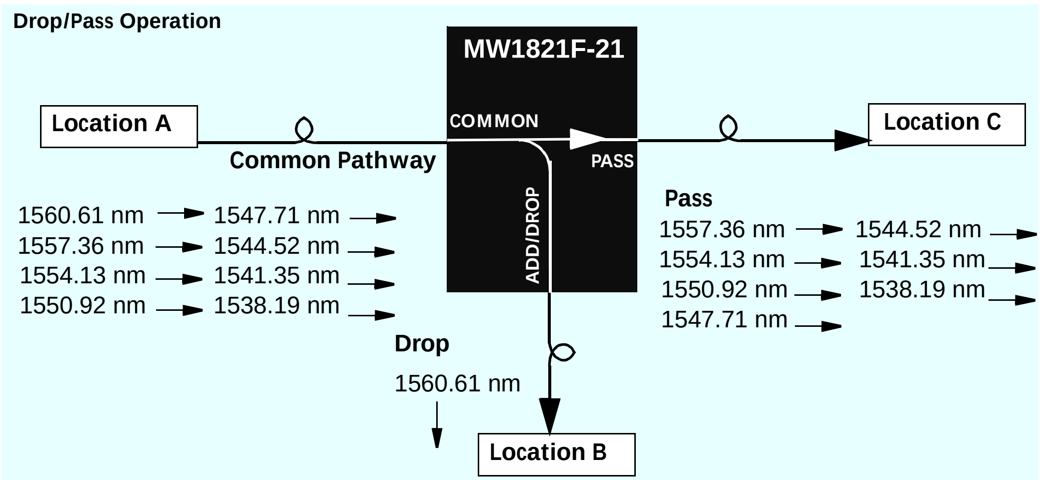

Figure 1-10. MegaWav MW1821F-21 Filter Used in a Drop/Pass Operation

When the common pathway reaches location B, the MW1821F-21 filter removes the signal on the 1560.61 nm wavelength (the drop function) and passes the common pathway on to location C with only seven signals remaining on it.

Add/pass operations

Figure 1-11 illustrates an add/pass operation again using an MW1821F-21 filter, which is tuned to operate on the 1560.61 nm optical path. The filter is positioned at location B, mid-span between locations A and C. In this case, there are seven signals on the common pathway traveling from location A, There is no signal on the available 1560.61 nm wavelength.

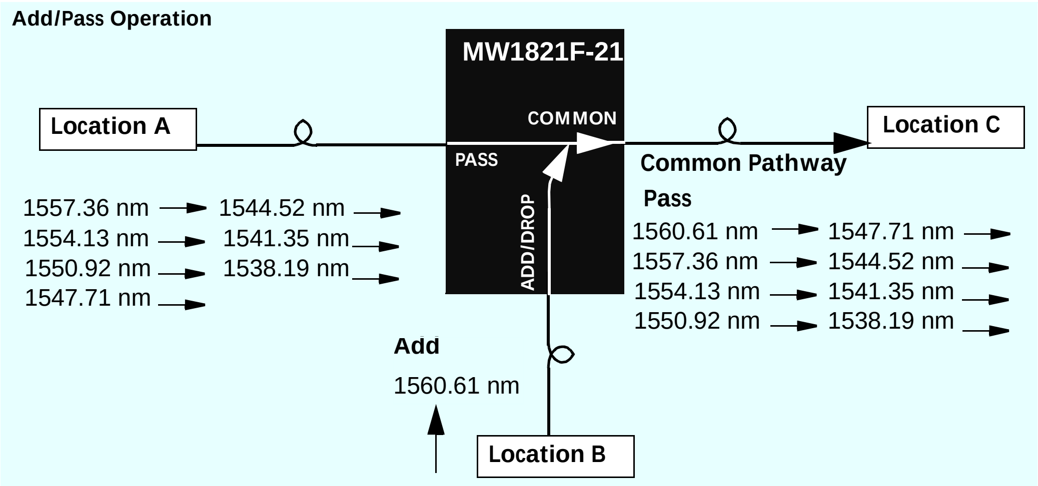

Figure 1-11. MegaWav MW1821F-21 Filter Used in an Add/Pass Operation

When the common pathway reaches location B, the MW1821F-21 filter inserts the signal on the 1560.61 nm wavelength (the add function) and passes the common pathway on to location C, now with a full complement of eight signals on it.

Combined add/drop/pass operations

In the following example, a complete add/drop/pass operation is performed using two MW1821F-21 filters. The first filter drops the signal on the 1560.61 nm wavelength from the common pathway, and the second filter re-inserts a new signal on that same wavelength.

Figure 1-12 shows the two filters positioned at location B, mid-span between locations A and C. There are eight signals on the common pathway traveling from location A, one of which is on the 1560.61 nm wavelength

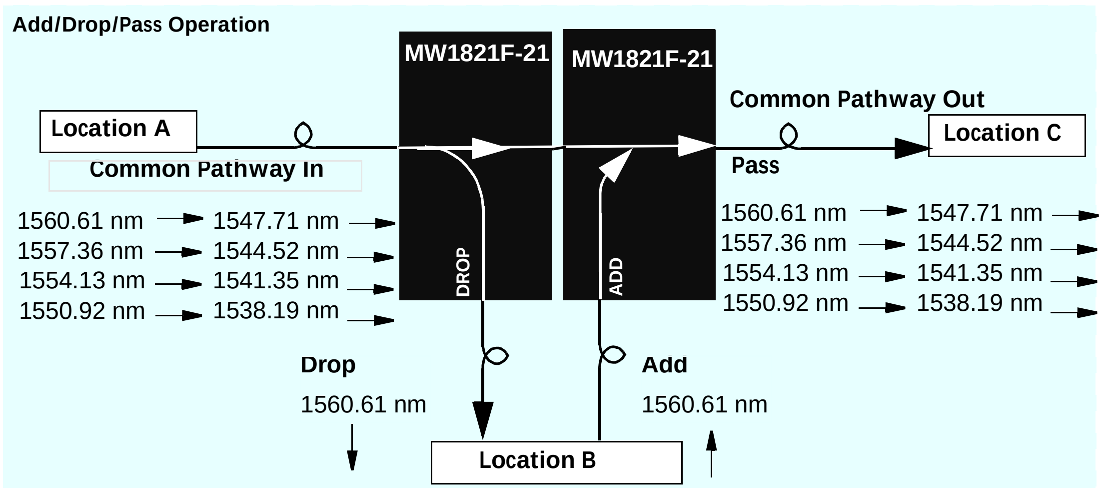

Figure 1-12. Two MegaWav MW1821F-21 Filters Used in an Add/Drop/Pass Operation

When the common pathway reaches location B, the first MW1821F-21 filter removes the signal on the 1560.60 nm wavelength,. The second MW1821F-21 filter then re-inserts a new signal on the 1560.61 nm wavelength. The filter then passes the common pathway on to location C, still with eight signals but now with a different signal at 1560.61 nm.

Where to go Next

For more details on each of the products mentioned in this chapter, proceed to the appropriate product-specific chapter.

For installation information of the products mentioned, proceed to Chapter 2.

2

Installation

This chapter describes how to unpack and install the MegaWav chassis and MegaWav module(s).

This chapter contains the following sections:

Warning

⚠ **Never stare directly into a fiber optic connector.**

Although the light used in most fiber optic transmissions is not visible to the naked eye, potentially harmful levels of optical radiation may be present at the optical output ports and unconnected transmit fiber ends.

Failure to observe this warning can result in serious personal injury.

Site Requirements

Before you select an installation site for the MegaWav products, read the physical and environmental requirements on page A-2 in Appendix A.

Required Tools and Equipment

To install the chassis unit as a rack- or wall-mount unit, you will need the following tools and equipment:

- A screwdriver
- Four screws to rack- or wall-mount the chassis

No tools are required to install MegaWav modules in the chassis.

Installing a MegaWav Chassis

If you are using MegaWav *16-channel DWDM* modules at your installation, use an MW18202H two-slot chassis to house the modules. For all other types of MegaWav functional modules, use an MW18204H four-slot chassis.

The following unpacking an installation information applies equally to both the four-slot and the two-slot chassis.

Unpacking

To unpack the chassis:

1. Remove the unit from the shipping carton. Save the packing material in case you need to repackage the unit later.
2. Check the configuration of the unit against the items listed on the packing slip. Report any discrepancies as described on page C-3 in Appendix C.

Shipment Contents

The MegaWav chassis shipment contains the following items:

- MegaWav chassis
- 1 ... 4 pre-installed MegaWav modules in an MW18202H unit; one or two pre-installed MegaWav modules in an MW18204H unit (unused module bays in the chassis will contain blank module panel assemblies)
- Two mounting brackets (flush-mount attached) with six mounting screws (see Figure 2-1 on page 2-6)
- This manual

Installing

The chassis unit can be placed on a flat surface as a free-standing unit, or it can be wall-mounted or rack-mounted in a standard 48.26 cm (19 inch) wide equipment cabinet.

Keep in mind that all MegaWav modules and module cables need to be accessible from the back of the chassis unit.

The following sections describe the steps to install the chassis as:

- A free-standing unit
- A rack-mounted unit
- A wall-mounted unit

A free-standing unit

To install the MegaWav chassis unit as a free-standing unit, simply position the unit on a selected flat surface. The mounting brackets may be remove if desired.

A rack-mounted unit

Before you rack-mount the unit, determine if you want to flush-mount or mid-mount the chassis into the cabinet. The chassis's mounting brackets are pre-installed for flush-mounting, but can be converted for mid-mounting applications. Refer to Figure 2-1 on page 2-6 for the location and positioning of the brackets on a chassis unit.

The difference between flush-mount and mid-mount is:

- Flush-mount sets the front edge of the unit flush with the front edge of the rack
- Mid-mount sets the front edge of the unit 38 mm (1.5 inches) out from the front edge of the rack.

To mid-mount the chassis:

1. Remove the three screws securing each mounting bracket to the unit.
2. Rotate the mounting brackets 180° so the flanges are facing the back of the unit.
3. Replace the three screws to secure each mounting bracket to the unit.

Once the mounting brackets are in position, you are ready to install the unit.

To install the MegaWav chassis unit in a rack:

1. Raise the unit to the appropriate installation height.
2. Align the screw holes on the mounting brackets with the screw holes on the equipment rack.
3. Install the screws through the mounting brackets on the unit into the mounting brackets on the rack. The unit requires two screws for each side of the chassis.

A wall-mounted unit

To install the MegaWav chassis unit as a wall-mounted unit:

1. Remove the three screws securing each mounting bracket to the chassis unit.
2. Rotate the mounting brackets 90° to position the flange parallel to the top of the chassis unit.
3. Replace the screws securing the mounting brackets to the unit.
4. Place the chassis unit against the wall it will be mounted to. Secure the mounting brackets to the wall using four screws.

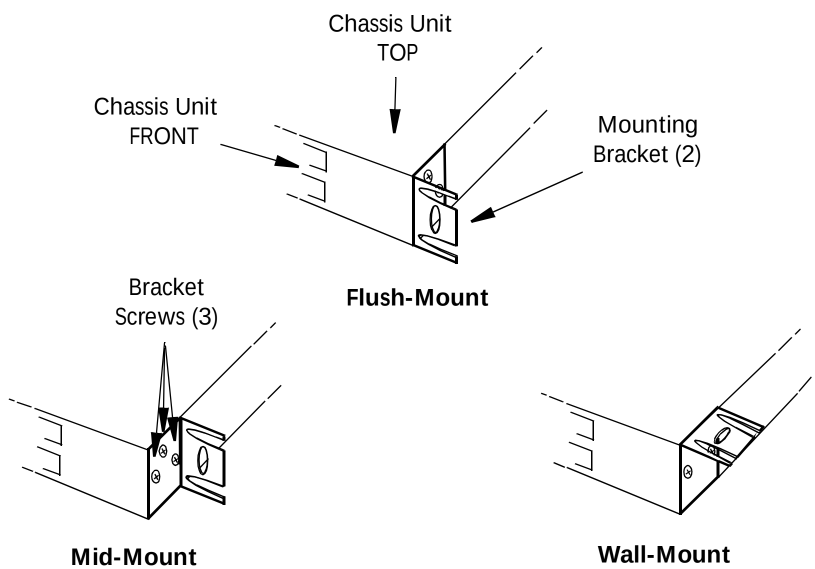

Figure 2-1. Base Unit Mounting Brackets

Installing Additional MegaWav Modules

Unpacking

To unpack the module:

1. Remove the unit from the shipping carton. Save the packing material in case you need to repackage the unit later.
2. Check the configuration of the unit against the items listed on the packing slip. Report any discrepancies as described on page C-3 in Appendix C.

Note: Do not remove the MegaWav module cover. There are no operator-serviceable components. The warranty is voided if the warranty seals are broken.

Shipment Contents

The MegaWav module shipment contains the following items:

- MegaWav module(s)
- This manual

Installing

The MegaWav module can be mounted into a MegaWav chassis unit or placed on a flat surface as a stand-alone unit. We highly recommend that you always mount MegaWav modules in a chassis unit for stability and added protection. Always position the module for installation keeping in mind that all cables connect to the back of the unit.

The following sections describe the steps to install the module as:

- A Free-Standing Module
- A Chassis Component

A Free-Standing Module

To install the MegaWav module as a free-standing unit, simply position the unit on a selected flat surface.

A Chassis Component

To install a module into a chassis:

1. Locate a blank module panel (item 1 in Figure 2-2) on the back of the MegaWav chassis unit.
2. Remove a blank module panel by loosening the two captive screws (item 2 in Figure 2-2) and sliding the panel out of the chassis.
3. With the module model number plate facing into the chassis slot, slide the module into the slot until the model number plate can be seen in one of the windows on the chassis front panel.
4. Tighten the two module captive screws to secure the module in the chassis.

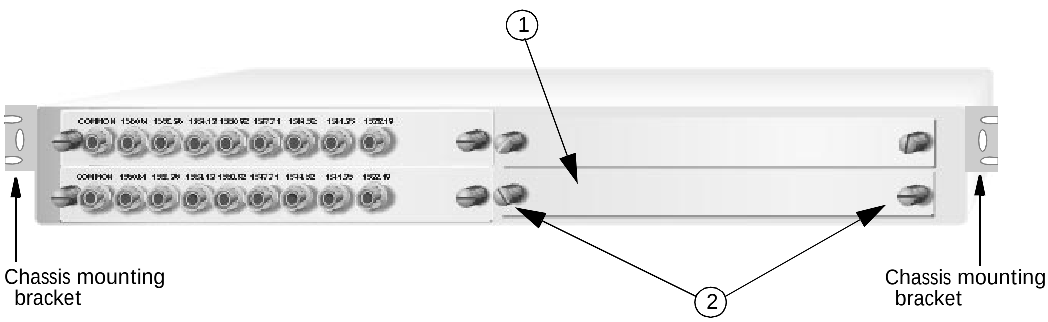

Figure 2-2. Module Slots on the Rear Panel of a Four-slot Chassis

Note: When removing or installing a MegaWav module from the chassis, do not pull on the optical port connectors. This may damage the connectors. Use the two captive screws when necessary.

Attaching Fiber Optic Cables

Figure 2-3 illustrates how the fiber optic cables are attached to the back of a MegaWav module, in this case, an MW18202W dual broadband 1310/1550 nm WDM module. This configuration has the module attached to various Artel and third party equipment.

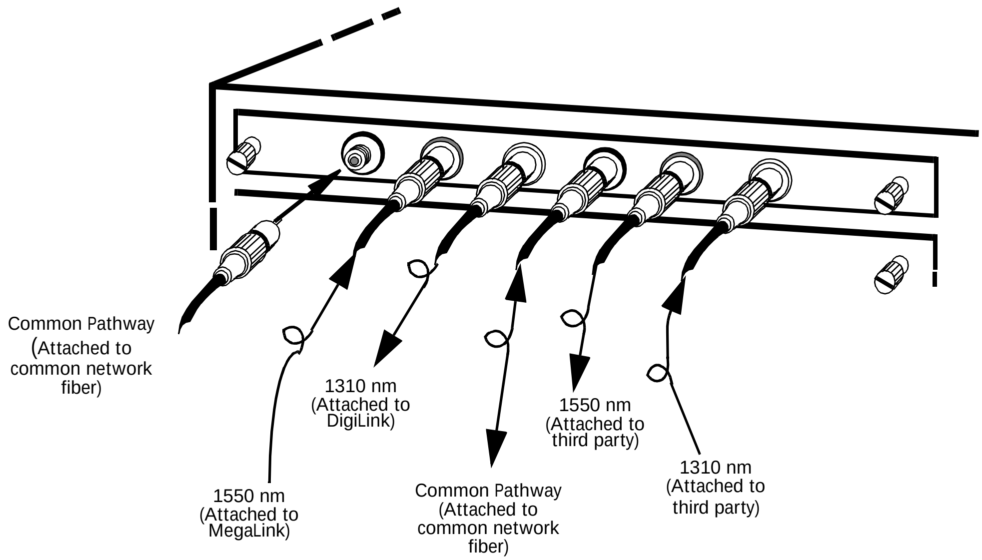

Figure 2-3. Sample Broadband WDM Cabling

Note: Clean the cable connections with an alcohol wipe before attaching cables to the module.

Where to go Next

Depending on the type of the module you are installing, refer to:

- Chapter 3 for the WDM modules
- Chapter 4 for the DWDM modules
- Chapter 5 for the combiner/splitter modules
- Chapter 6 for the add/drop/pass filter modules

3

Broadband WDM Modules

Chapter 3

This chapter focuses on the MegaWav broadband WDM modules. Information includes:

Broadband WDM Product Overview

The MegaWav 1310/1550 broadband wavelength division multiplexer (WDM) modules include the following models:

Table 3-1. MegaWav Broadband WDM Models

Model	Description
The MW18201W Module	Single 1310/1550 nm broadband wavelength division multiplexer/demultiplexer (WDM/WDD)
The MW18202W Module	Dual 1310/1550 nm broadband WDM/WDD

The MegaWav WDM modules are bidirectional and can be used to either:

- Take signals on 1310 nm and 1550 nm wavelengths from separate fiber optic cables, multiplex them, and output them on a common fiber optic pathway
- Take signals on 1310 nm and 1550 nm wavelengths from the common fiber optic pathway, demultiplex them, and output them on separate fiber optic cables

The MW18201W Module

An MW18201W module uses traditional two-channel wavelength division multiplexing and/or demultiplexing. It supports one 1310 nm and one 1550 nm wavelength channel.

Chassis compatibility

An MW18201W module consumes one slot in an MW18204H four-slot chassis. It does not fit in an MW18202H two-slot chassis.

A model number is printed on a label on the W18201W module. When the module is installed in a MW18204H chassis, the label shows through a window in the front of the chassis, identifying the module (see Figure 3-1).

Figure 3-1. Front View of an MW18204H Chassis with MW18201W Module

Port usage

The MW18201W module has three communication ports, as shown in Figure 3-2:.

Figure 3-2. The MW18201W Module

- The leftmost port provides a fiber cable connection for the common pathway
- The middle port is used as either an input or output port for the signal on the 1550 nm wavelength
- The rightmost port is used as either an input or output port for the signal on the 1310 nm wavelength

Operating modes

Because MegaWav broadband WDM modules are bidirectional, signals can be simultaneously sent and received over the common pathway fiber. There are three operating modes for the MW18A1W:

- As a *multiplexer*, where the 1310 and 1550 ports are both input ports and the the COMMON port is the output port for both signals onto the common pathway fiber
- As a *demultiplexer*, where the COMMON port is the input port for the two signals off the common pathway fiber (one on the 1310 nm path and the other on the 1550 nm path), and the 1310 and 1550 ports are the output ports
- As a *bidirectional multiplexer/demultiplexer*, where the COMMON port is the input port for one signal from the common pathway and the output port for the other signal onto the common pathway—one of the 1310 or 1550 ports functions as the input port and the other as the output port

Figure 1-5 on page 1-9 illustrates three examples of these operating modes.

Broadband WDM module cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. Place the protective caps on the connectors anytime the port is not populated or when the input/output cable has been removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

The MW18202W Module

The dual MW18202W module essentially provides two MW18201Ws in the same size module container. This allows you to multiplex/demultiplex two sets of 1310 and 1550 nm fiber on two separate common pathways.

Chassis compatibility

An MW18202W module consumes one slot in an MW18204H four-slot chassis. It does not fit in an MW18202H two-slot chassis.

A model number is printed on a label on the W18202W module. When the module is installed in a MW18204H chassis, the label shows through a window in the front of the chassis, identifying the module (see Figure 3-3).

Figure 3-3. Front View of an MW18204H Chassis with MW18202W Module

Port usage

The MW18202W module has six communication ports, as shown in Figure 3-4.

Figure 3-4. The MW18202W Module

- The leftmost port is the COMMON for the 1550 and 1310 nm connections directly to its right.
- The other COMMON port (fourth from the left in Figure 3-4) is for the 1550 and 1310 nm connections directly to its right.

Operating Modes

Because MegaWav broadband WDM modules are bidirectional, signals can be simultaneously sent and received over the common pathway fibers. The two COMMON ports function independent of one another.Thus, there are three operating modes, and each channel can function in any of the three modes:

- As a multiplexer, where the 1310 and 1550 ports are both input ports and the the COMMON port is the output port for both signals onto the common pathway fiber
- As a demultiplexer, where the COMMON port is the input port for the two signals off the common pathway fiber (one on the 1310 nm path and the other on the 1550 nm path), and the 1310 and 1550 ports are the output ports
- As a combined bidirectional multiplexer/demultiplexer, where the COMMON port is the input port for one signal from the common pathway and the output port for the other signal onto the common path—one of the 1310 or 1550 ports functions as the input port and the other as the output port

Typical applications include 1310/1550 CATV and digital telecommunications carrier system as well as interoffice service channel monitoring. Figure 1-6 on page 1-9 illustrates an example of how the dual module can function.

Broadband WDM module cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. Place the protective caps on the connectors anytime the port is not populated or when the input/output cable has been removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

Sample Configurations

Figure 3-5 illustrates a typical unidirectional application scenario for a pair of broadband WDM modules.

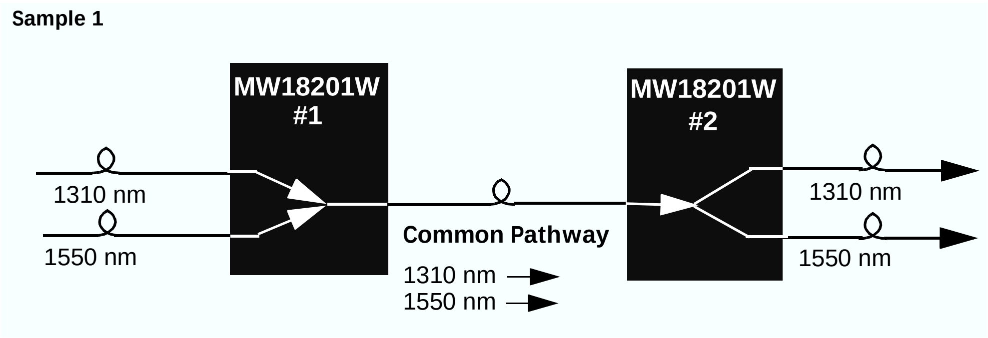

Figure 3-5. Unidirectional Broadband WDM Example

The first module (MW18201W #1) acts as a standard multiplexer, blending the 1310 nm and 1550 nm inputs for transmission on the common pathway. The second module (MW18201W #2) acts as a standard demultiplexer, receiving its input from the common and extracting the two signals as separate 1310 nm and 1550 nm outputs.

The 1310 and 1550 nm signals both travel in the same direction on the common pathway from module #1 to module #2.

Figure 3-6 shows a typical bidirectional scenario.

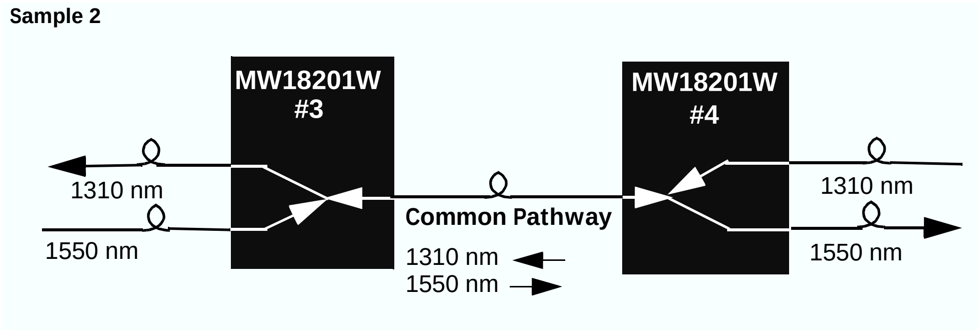

Figure 3-6. Bidirectional Broadband WDM Example

The first module (MW18201 #3) accepts the 1550 nm signal as an input on its 1550 port and the 1310 nm signal as an input from the common port. It outputs the 1550 nm signal onto the common pathway and outputs the 1310 nm signal from its 1310 port.

The second module (MW18201 #4) accepts the 1310 nm signal as an input on its 1310 port and the 1550 nm signal as an input from the common pathway. It outputs the 1310 nm signal onto the common pathway and outputs the 1550 nm signal from its 1550 port.

In sample 2, the two signals travel in opposite directions on the common pathway—the signal on the 1310 nm wavelength is output from module #4 and is sent to module #3 while the signal on the 1550 nm wavelength is output from module #3 and sent to module #4.

4

DWDM Modules

This chapter focuses on the MegaWav DWDM modules. Information includes:

DWDM Product Overview

The MegaWav DWDM modules support the multiplexing and demultiplexing of four, eight, or 16 optical signals. The six models listed in Table 4-1 are available.

Table 4-1. MegaWav DWDM Models

MegaWav DWDM	Functionality
MW18204D-A	Four-channel optical Mux/Demux modules
MW18204D-B	
MW18208D-A	Eight-channel optical Mux/Demux modules
MW18208D-B	
MW18216D-A	16-channel optical Mux/Demux modules
MW18216D-B	

These modules provide a low-loss, high-isolation means to couple multiple lasers on to a single fiber or to demultiplex multiple wavelengths at the receiver end. They are bidirectional modules designed to:

- Take multiple signals input on separate fiber optic cables, multiplex them, and output them over a common fiber optic pathway
- Take multiple optic signals as inputs from the common fiber optic cable, demultiplex them, and transport them as outputs over separate cables.

Special optional sets (of -A and -B module units) are provided to further reduce loss and enhance performance. For best performance, use a -A module at one end of the common fiber pathway and a -B module at the opposite end of the common pathway. See page 4-4 for more details on four-channel performance; see page 4-8 for more details on eight-channel performance; see page 4-13 for more details on 16-channel performance.

The MW18204D Modules

The MW18204D-A and MW18204D-B models use four ITU-standard notched wavelengths for dense DWDM and/or DWDD operations. Figure 4-1 shows a view of a unit's rear panel.

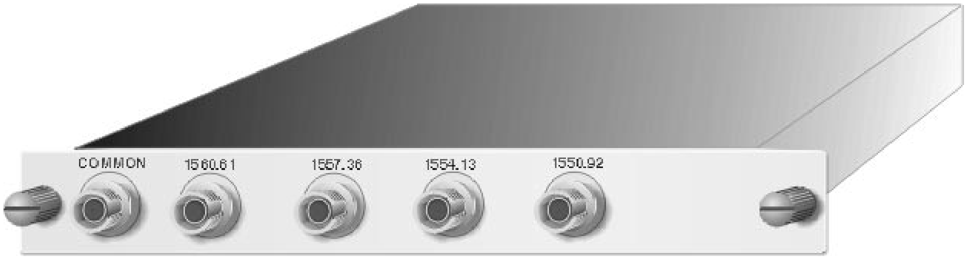

Figure 4-1. Rear View of an MW18204D Module

Chassis compatibility

An MW18204D DWDM module consumes one slot in an MW18204H four-slot chassis. These modules do not fit in an MW18202H two-slot chassis.

Identifying the modules

You can identify whether the MW18204D module is a -A or -B model by the model number label, which appears in a window on the front panel of the MW18204H chassis when the module is installed. Figure 4-2 shows an example of a the chassis with an MW18204D-A module installed.

Figure 4-2. Front View of an MW18204H Chassis with an MW18204D-A Module

Port usage

Both modules have five communication ports—a COMMON and four channel ports. The COMMON is the leftmost port—it provides a fiber cable connection for the common pathway.

Each of the four channel ports is labeled with the wavelength it supports:

- 1560.61 (nm)
- 1557.36 (nm)
- 1554.13 (nm)
- 1550.92 (nm)

Both MW18204D models are bidirectional and can perform bidirectional multiplexing/demultiplexing of signals on the four wavelengths. Any of these channel ports may be used as an input port or an output port, depending on your application. The COMMON port can be used as:

- An output port when the module is used as a four-channel multiplexer
- An input port when the module is used as a four-channel demultiplexer
- An I/O port when the module is used as a bidirectional Mux/Demux device

Performance considerations

You can achieve lower insertion losses (and therefore greater distances) by using a -A module at one end of the common pathway and a -B module at the other end of the common pathway. The channel optics in the -A and -B modules mirror each other, reducing maximum insertion losses over the range of channels.

Figure 4-3 shows the channel insertion losses incurred in the two MW18204D modules. In the -A module, the worst-case insertion loss incurred by the signal on the 1560.61 nm wavelength is 3.4 dB and the worst-case loss incurred by the signal on the 1550.92 nm wavelength is 2.5 dB. In the -B module, the losses are reversed—2.5 dB for the signal on 1560.61 and 3.4 dB for the signal on 1550.92.

This means that when you use a -A and a -B module for mux/demux functions at the opposite ends of the common pathway, the worst-case MegaWav insertion loss end-to-end on the 1560.61 nm channel or the 1550.92 nm channel is 5.9 dB.

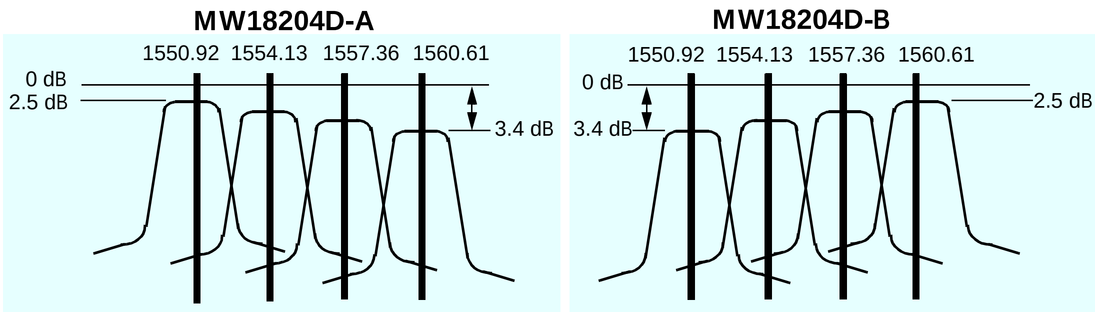

Figure 4-3. Insertion Losses on the MW18204D Modules

On the other hand, if you use two MW18204D-A modules in a DWDM system, the insertion loss on the 1560.61 nm channel could be 6.8 dB. If you use two MW18204D-B modules, the insertion loss on the 1550.92 nm channel could be 6.8 dB.

Figure 4-2 lists the worst-case insertion losses for each channel on the MW18204D modules.

Table 4-2. Worst-case Insertion Losses on the MW18204D Channels

Channel	-A Model Insertion Loss	-B Model Insertion Loss
1550.92	2.5 dB	3.4 dB
1554.13	2.8 dB	3.1 dB
1557.36	3.1 dB	2.8 dB
1560.61	3.4 dB	2.5 dB

Note: When a -A and a -B module are used on opposite ends of the common pathway, the worst-case insertion loss incurred by a MegaWav is 5.9 dB end-to-end on each of the four optical channels.

DWDM module cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. The protective caps must be placed on the connectors anytime the cable is removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

The MW18208D Modules

The MW18208D-A and MW18208D-B models use eight ITU-standard notched wavelengths for dense DWDM and/or DWDD operations. Figure 4-4 shows a view of a unit's rear panel.

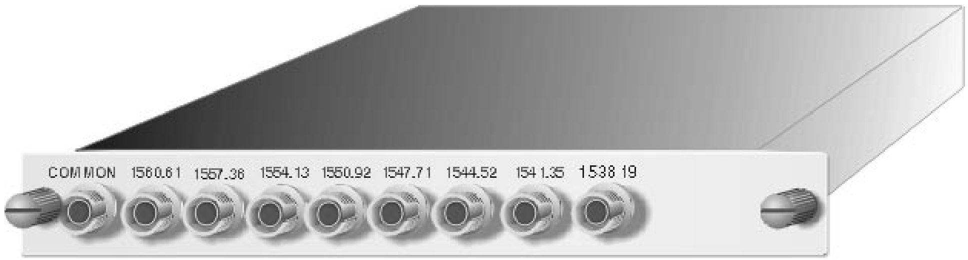

Figure 4-4. Rear View of an MW18208D Module

Chassis compatibility

An MW18208D DWDM module consumes one slot in an MW18204H four-slot chassis. These modules do not fit in an MW18202H two-slot chassis.

Identifying the modules

You can identify whether the MW18208D module is a -A or -B model by the model number label, which appears in a window on the front panel of the MW18204H chassis when the module is installed. Figure 4-5 shows an example of a the chassis with an MW18208D-B module installed.

Figure 4-5. Front View of an MW18204H Chassis with an MW18208D-A Module

Port utilization

Both MW18208D modules have nine ports—a COMMON and eight channel ports. The leftmost port provides a fiber cable connection for the common pathway. Each of the eight channel ports is labeled with the wavelength it supports:

- 1560.61 (nm)
- 1557.36 (nm)
- 1554.13 (nm)
- 1550.92 (nm)
- 1547.72 (nm)
- 1544.53 (nm)
- 1541.35 (nm)
- 1538.19 (nm)

Both MW18208D models are bidirectional and can perform combined multiplexing and demultiplexing of signals on the eight wavelengths. Any of these channel ports may be used as an input port or an output port, depending on your application. The COMMON port can be used as:

- An output port when the unit is used as an eight-channel multiplexer
- An input port when the unit is used as an eight-channel demultiplexer
- An I/O port when the unit is used as a bidirectional Mux/Demux device

Performance Considerations

You can achieve lower insertion losses (and therefore greater distances) by using a -A module at one end of the common pathway and a -B module at the other end of the common pathway. The channel optics in the -A and -B modules mirror each other, reducing maximum insertion losses over the range of channels.

lFigure 4-6 shows the channel insertion losses incurred in the two MW18208D modules. In the -A module, the worst-case insertion loss incurred by the signal on the 1560.61 nm wavelength is 4.6 dB, and the worst-case loss for the signal on the 1538.19 nm wavelength is 2.5 dB. In the -B module, the losses are reversed—2.5 dB for the signal on 1560.61 and 4.6 dB for the signal on 1538.19.

This means that when you use a -A and a -B module for mux/demux functions at the opposite ends of the common pathway, the worst-case MegaWav insertion loss end-to-end on the 1560.61 nm channel or the 1538.19 nm channel is 7.1 dB.

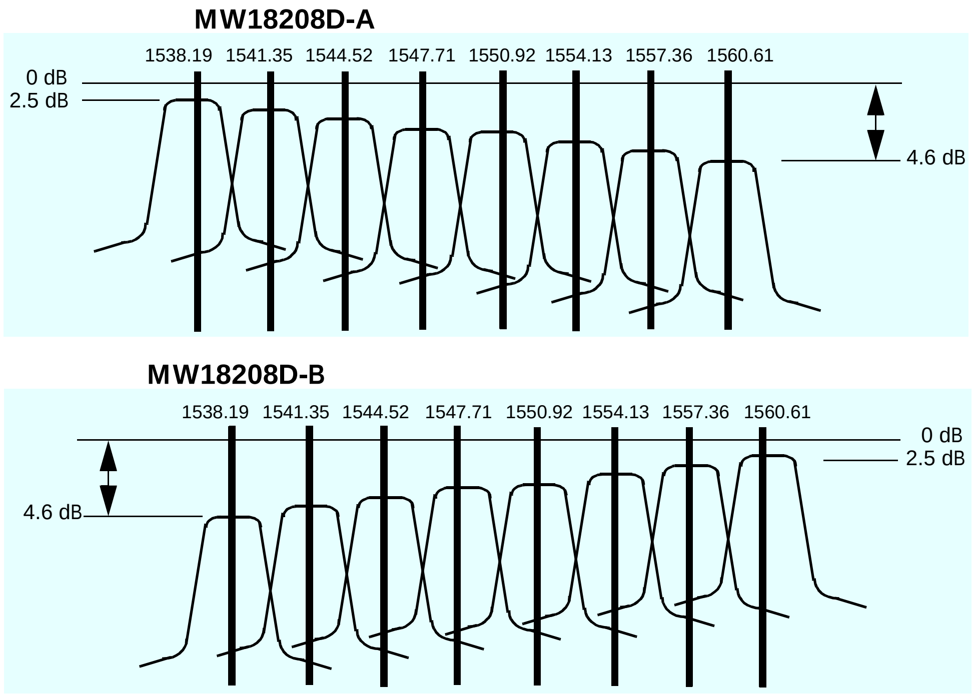

Figure 4-6. Insertion Losses on the MW18208D Modules

On the other hand, if you use two MW18208D-A modules in a DWDM system, the insertion loss on the 1560.61 nm channel could be 9.2 dB. If you use two MW18204D-B modules, the insertion loss on the 1538.19 nm channel could be 9.2 dB.

Table 4-3 lists the worst-case insertion losses for each channel on the MW18208D modules.

Table 4-3. Worst-case Insertion Losses on the MW18208D Channels

Channel	-A Model Insertion Loss)	-B Model Insertion Loss
1538.19	2.5 dB	4.6 dB
1541.35	2.8 dB	4.3 dB
1544.52	3.1 dB	4.0 dB
1547.71	3.4 dB	3.7 dB
1550.92	3.7 dB	3.4 dB
1554.13	4.0 dB	3.1 dB
1557.36	4.3 dB	2.8 dB
1560.61	4.6 dB	2.5 dB

Note: When a -A and a -B module are used on opposite ends of the common pathway, the worst-case insertion loss incurred by a MegaWav is 7.1 dB end-to-end on each of the eight optical channels.

DWDM Module Cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. The protective caps must be placed on the connectors anytime the cable is removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

The MW18216D Modules

The MW18216D-A and MW18216D-B modules use 16 ITU-standard notched wavelengths for dense DWDM and/or DWDD operations. Figure 4-7 shows a view of a unit's rear panel.

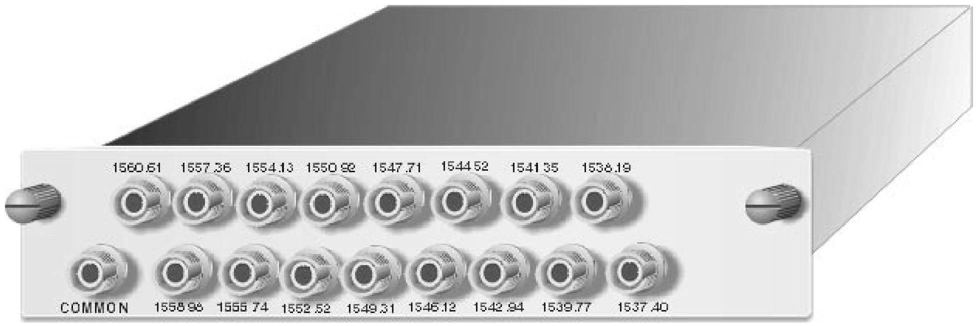

Figure 4-7. Rear View of an MW18216D Module

Chassis compatibility

An MW18216D DWDM module consumes one slot in an MW18202H two-slot chassis. These modules do not fit in an MW18204H four-slot chassis.

Identifying the modules

You can identify whether the MW18216D module is a -A or -B model by the model number label, which appears in a window on the front panel of the MW18202H chassis when the module is installed. Figure 4-5 shows an example of a the chassis with an MW18216D-A module installed.

Figure 4-8. Front View of an MW18202H Chassis with an MW18216D-A Module

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Port Utilization

The module has 17 ports, a COMMON and 16 channel ports. The bottom left port provides a fiber cable connection for the common pathway. Each of the 16 channel ports is labeled with the wavelength it supports:

- 1560.61 (nm)
- 1558.98 (nm)
- 1557.36 (nm)
- 1555.74 (nm)
- 1554.13 (nm)
- 1552.52 (nm)
- 1550.92 (nm)
- 1549.31 (nm)
- 1547.72 (nm)
- 1546.12 (nm)
- 1544.53 (nm)
- 1542.94 (nm)
- 1541.35 (nm)
- 1539.77 (nm)
- 1538.19 (nm)
- 1536.61 (nm)

The MW18216D modules are bidirectional and can perform combined multiplexing and demultiplexing of signals on the 16 wavelengths. Any of the channel ports may be used as an input port or an output port, depending on your application.

The COMMON port can be used as:

- An output port when the unit is used as a 16-channel multiplexer
- An input port when the unit is used as a 16-channel demultiplexer
- An I/O port when the unit is used as a bidirectional Mux/Demux device

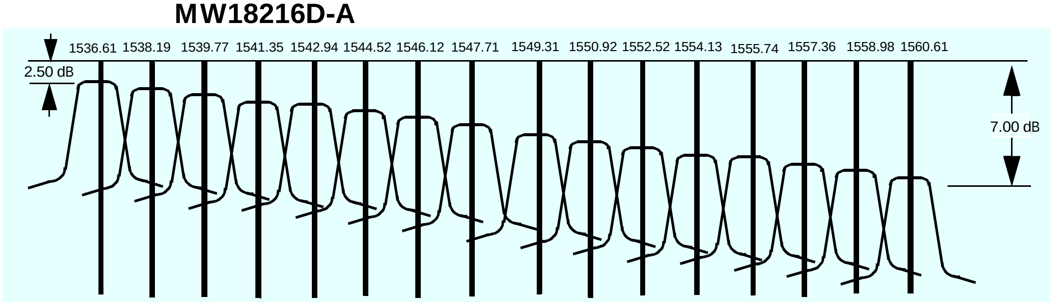
Performance considerations

You can achieve lower insertion losses (and therefore greater distances) by using a -A module at one end of the common pathway and a -B module at the other end of the common pathway. The channel optics in the -A and -B modules mirror each other, reducing maximum insertion losses over the range of channels.

Figure 4-9 shows the channel insertion losses incurred in the two MW18216D modules. In the -A module, the worst-case insertion loss incurred by the signal on the 1560.61 nm channel is 7.0 dB, and the worst-case loss for the signal on the 1536.61 nm channel is 2.5 dB. In the -B module, the losses are reversed—2.5 dB for the signal on 1560.61 and 7.0 dB for the signal on 1536.61.

This means that when you use a -A and a -B module for mux/demux functions at the opposite ends of the common pathway, the worst-case MegaWav insertion loss end-to-end on the 1560.61 nm channel or the 1536.61 nm channel is 9.5 dB.

MW18216D-A



MW18216D-B

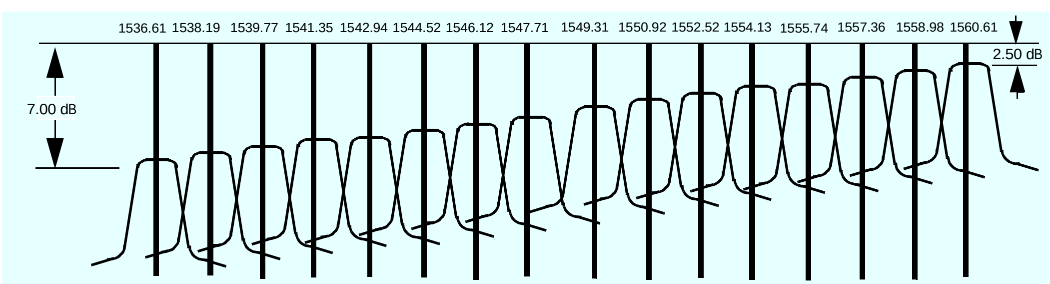


Figure 4-9. Insertion Losses on the MW18216D Modules

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On the other hand, if you use two MW18216D-A modules in a DWDM system, the insertion loss on the 1560.61 nm channel could be 14.0 dB. If you use two MW18216D-B modules, the insertion loss on the 1536.61 nm channel could be 14.0 dB.

Table 4-4 lists the worst-case insertion losses for each channel on the MW18208D modules.

Table 4-4. Worst-case Insertion Losses on the MW18216D Channels

Channel	-A Model Insertion Loss	-B Model Insertion Loss
1536.61 (nm)	2.5 dB	7.0 dB
1538.19 (nm)	2.8 dB	6.7 dB
1539.77 (nm)	3.1 dB	6.4 dB
1541.35 (nm)	3.4 dB	6.1 dB
1542.94 (nm)	3.7 dB	5.8 dB
1544.52 (nm)	4.0 dB	5.5 dB
1546.12 (nm)	4.3 dB	5.2 dB
1547.71 (nm)	4.6 dB	4.9 dB
1549.31 (nm)	4.9 dB	4.6 dB
1550.92 (nm)	5.2 dB	4.3 dB
1552.52 (nm)	5.5 dB	4.0 dB
1554.13 (nm)	5.8 dB	3.7 dB
1555.74 (nm)	6.1 dB	3.4 dB
1557.36 (nm)	6.4 dB	3.1 dB
1558.98 (nm)	6.7 dB	2.8 dB
1560.61 (nm)	7.0 dB	2.5 dB

Note: When a -A and a -B module are used on opposite ends of the common pathway, the worst-case insertion loss incurred by the MegaWav is 9.5 dB end-to-end on any of the 16 optical channels in use.

DWDM Module Cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. The protective caps must be placed on the connectors anytime the cable is removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

Sample Configuration

Figure 4-10 illustrates a typical bidirectional application, using an -A/-B pair of MW18204D four-channel DWDM modules.

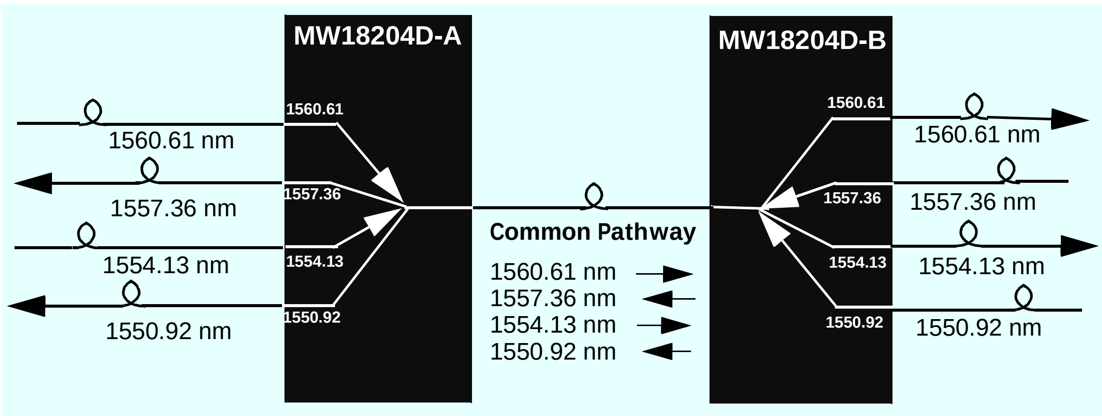

Figure 4-10. A DWDM Bidirectional Example

In this example, the *MW18204D-A* module multiplexes the two signals it receives as inputs on its 1560.61 and 1554.13 ports, outputs them on the common pathway, and transmits them to the MW18204D-B module. The module also demultiplexes the two signals that it receives as inputs from the common pathway and outputs them individually to its 1557.36 and 1550.92 ports.

On the other end of the common pathway, the *MW18204D-B* module multiplexes the two signals it receives as inputs on its 1557.36 and 1550.92 ports, outputs them on the common pathway, and transmits them to the MW18204D-A module. The MW18204D-B module also demultiplexes the two signals that it receives from the MW18204D-A module as inputs from the common pathway and outputs them individually to its 1560.61 and 1554.13 ports.

5

Combiner/Splitter Modules

Chapter 5

This chapter focuses on the MegaWav combiner/splitter modules. Information includes:

Combiner/Splitter Product Overview

The MegaWav multichannel optical combiner/splitter modules can be used in single-channel broadcast and DWDM applications. The three combiner/splitter modules are described in Table 5-1.

Table 5-1. MegaWav Combiner/Splitter Models

MegaWav Combiner/Splitter	Functionality
MW18202C	Two-way optical combiner/splitter
MW18204C	Four-way optical combiner/splitter
MW18208C	Eight-way optical combiner/splitter

The combiner/splitter modules are unidirectional devices used to perform either of the following:

- Receive multiple signal inputs and combine them as an output on the common fiber pathway
- Receive the signal from the common pathway and split it across multiple output ports

Note: The splitter cannot demultiplex multi-wavelength signals coming in on the common pathway into individual wavelength components. It simply replicates the input signal it receives and outputs copies of it through multiple ports. To demultiplex an input from the common pathway, you must use a WDM module (see Chapter 3) or DWDM module (see Chapter 4).

These products are moderate-loss devices suitable for cable TV applications and fiber-in-the-loop networks.

The MW18202C Splitter/Combiner

Figure 5-3 shows an MW18202C two-way splitter/combiner module. The unit has three ports, a COMMON on the far left and two signal ports to its right.

Figure 5-1. The MW18202C Splitter/Combiner

Chassis compatibility

The MW18202C splitter/combiner consumes one slot in an MW18204H chassis. It does not fit in an MW18202H chassis.

Identifying the module

You can identify whether the MW18202C module by the model number label, which appears in a window on the front panel of the MW18204H chassis when the module is installed. Figure 5-4 shows an example of a the chassis with an MW18204C module installed.

Figure 5-2. Front View of an MW18204H Chassis with an MW18202C Module

When the unit is used as a splitter:

The COMMON is the input port. The input signal can comprise:

- One optical signal
- Multiplexed broadband 1310/1550 nm signals
- Multiplexed DWDM signals

Two copies of the input signal are replicated and transmitted as outputs on PORT 1 and PORT 2. The splitter does not perform optical demultiplexing of its input signal. If the common input is a broadband or DWDM signal, both of the replicated outputs is a copy of the same broadband or DWDM signal.

The MW18202C unit is unidirectional. In *splitter mode* the two signal ports must be used as output ports—they cannot be used to receive signals.

When the unit is used as a combiner:

The COMMON is the output port. Two input signals, received on PORT 1 and PORT 2, are combined as a single output on the common pathway. Each of the two input signals must be sent to the combiner on a different DWDM wavelength.

The MW18202C unit is unidirectional. In *combiner mode* the two signal ports must be used as input ports—they cannot be used to transmit signals.

Performance considerations

An MW18202C two-way module incurs 3.8 dB of insertion loss on every signal that is split or combined by the device. This value includes losses through the COMMON and channel connectors as well as through the device filter.

Combiner/Splitter Module Cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. The protective caps must be placed on the connectors anytime the cable is removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

The MW18204C Splitter/Combiner

Figure 5-3 shows an MW18204C four-way splitter/combiner module. The unit has five ports, a COMMON on the far left and four signal ports to its right.

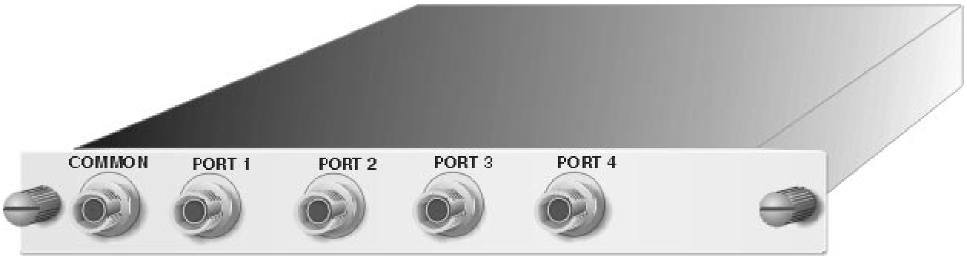

Figure 5-3. The MW18204C Splitter/Combiner

Chassis compatibility

The MW18204C splitter/combiner consumes one slot in an MW18204H chassis. It does not fit in an MW18202H chassis.

Identifying the module

You can identify whether the MW18204C module by the model number label, which appears in a window on the front panel of the MW18204H chassis when the module is installed. Figure 5-4 shows an example of a the chassis with an MW18204C module installed.

Figure 5-4. Front View of an MW18204H Chassis with an MW18204C Module

When the unit is used as a splitter:

The COMMON is the input port. The input signal can comprise:

- One optical signal
- Multiplexed broadband 1310/1550 nm signals
- Multiplexed DWDM signals

Four copies of the input signal are replicated and transmitted as outputs on each of the signal ports (PORT 1 ... PORT 4). The splitter does not perform optical demultiplexing of its input signal. If the common input is a broadband or DWDM signal, each of the replicated outputs is a copy of the same broadband or DWDM signal.

The MW18204C unit is unidirectional. In *splitter mode* the four signal ports must be used as output ports—they cannot be used to receive signals.

When the unit is used as a combiner:

The COMMON is the output port. Four input signals, received on each of the signal ports (PORT 1 ... PORT 4), are combined as a single output on the common pathway. Each of the four input signals must be sent to the combiner on a different DWDM wavelength. The MW18204C unit is unidirectional. In *combiner mode* the four signal ports must be used as input ports—they cannot be used to transmit signals.

Performance considerations

An MW18204C four-way module incurs 7.5 dB of insertion loss on every signal that is split or combined by the device. This value includes losses through the COMMON and the signal port connectors as well as through the device filter.

Combiner/Splitter Module Cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. The protective caps must be placed on the connectors anytime the cable is removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

The MW18208C Splitter/Combiner

Figure 5-5 shows an MW18208C eight-way splitter/combiner module. The unit has nine ports, a COMMON on the far left and eight signal ports to its right

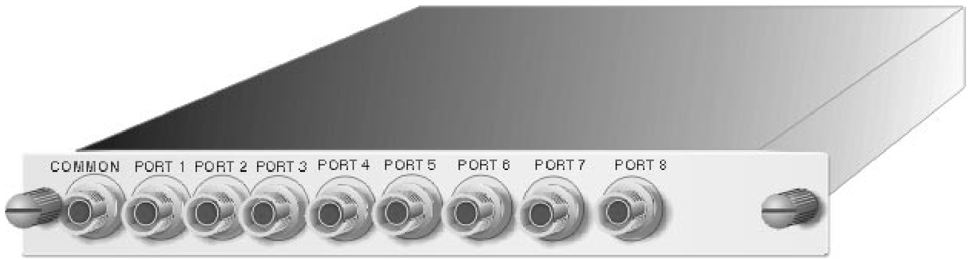

Figure 5-5. The MW18208C Splitter Combiner

Chassis compatibility

The MW18208C splitter/combiner consumes one slot in an MW18204H chassis. It does not fit in an MW18202H chassis.

Identifying the module

You can identify whether the MW18208C module by the model number label, which appears in a window on the front panel of the MW18204H chassis when the module is installed. Figure 5-6 shows an example of a the chassis with an MW18208C module installed.

Figure 5-6. Front View of an MW18204H Chassis with an MW18204C Module

When the unit is used as a splitter:

The COMMON is the input port. The input signal can comprise:

- One optical signal
- Multiplexed broadband 1310/1550 nm signals
- Multiplexed DWDM signals

Eight copies of the input signal are replicated and transmitted as on each of the signal channel ports (PORT 1 ... PORT 8). The splitter does not perform optical demultiplexing of its input signal. If the common input is a broadband or DWDM signal, each of the replicated outputs is a copy of the same broadband or DWDM signal.

The MW18208C unit is unidirectional. In *splitter mode* the eight signal ports must be used as output ports—they cannot be used to receive signals.

When the unit is used as a combiner:

The COMMON is the output port. Eight input signals, received on each of the signal ports (PORT 1 ... PORT 8), are combined as a single output on the common pathway. Each of the eight input signals must be sent to the combiner on a different DWDM wavelength. The MW18208C unit is unidirectional. In *combiner mode* the eight signal ports must be used as input ports—they cannot be used to transmit signals.

Performance considerations

An MW18208C eight-way module incurs 11 dB of insertion loss on every signal that is split or combined by the device. This value includes losses through the COMMON and channel connectors as well as through the device filter.

Combiner/Splitter Module Cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. The protective caps must be placed on the connectors anytime the cable is removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

Sample Configurations

Figure 5-7 shows two MW18204C modules, the first used as a four-way combiner and the second as a four-way splitter.

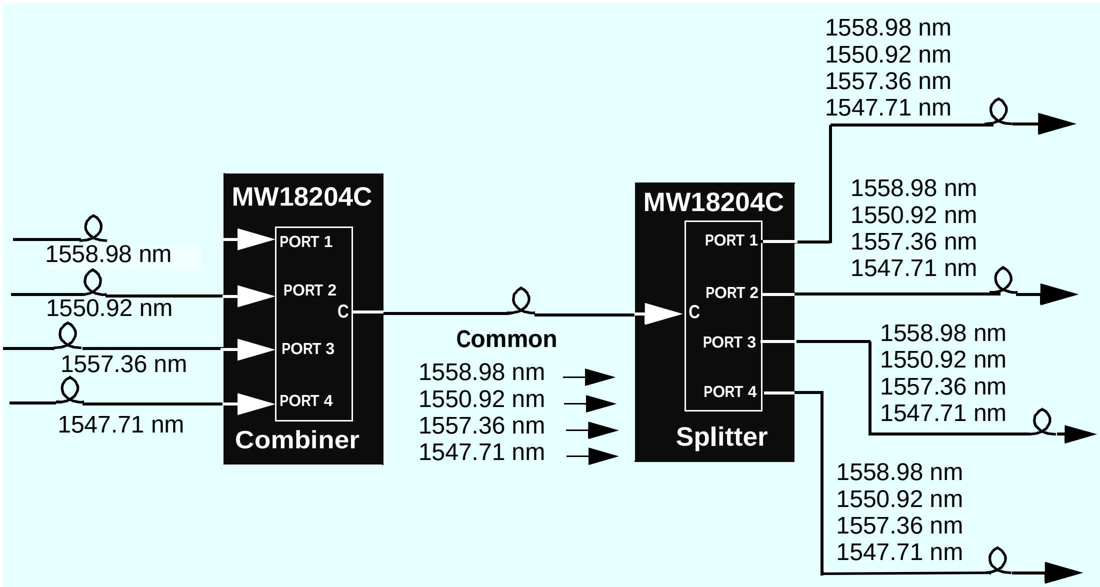

Figure 5-7. A Combiner/Splitter Example

The MW18204C combiner receives four signals (on the1558.98 nm, 1550.92 nm, 1557.36 nm, and 1547.71 nm wavelengths) as inputs on PORTs 1 ... 4, respectively. It combines the signals and sends them as an output over the common pathway.

The MW18204C splitter receives the combined signals as an input on its COMMON port and sends four copies of the COMMON signal as outputs on PORTs 1 ... 4.

Using a Combiner as a DWDM Multiplexer

For unidirectional DWDM applications where insertion loss is not a critical factor, a four-way or eight-way combiner can be used as a low-cost multiplexer on one end of the common pathway. An MW182xxD DWDM module must be used as the demultiplexer on the other end of the common pathway.

Figure 5-8 shows an example of an MW18204C four-way combiner used with an MW18204D-B DWDM module. Notice that the appropriate four wavelengths supported by the four-channel DWDM module must be input to the combiner.

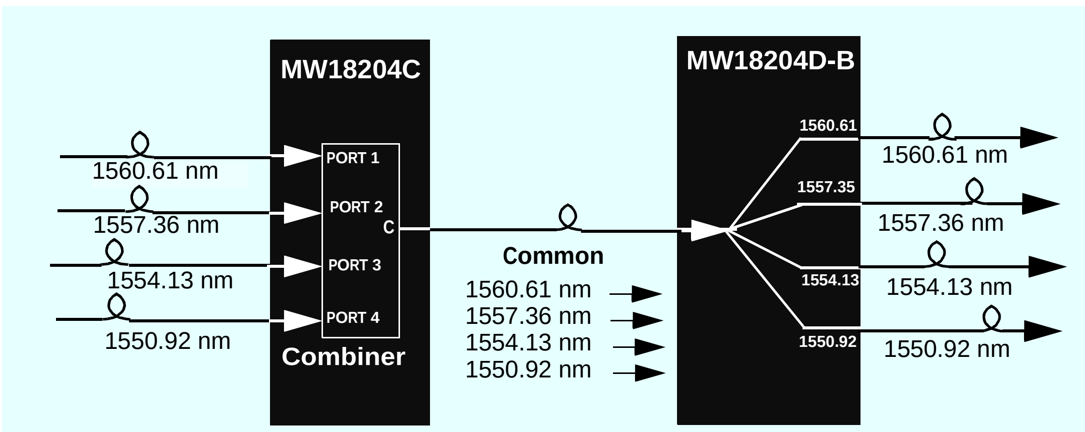

Figure 5-8. An MW18204C Combiner Used as a DWDM Multiplexer

Advantage

The advantage to this application is cost. Since combiner modules do not have optics that are tuned to specific wavelengths, they are less expensive than the DWDM modules.

Constraints

Remember, however, that a combiner module is unidirectional. Using it in this application makes bidirectionality—i.e., return paths—unattainable over the common pathway.

The combiner also introduces more insertion loss into the system. A four-way splitter incurs up to 7.5 dB of loss on each channel. (For an eight-channel application, the eight-way combiner incurs 11 dB of loss on each channel.)

Table 5-2 compares worst-case insertion losses in a four-channel DWDM system—an MW18204C four-way combiner is used as a multiplexer and MW18204D-A and MW18204D-B DWDM modules are used on opposite ends of the common pathway. The combiner can increase insertion loss by up to 5 dB/channel.

Table 5-2. Insertion Losses in a Four-channel System

Configuration	Loss on the 1560.61 nm Channel	Loss on the 1557.36 nm Channel	Loss on the 1554.13 nm Channel	Loss on the 1550.92 nm Channel
MW18204C -> MW18204D-B	10 dB	10.3 dB	10.6 dB	10.9 dB
MW18204C -> MW18204D-A	10.9 dB	10.6 dB	10.3 dB	10 dB
MW18204D-A -> MW18204D-B	5.9 dB	5.9 dB	5.9 dB	5.9 dB

Table 5-3 compares worst-case insertion losses in an eight-channel DWDM system—an MW18208C eight-way combiner is used as a multiplexer and MW18208D-A and MW18208D-B DWDM modules are used on opposite ends of the common pathway. The combiner can increase insertion loss by as much as 8.5 dB on a channel.

Table 5-3. Insertion Losses in an Eight-channel System

Configuration	Loss on the 1560.61 nm Channel	Loss on the 1557.36 nm Channel	Loss on the 1554.13 nm Channel	Loss on the 1550.92 nm Channel
MW18208C -> MW18208D-B	13.5 dB	13.8 dB	14.1 dB	14.4 dB
MW18208C -> MW18208D-A	15.6 dB	15.3 dB	15 dB	14.7 dB
MW18208D-A -> MW18208D-B	7.1 dB	7.1 dB	7.1 dB	7.1 dB
	Loss on the 1547.71 nm Channel	**Loss on the 1544.52 nm Channel**	**Loss on the 1541.35 nm Channel**	**Loss on the 1538.19 nm Channel**
MW18208C -> MW18208D-B	14.7 dB	15 dB	15.3 dB	15.6 dB
MW18208C -> MW18208D-A	14.4 dB	14.1 dB	13.8 dB	13.5 dB
MW18208D-A -> MW18208D-B	7.1 dB	7.1 dB	7.1 dB	7.1 dB

Using a Two-way Combiner as an Add Filter

The MW18202C combiner module can be used as a low-cost alternative to an MW1821F filter in a unidirectional add application. Figure 5-9 shows the two-way combiner used to add a signal on the 1554.13 nm wavelength at mid-span to a DWDM transmission.

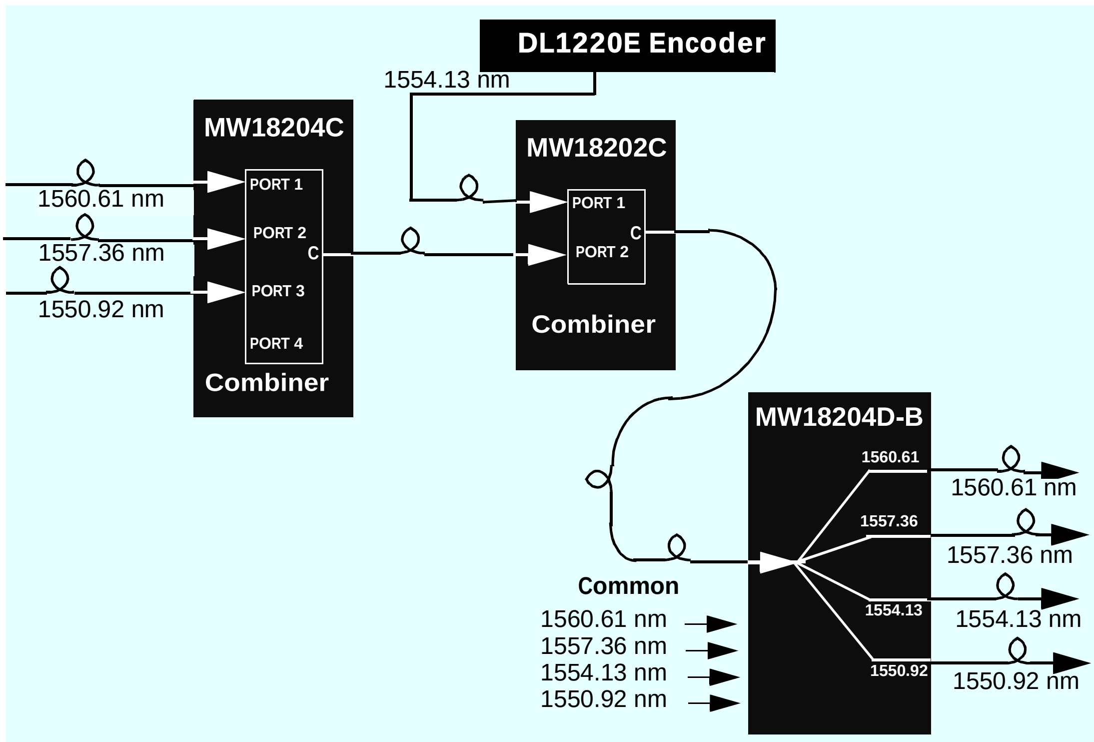

Figure 5-9. An MW18202C Combiner Used as an Add Filter

Advantage

The advantage to this application is cost. Since combiner modules do not have optics that are tuned to specific wavelengths, they are less expensive than the add/drop/pass filter modules.

Constraints

The two-way combiner can be used only as an add filter. It cannot be used as a drop filter. (For more information on add/drop/pass filter modules, see Chapter 6.)

When you use a combiner module, the entire system becomes unidirectional. Using it in this application makes bidirectionality—i.e., return paths—unattainable over the common pathway.

The two-way combiner has a slightly higher insertion loss than an add/drop/pass filter—3.8 dB for the combiner as opposed to 3.0 dB for a filter module.

6

Filter Modules

This chapter focuses on the MegaWav DWDM Filter modules. Information includes:

Filter Product Overview

The MegaWav Filter group allows you to perform add/drop/pass functions at mid-span locations along a DWDM path. The filters use ITU-standard wavelengths, as listed in Table 6-1. Each wavelength-specific filter can be identified by the two-digit ITU channel number, which is appended to the model number.

Table 6-1. MegaWav Optical Add/Drop/Pass Filters

Model Number	ITU Channel Number	Description
MW18201F-21	21	1560.61 nm optical add/drop/pass filter
MW18201F-23	23	1558.98 nm optical add/drop/pass filter
MW18201F-25	25	1557.36 nm optical add/drop/pass filter
MW18201F-27	27	1555.74 nm optical add/drop/pass filter
MW18201F-29	29	1554.13 nm optical add/drop/pass filter
MW18201F-31	31	1552.52 nm optical add/drop/pass filter
MW18201F-33	33	1550.92 nm optical add/drop/pass filter
MW18201F-35	35	1549.31 nm optical add/drop/pass filter
MW18201F-37	37	1547.71 nm optical add/drop/pass filter
MW18201F-39	39	1546.12 nm optical add/drop/pass filter
MW18201F-41	41	1544.52 nm optical add/drop/pass filter
MW18201F-43	43	1542.94 nm optical add/drop/pass filter
MW18201F-45	45	1541.35 nm optical add/drop/pass filter
MW18201F-47	47	1539.77 nm optical add/drop/pass filter
MW18201F-49	49	1538.19 nm optical add/drop/pass filter
MW18201F-51	51	1536.91 nm optical add/drop/pass filter

Adding a wavelength

When used to perform an add operation, a filter has two inputs and one output. The filter receives a DWDM input signal via its PASS port and a specific wavelength input via its ADD/DROP port. The filter blends the inputs together and transmits a new DWDM signal as an output via its COMMON port.

Figure 6-1 shows an add operation using an MW18201F-21 filter.

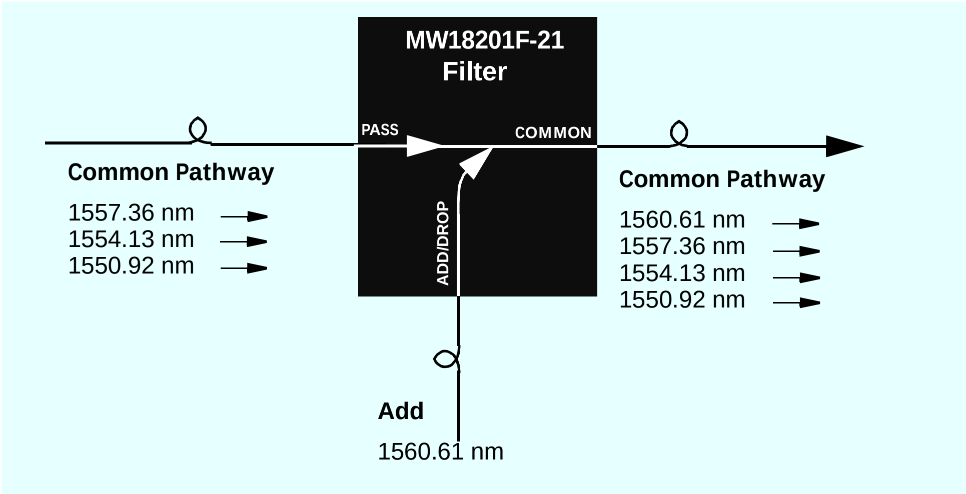

Figure 6-1. An Add Operation

The MW18201F-21 filter is tuned to the 1560.61 nm wavelength. The DWDM input signal (on the PASS port) does not carry a 1560.61 nm wavelength signal. The filter inserts a signal on the 1560.61 nm wavelength as an input to its ADD/DROP port, then transmits it as part of the DWDM output signal (going out the COMMON port) along with the three wavelengths blended on the original input signal.

Dropping a wavelength

When used to perform a drop operation, a filter has one input port and two output ports. The filter receives a DWDM input signal via its COMMON port. It extracts the specific wavelength to which it is tuned from the input signal and transmits the extracted signal as an output via its channel ADD/DROP port. The filter then transmits the remaining DWDM signals as outputs via its PASS port.

Figure 6-2 shows a drop operation using an MW18201F-33 filter.

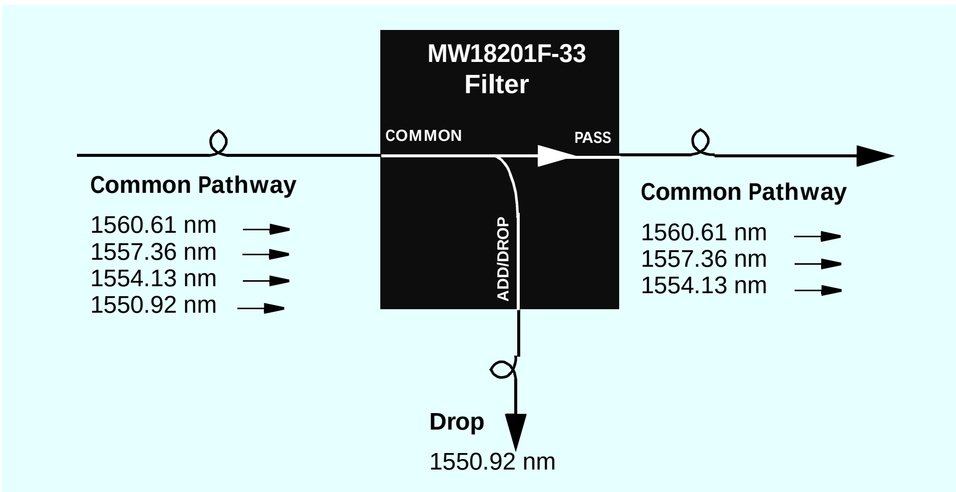

Figure 6-2. A Drop Operation

The MW18201F-33 filter is tuned to the 1550.92 nm wavelength. The DWDM input signal (on the COMMON port) carries signals on four wavelengths, one of which is on the 1550.92 nm wavelength. The filter extracts the signal on the 1550.92 nm wavelength and outputs it via the ADD/DROP port, and outputs the remaining three DWDM signal out the PASS port.

Signal replacement

Generally, when you are using a filter to perform an add operation, the DWDM input signal (the signal being received on the filter's PASS port) does not carry a signal on the wavelength to which the filter is tuned. If the DWDM input does carry such a signal, the filter will discard it and replace it with the new signal that it adds via the ADD/DROP port. Figure 6-3 shows an example of how the filter responds to such a situation.

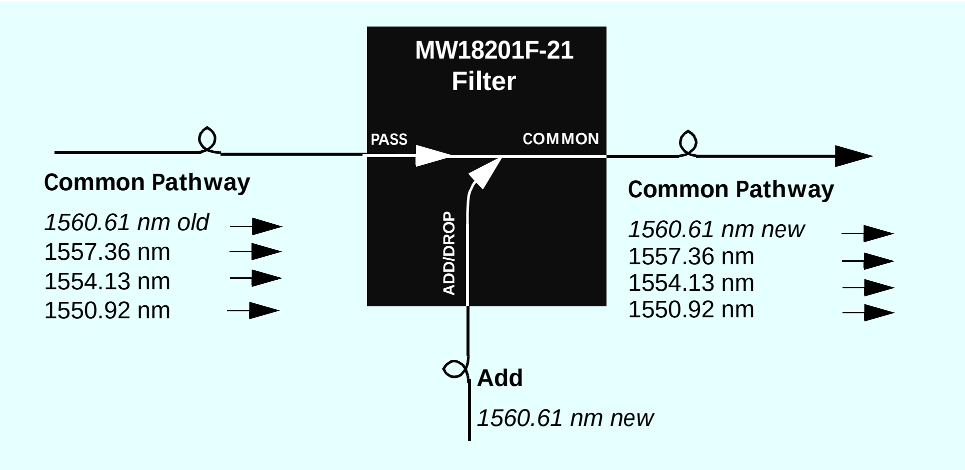

Figure 6-3. Replacing an Input Signal in an Add Operation

The example uses an MW18201F-21 filter to add a new signal on the 1560.61 nm wavelength. The DWDM input signal is already carrying a signal on that wavelength (called *1560.61 nm old*). In the process of adding the *1560.61 nm new* signal to the DWDM output transmission, the filter will discard the *1560.61 nm old* signal. The discarded signal cannot be recovered.

Unidirectional and bidirectional signal handling

Each filter is unidirectional with respect to the wavelength to which it is tuned, and it is bidirectional with respect to all other wavelengths. Figure 6-4 shows an example of how signals can pass in both directions through an add filter.

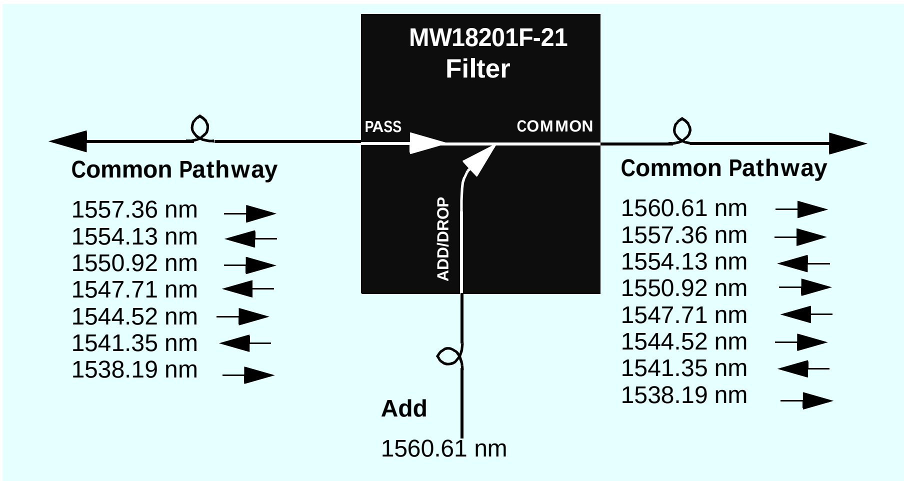

Figure 6-4. Bidirectional Signal Handling in an Add Operation

The example uses an MW18201F-21 filter, which is tuned to control a 1560.61 nm wavelength, in a add operation. The filter controls the direction of the signal on the 1560.61 nm wavelength, making sure that it is output from the filter's COMMON port onto the common pathway. It does not allow the signal on the 1560.61 nm wavelength to travel in the other direction on the common pathway.

All the other wavelengths carried on the common pathway can move in either direction through the filter. Their directionality is controlled by other devices outside the filter, and the filter ignores their direction.

The Add/Drop/Pass Filters

The filter modules have three ports—a COMMON, a PASS, and an ADD/DROP port. There are 16 different filter models (listed in Table 6-1 on page 6-2), each tuned to a different ITU channel. Figure 6-5 shows the rear panel of a filter module, which is common to all 16 models.

Figure 6-5. An MW18201F-21 Filter

Chassis compatibility

An MW18201F filter module consumes one slot in an MW18204H four-slot chassis. It does not fit in an MW18202H two-slot chassis.

Identifying the filter

The wavelength to which the filter is tuned is indicated by a label on top of the module. The ITU channel number is also shown in the last two digits of the model number, which appears through a window on the front panel of the chassis when the filter module is installed. Table 6-1 on page 6-2 lists the ITU channel numbers as they correspond to the various wavelengths,

Figure 6-6. Front View of an MW18204H Chassis with an MW18201F-21 Module

Port usage

When a filter is used in an add operation, the PASS port and the ADD/DROP port are used as input ports, and the COMMON port is used as the output port for a DWDM transmission with the new signal added. Figure 6-1 on page 6-3 shows an example of port utilization in an add operation.

When a filter is used in a drop operation, the COMMON port is used as the input port, and the PASS port and the ADD/DROP port are used as output ports. Figure 6-2 on page 6-4 shows an example of port utilization in a drop operation.

Table 6-2. Add/Drop/Pass Filter Port Utilization

Filter Mode	Filter Port		
	COMMON	**PASS**	**ADD/DROP**
Add	output	input	input
Drop	input	output	output

Insertion loss

The worst-case passband insertion loss incurred by using any of these filters, is 3 dB. Insertion loss is measured from the COMMON port to the ADD/DROP port or from the COMMON port to the PASS port; insertion loss includes losses at the connectors and from the filter.

Filter module cabling

All MegaWav module ports come with protective caps to protect the fiber optic connection from any contamination caused by dirt and debris. The protective caps must be placed on the connectors anytime the cable is removed.

Before attaching the cable to the module port, clean the cable and port connectors using an alcohol wipe and an oil-free canned air blast.

Use only singlemode fiber in a MegaWav system.

Sample Configuration

Figure 6-7 shows a DWDM network that utilizes a MW18208D-A eight-channel DWDM module at location A with four MW18201F add/drop/pass filters at locations B, C, and D. These MegaWav modules facilitate video transmissions between five DigiLink 1200 encoders and five DigiLink 1220 decoders.

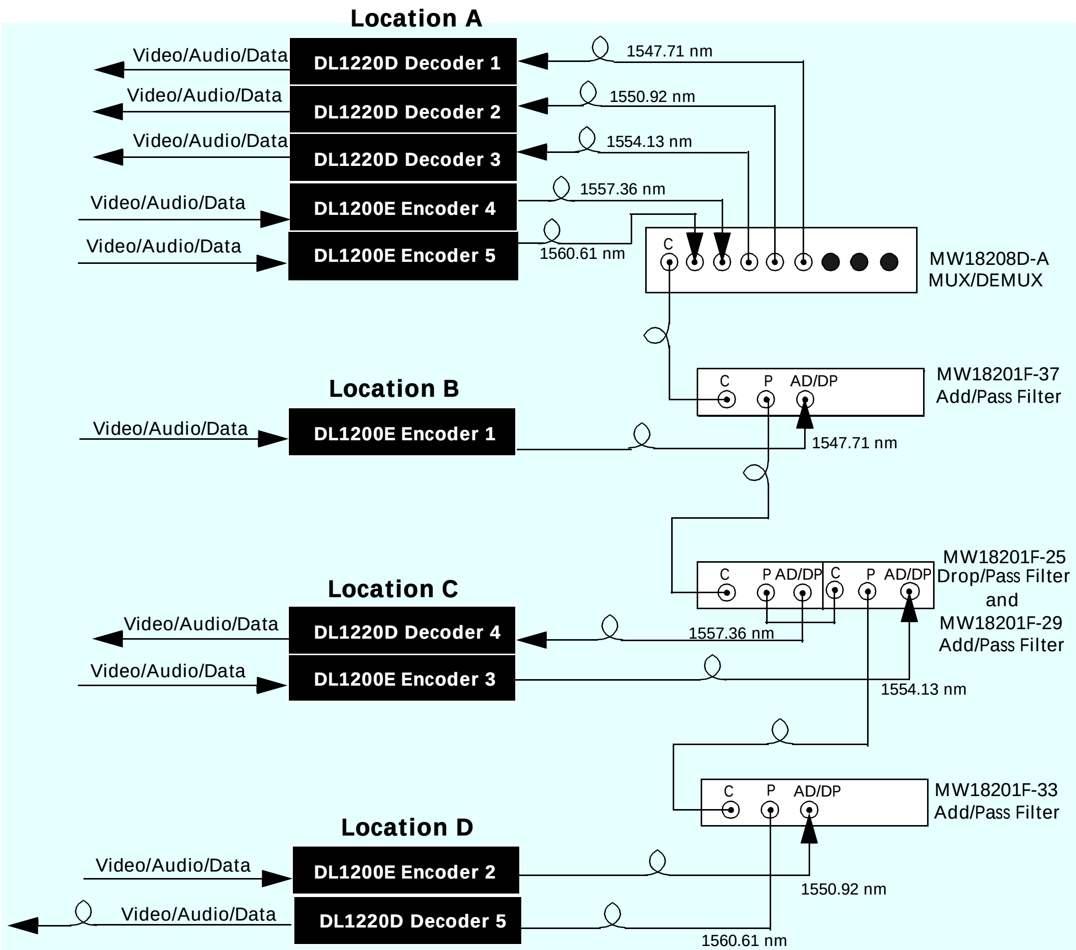

Figure 6-7. Add/Drop/Pass Filter Example

The MW18208D-A DWDM module at location A provides five I/O ports for the encoders and decoders at that location:

- It acts as a multiplexer for encoders 4 and 5 at location A, which input their signals to the module's 1560.61 and 1557.36 ports
- It acts as a demultiplexer for decoders 1 ... 3 at location A, which receive their signals as outputs from the module's 1554.13, 1550.92, and 1547.71 ports

The MW18201F-37 filter at location B acts as an *add* filter for encoder 1and as a *pass* filter for the signals coming from location A, location C, and location D:

- The filter adds the input from encoder 1 via its ADD/DROP port and outputs it via its COMMON port to location A, where it is demultiplexed and output to decoder 1
- The filter passes transmissions via it PASS port from encoder 4 at location A (on the 1557.36 nm wavelength) to location C and from encoder 5 at location A (on the 1560.61 nm wavelength) though location C to location D
- The filter passes transmissions via its COMMON port from encoder 2 at location D (on the 1550.92 nm wavelength) and encoder 3 at location C (on the 1554.13 nm wavelength) to location A, where they are demultiplexed and output to decoder 2 and 3, respectively

The MW18202F-25-29 filter at location C acts as a *drop* filter for decoder 4, as an *add* filter for encoder 1, and as a *pass* filter for signals coming from location A and location D:

- The filter drops the 1557.36 nm signal transmitted from encoder 4 at location A as an output via its ADD/DROP port to decoder 4 at location C
- The filter adds a 1554.13 nm input from encoder 3 via its ADD/DROP port and outputs it via its COMMON ports through location B to location A, where it is demultiplexed and output to decoder 3
- The filter passes the 1560.61 nm transmission via its PASS ports from encoder 5 at location A to location D
- The filter passes the transmission via its COMMON ports from encoder 2 at location D through location B to location A, where it is demultiplexed and output to decoder 2

The MW18201F-33 filter at location D acts as an *add* filter for encoder 2 and as a *pass* filter for decoder 5

- The filter adds a 1550.92 nm input from encoder 2 via its ADD/DROP port and outputs it via its COMMON port through locations C and B to location A, where it is demultiplexed and output to decoder 2
- The filter passes the transmission via its PASS port to decoder 5 at location D; this is the signal on the 1560.61 nm wavelength that originated from encoder 5 at location A

Appendix A

A

Specifications

This appendix lists specifications for the MegaWav Dense Wavelength Division Multiplexer System. They include:

Environmental Specifications

Table A-1 describes the environmental specifications for the MegaWav chassis and all of its module components.

Table A-1. Environmental Specifications

Specification	MegaWav
Operating Temperature	0 ... +60° C
Relative Humidity	10 ... 95% (noncondensing)
Ambient Storage Temperature	-40 ... +85° C

Physical Specifications

Table A-2 describes the physical specifications of the MegaWav chassis.

Table A-2. Physical Specifications

Specification	MegaWav
Chassis Dimensions (H x W x D)	1.75 x 19.0 x 10.5 inch 4.44 x 48.26 x 26.67 cm
Chassis Weight	7 lbs 3.175 kg
Rack Mount Requirement	One 19 inch Rack Unit

Optical Specifications

Table A-3 lists optical specifications for the MegaWav modules.

Table A-3. MegaWav Optical Specifications

	WDM	DWDM		Combiner	Filter
Channel Spacing	1310 nm 1550 nm	4- and 8-channel	400 GHz	Dual window	200 GHz
		16-channel	200 GHz		
Channel Passband	1280 ... 1360 nm 1520 ... 1570 nm	0.5 nm		1270 ... 1350 nm 1510 ... 1590 nm	0.5 nm
Channel Isolation	50 dB	4- and 8-channel	33 dB (min)		25 dB
		16-channel	25 dB (min)		
Back Reflection	-45 dB max.	-33 dB max.		-45 dB max.	-33 dB max.
Fiber	9/125 µm single mode	9/125 µm single mode		9/125 µm single mode	9/125 µm single mode
Connector	FC/PC	FC/PC		FC/PC	FC/PC
Transmission Direction	Bidirectional	Bidirectional		Unidirectional	Bidirectional

Insertion Losses

Table A-4. Insertion Loss Characteristics of the MegaWav Modules

WDM	DWDM		Combiner/Splitter		A/D/P Filter
1.5 dB on each channel	MW18204-A (four-channel)	3.4 dB on 1560.61	MW18202C (two-way)	3.8 dB on each channel	3.0 dB
		3.1 dB on 1557.36			
		2.8 dB on 1554.13			
		2.5 dB on 1550.92			
	MW18204-B (four-channel)	2.5 dB on 1560.61	MW18204C (four-way)	7.5 dB on each channel	
		2.8 dB on 1557.36			
		3.1 dB on 1554.13			
		3.4 dB on 1550.92			
	MW18208-A (eight-channel)	4.6 dB on 1560.61	MW18208C (eight-way)	11.0 dB on each signal	
		4.3 dB on 1557.36			
		4.0 dB on 1554.13			
		3.7 dB on 1550.92			
		3.4 dB on 1547.71			
		3.1 dB on 1544.52			
		2.8 dB on 1541.35			
		2.5 dB on 1538.19			
	MW18208-B (eight-channel)	2.5 dB on 1560.61			
		2.8 dB on 1557.36			
		3.1 dB on 1554.13			
		3.4 dB on 1550.92			
		3.7 dB on 1547.71			
		4.0 dB on 1544.52			
		4.3 dB on 1541.35			
		4.6 dB on 1538.19			

WDM	DWDM		Combiner/Splitter		A/D/P Filter
	MW18216-A (16-channel)	7.0 dB on 1560.61			
		6.7 dB on 1558.98			
		6.4 dB on 1557.36			
		6.1 dB on 1555.74			
		5.8 dB on 1554.13			
		5.5 dB on 1552.52			
		5.2 dB on 1550.92			
		4.9 dB on 1549.31			
		4.6 dB on 1547.71			
		4.3 dB on 1546.12			
		4.0 dB on 1544.52			
		3.7 dB on 1542.94			
		3.4 dB on 1541.35			
		3.1 dB on 1539.77			
		2.8 dB on 1538.19			
		2.5 dB on 1536.61			
	MW18216-B (16-channel)	2.5 dB on 1560.61			
		2.8 dB on 1558.98			
		3.1 dB on 1557.36			
		3.4 dB on 1555.74			
		3.7 dB on 1554.13			
		4.0 dB on 1552.52			
		4.3 dB on 1550.92			
		4.6 dB on 1549.31			

WDM	DWDM		Combiner/Splitter		A/D/P Filter
		4.9 dB on 1547.71			
		5.2 dB on 1546.12			
		5.5 dB on 1544.52			
		5.8 dB on 1542.94			
		6.1 dB on 1541.35			
		6.4 dB on 1539.77			
		6.7 dB on 1538.19			
		7.0 dB on 1536.61			

ITU Channel Grid

The following table shows the ITU channels utilized by the three types of MegaWav DWDM modules.

Table A-5. ITU Optical Wavelength Channel Grid

ITU Channel Standards			MegaWav DWDM Module		
Channel	**Frequency**	**Wave length**	**16-channel**	**8-channel**	**4-channel**
21	192,100 GHz	1560.61 nm	X	X	X
22	192,200 GHz	1559.79 nm			
23	192,300 GHz	1558.98 nm	X		
24	192,400 GHz	1558.17 nm			
25	192,500 GHz	1557.36 nm	X	X	X
26	192,600 GHz	1556.56 nm			
27	192,700 GHz	1555.74 nm	X		
28	192,800 GHz	1554.94 nm			
29	192,900 GHz	1554.13 nm	X	X	X
30	193,000 GHz	1553.33 nm			
31	193,100 GHz	1552.52 nm	X		
32	193,200 GHz	1551.72 nm			
33	193,300 GHz	1550.92 nm	X	X	X
34	193,400 GHz	1550.12 nm			
35	193,500 GHz	1549.31 nm	X		
36	193,600 GHz	1548.52 nm			
37	193,700 GHz	1547.71 nm	X	X	
38	193,800 GHz	1546.92 nm			
39	193,900 GHz	1546.12 nm	X		
40	194,000 GHz	1545.32 nm			

Table A-5. ITU Optical Wavelength Channel Grid

ITU Channel Standards			MegaWav DWDM Module		
Channel	Frequency	Wave length	16-channel	8-channel	4-channel
41	194,100 GHz	1544.52 nm	X	X	
42	194,200 GHz	1543.73 nm			
43	194,300 GHz	1542.94 nm	X		
44	194,400 GHz	1542.14 nm			
45	194,500 GHz	1541.35 nm	X	X	
46	194,600 GHz	1540.56 nm			
47	194,700 GHz	1539.77 nm	X		
48	194,800 GHz	1538.98 nm			
49	194,900 GHz	1538.19 nm	X	X	
50	195,000 GHz	1537.40 nm			
51	195,100 GHz	1536.61 nm	X		

B

Fiber Optic Cables

Appendix B provides information on fiber optic cables and describes how to select the proper cable for your network application.

This chapter consists of the following sections:

Fiber Optic Cable Overview

Fiber optic cables are used to carry digital signals in the form of modulated pulses of light. A fiber optic cable consists of two concentric cylindrical glass regions. The inner region *core* (**1**) has a refractive index higher than the outer region *cladding* (**2**). As a result, light injected into the core at an angle within a cone-shaped zone (the numerical aperture) is totally reflected whenever it encounters the core and cladding boundary. The light rays travel paths known as *modes* (**3**). The rays continue to be reflected down the length of the fiber by the total internal reflection as seen in Figure B-1.

The cladding is usually surrounded by a third layer, the *buffer* (**4**), which protects the optical properties of the cladding and core. One or more buffered fibers are surrounded with various strength members and jacketing to form a fiber optic cable.

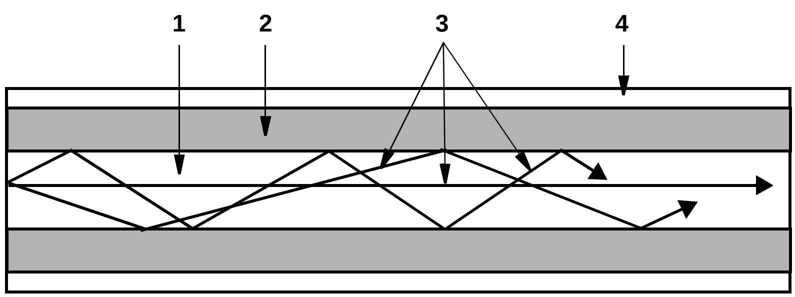

Figure B-1. Fiber Optic Cable Model

Fibers are usually classified by their refractive index profiles, core size, and numerical aperture. There are three main types of fibers:

- Multimode step-index fibers
- Multimode graded-index fibers
- Singlemode fibers

Note: Use only singlemode fiber in a MegaWav system.

Multimode Step-Index Fiber Cable

Multimode step-index fibers have core diameters in the 50 µm to 1000 µm range. This large core size supports many modes, or paths, for the light to travel. The path lengths for the various modes are different. Because of this, the various rays take a longer or shorter time to travel the length of the fiber. The light ray traveling the center of the core without reflecting arrives at the end of the fiber first. Thus, light entering the fiber at the same time (**1**) exits the cable at different times (**2**). The light has spread out in time. This phenomenon is known as *modal dispersion*.

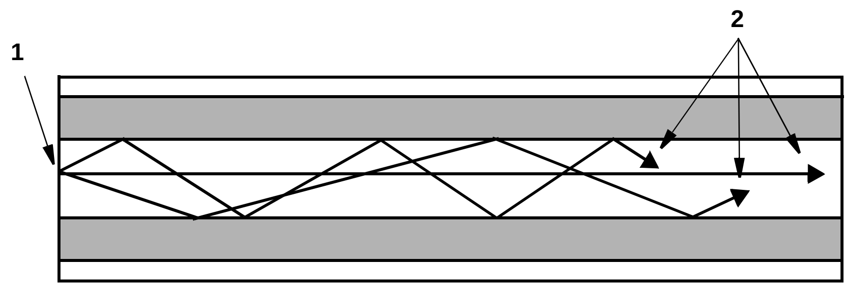

Figure B-2. MultiMode Step-Index Fiber

For more information on modal dispersion, refer to the page B-9.

Multimode Graded-Index Fiber Cable

Graded-index fibers have a core index of refraction profile that changes gradually. The index is highest in the center and decreases until the core and cladding boundary is reached. Unlike step-index fibers, light is refracted as it traverses the index gradient, continually bending back towards the center (**1**).

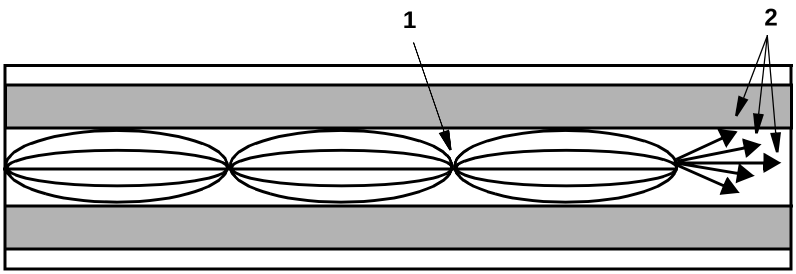

Figure B-3. Multimode Graded-Index Fiber

Because light travels faster in glass with a lower refractive index, the light farther from the center axis travels faster. The rays following the longest paths have a faster average velocity, so that all modes tend to arrive at any point at nearly the same time (**2**). This reduces modal dispersion to provide a higher bandwidth fiber.

For more information on modal dispersion, refer to page B-9.

Table B-1 provides information on graded-index multimode fiber optic cable attenuation characteristics.

Table B-1. Graded-Index Multimode Fiber Optic Cable Characteristics

Fiber Geometry Core and Cladding (fiber grade)		Maximum Attenuation (dB/km)		Typical Attenuation (dB/km)		Modal Bandwidth (MHz/km)	
		1310	1550	1310	1550	Min.	Max.
50/125 µm	Standard	1.5	1.0	1.0	0.5	400	800
	High	0.9	0.6	0.7	0.4	600	1200
	Premium	0.7	0.4	0.5	0.3	800	2000
62.5/125 µm	Standard	2.0	1.0	1.2	0.6	150	300
	High	1.0	0.7	0.8	0.5	400	800
	Premium	0.8	0.5	0.6	0.4	500	1000

Singlemode Fibers

Singlemode fibers offer a method of limiting modal dispersion. These fibers have a core diameter small enough to allow only one mode to propagate (**1**).

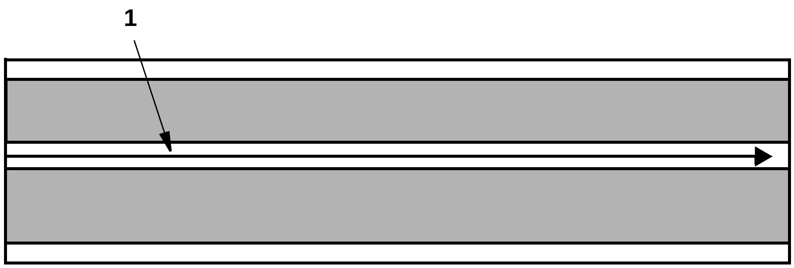

Figure B-4. Singlemode Fiber

With dispersions of only tens of picoseconds per kilometer, the fibers have exceptional bandwidths and low losses that make them suited to long distance, high speed telecommunications, and CATV.

Singlemode fiber's small core size make it more difficult to splice. This type of fiber generally require a laser light source (vs. a LED light source) to couple a sufficient amount of light into the small fiber core.

Table B-2 provides information on step-index singlemode fiber optic cable characteristics.

Table B-2. Step-Index Singlemode Fiber Optic Cable Characteristics

Fiber Geometry Core and Cladding (fiber grade)		Maximum Attenuation (dB/km)		Typical Attenuation (dB/km)	
		1310	1550	1310	1550
9/125 µm	Standard	1.0	0.6	0.7	0.4
	High	0.7	0.5	0.5	0.3
	Premium	0.5	0.25	0.35	0.23

Note: The optical component described in this manual will work only in singlemode fiber systems. Singlemode fiber cable has higher bandwidth and lower loss properties than multimode fiber cable.

Fiber Optic Cable Properties

Bandwidth in optical fiber is limited by *dispersion*, which is the spreading of a light pulse as it travels along a fiber optic cable. Because of dispersion, fiber bandwidth is inversely proportional to fiber length.

There are two types of dispersion:

- Modal dispersion
- Chromatic dispersion

In addition to dispersion information, this section includes information on:

- Modal bandwidth
- Signal attenuation

Modal Dispersion

Modal dispersion is the spreading of light over time as it travels through a fiber optic cable. Dispersion is the main mechanism that limits the bandwidth or information-carrying capacity of a fiber. Dispersion limits fiber bandwidth, and therefore data rate.

Some of the light transmitted over a multimode fiber enters the core at a non-zero angle with respect to the axis of the fiber. The light rays travel paths known as *modes*, repetitively reflecting off the core and cladding boundary traveling in a zig-zag pattern along the length of the fiber.

The path length for the modes reflecting off the core and cladding boundry (**1**) is longer than the path length of a light ray traveling along the axis of the fiber (**2**). The longer path results in different propagation delays for components of a single light pulse. Figure B-5 illustrates modal dispersion in both Multimode Step Index Fiber and Multimode Graded Index Fiber.

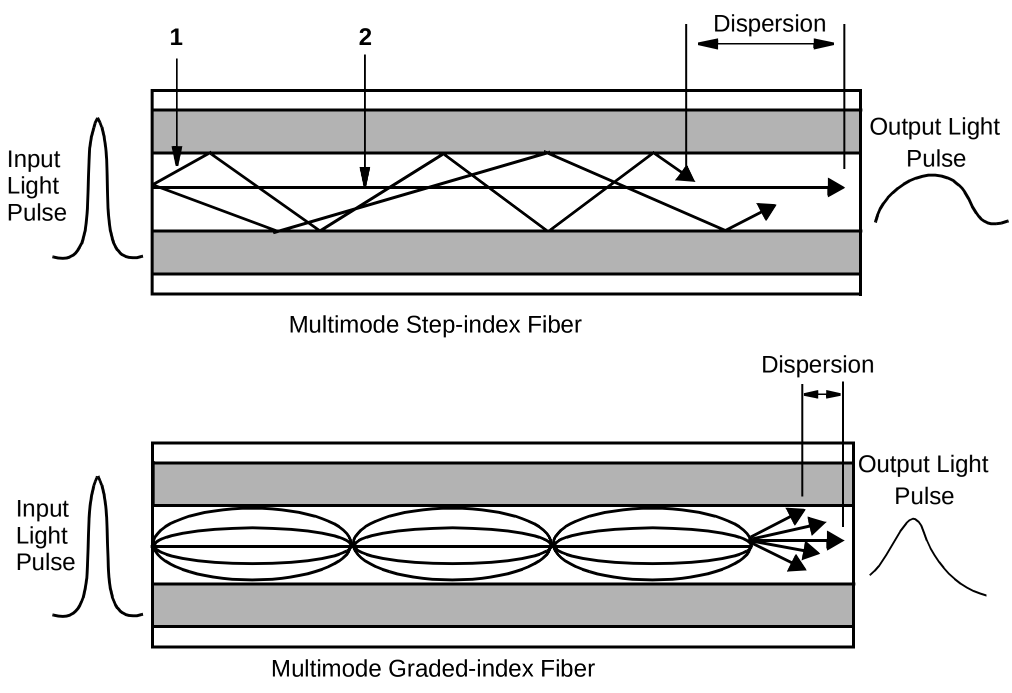

Figure B-5. Modal Dispersion

Modal dispersion is not present in singlemode fiber due to the very narrow diameter of the core. Figure B-6 illustrates how a light pulse travels through a singlemode fiber.

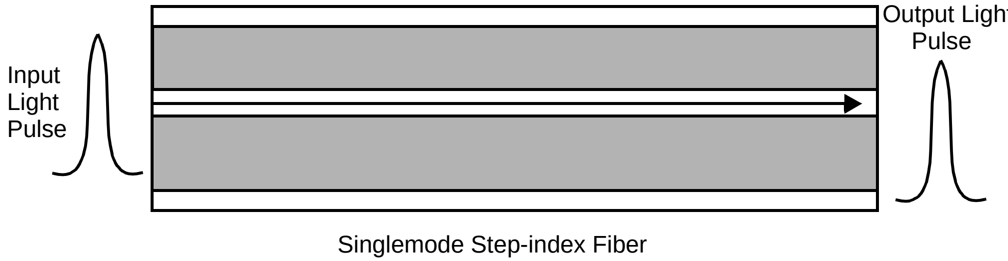

Figure B-6. Singlemode Fiber

Chromatic Dispersion

In addition to modal dispersion, *chromatic dispersion* occurs when optical energy is spread over a range of wavelengths (colors). Different wavelengths traveling the same path have different propagation velocities, which causes pulse spreading.

The propagation delay through the fiber core material is also a function of the light wavelength. The optical energy from LEDs and laser diodes tends to be distributed over a range of wavelengths, therefore its color is not pure. The different colors travel through the optical fiber at different speeds. This phenomena is referred to as chromatic dispersion.

You can reduce chromatic dispersion by:

- Operating at the zero dispersion wavelength of the optical fiber (1310 nm for silica glass)
- Using a light source with a narrow spectral width, such as a 1550 nm distributed feedback (DFB) laser diode.

Modal Bandwidth

In general, the total fiber bandwidth is a function of both the modal and the chromatic bandwidth of the fiber. The chromatic bandwidth of an optical fiber is dependent upon the center wavelength and the spectral width of the emitting light source, as well as the material dispersion of the fiber (which is a function of wavelength).

Multimode fiber bandwidth is commonly rated in megahertz-kilometers (MHz-km). This rating refers only to the modal bandwidth (that is, the bandwidth limitations imposed by modal dispersion), and has been normalized to a 1 km length.

Signal Attenuation

Signal attenuation refers to the weakening of the optic signal strength as it travels along the fiber optic cable. Unlike signal attenuation in copper cables, signal attenuation in an optical fiber does not increase with increasing modulation frequency; it is constant across the usable frequency range of the fiber. Attenuation is proportional to fiber length and depends on the wavelength (color) of the light being propagated. In silica glass fibers, the dominant attenuation mechanism is Rayleigh scattering, which decreases gradually with increasing wavelength. Attenuation rises dramatically above 1550 nm due to infrared absorption.

Selecting Fiber Optic Cable

Two optical wavelengths have become standards for long distance high speed data transmission:

- 1310 nm — Provides the maximum data bandwidth due to the zero chromatic dispersion property of silica glass fibers at this wavelength.
- 1550 nm — Provides the lowest possible attenuation, which permits data transmission over the longest distance without repeaters.

When purchasing fiber optic cable, the most important considerations are the following fiber transmission specifications:

- Maximum attenuation
- Minimum bandwidth
- Diameter of the fiber core and cladding

Secondary considerations in choosing fiber optic cable include:

- Rated pull strength
- Cable constructions
- Number of fibers packaged in a cable

Refer to your cable manufacturer's specifications for information regarding these cable characteristics.

Using Fiber Optic Cable

To ensure proper operation of the fiber optical cables and equipment, follow the precautions listed below.

- Do not exceed the -25 dB maximum optical return loss in the optical fiber plant.
- Before you connect fiber cable to equipment, ensure that you clean the fiber carefully using an alcohol wipe and an oil-free canned air blast.
- When no fiber optic cable is connected to a port on a piece of equipment, install the protective plastic cap on the connector.
- Ensure that no dirt particles or other contaminates are introduced into the optical connector (port). Failure to keep the optical connector free of contaminants may result in severely reduced optical output power and reduced range.

  If a dirt particle becomes imbedded in the optical connector, return the unit to Artel.

Appendix C

C

Customer Service

This chapter provides information on contacting Artel Video Systems' Customer Service department.

This chapter contains the following sections:

Contacting Customer Service

Artel Video Systems' customer support services are designed to respond quickly and efficiently to our customers' needs. Our knowledgeable staff will answer any questions or concerns our customers may have in regards to any of Artel Video Systems' quality products.

You may contact Artel Customer Service by:

- Phone: 800 447-7204 (for after-hours emergency service, follow the menu instructions)
- Fax: 801 537-3009

When requesting assistance by phone or fax, please be ready to provide the following information:

- Your name, company name, and telephone number
- Product model and serial number
- Brief description of the problem
- List of symptoms
- Steps you have taken to try and resolve the problem

Product Damaged in Transit

If any portion of the unit is damaged in transit, forward an immediate request to the delivering carrier to perform an inspection of the product and to prepare a damage report. Save the container and all packing materials until the contents are verified.

Concurrently, report the nature and extent of the damage to Artel Customer Service so that action can be initiated to either repair or replace the damaged items.

Do not return any items to Artel until you obtain instructions from Artel Customer Service. Report the problem or deficiency to Customer Service along with the model number and serial number. Upon receipt of this information, Artel will provide you with service instructions, or a Return Authorization Number and shipping information. Refer to page C-2 for the appropriate phone/fax numbers.

SuperLink Program

Artel Video Systems, Inc. is committed to world class customer satisfaction with the SuperLink Service program.

SuperLink Service includes:

- *QuickLink 48 Program*—When you require faster than normal delivery (typically 2 to 4 weeks), we ship any standard Artel product anywhere within 48 hours of receiving your order for an additional 5% of cost.
- *7 x 24 Technical Assistance*—Artel provides a full time, toll free, technical assistance hot line, where you can reach someone 7 days a week, 24 hours a day, every day of the year.
- *911 Advance Replacement Policy*—If you need a replacement product immediately, Artel can provide it overnight. The Artel Advance Replacement policy assures that a direct substitute will be sent when the product is under warranty.

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