CLEARFIELD

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Frequently Asked Questions about WDM/CWDM/DWDM & Circulators:

1. What is a WDM? WDM stands for Wavelength Division Multiplexer. In fiber-optic communications, wavelength-division multiplexing is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths (i.e. colors) of laser light. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity. This is done by using light wavelength filters. The filters only allow specific wavelengths of light to pass through the filter to a fiber port and the remainder of the wavelengths to be reflected back to another fiber port. The wavelengths used are defined by the International Telecommunications Union; reference ITU G.694.2 for the ITU WDM Wavelength Grid. 1270nm through 1610nm are the typical wavelengths used in fiber optic communications.

2. What is a WDM used for? Fiber Optic WDM's are used to increase the amount of information or systems that can be transmitted over a single fiber. They are also used to create virtual fiber or fiber relief freeing up existing fibers to be used for other networks or systems. For example a typical 2 channel WDM point to point network will use a 2 channel 1310nm/1550nm multiplexer to combine the two different wavelengths onto one fiber and a demultiplexer at the opposite end to individually demultiplex or separate those wavelengths. This allows you to simultaneously transmit two different signals/systems over the same fiber. This would free up 1 other fiber creating virtual fiber or fiber relief.

3. What is a CWDM? CWDM stands for Course Wavelength Division Multiplexer. CWDM's work similar to the WDM's explained in questions 1 and 2. "Course" meaning the channel spacing is 20nm with a working channel passband of +/-6.5nm from the wavelengths center. This is tighter channel spacing than typical Wide Band Optic (WBO) WDM's, which allows for more channels within the ITU CWDM grid. CWDM's allow you to multiplex or demultiplex multiple wavelengths over one fiber. This is done by using light wavelength filters. The filters only allow specific wavelengths of light to pass through the filter to a single fiber port and the remainder of the wavelengths are then reflected back to another separate fiber port. When used in a series or concatenated together this allows you to add multiple wavelengths on to one fiber. From 1270nm to 1610nm there are 18 individual wavelengths/channels separated by 20nm spacing.

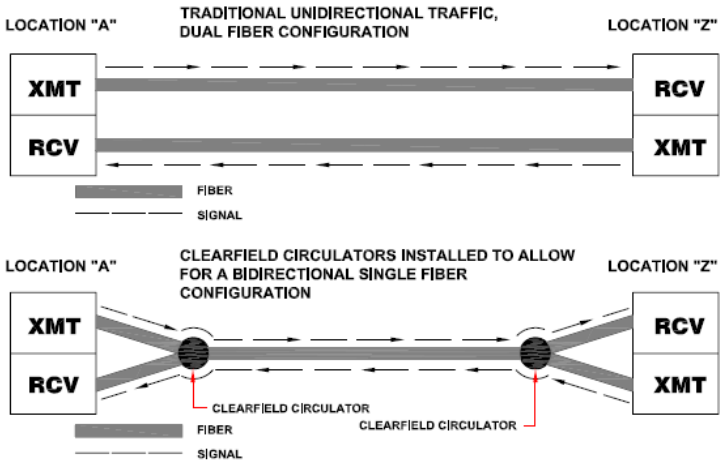
4. What is a CWDM used for? Fiber Optic CWDM's are used to increase the amount of information or systems that can be transmitted over a single fiber. They are also used to create virtual fiber or fiber relief freeing up existing fibers to be used for other networks or systems. For example a typical 4 channel CWDM point to point network will use a multiplexer to combine four different wavelengths onto one fiber and a demultiplexer at the opposite end to individually demultiplex or separate the wavelengths. This allows you to simultaneously transmit four different signals/systems over the same fiber. This would free up 3 other fibers on a four fiber network creating virtual fiber or fiber relief.

5. What is a DWDM? DWDM stands for Dense Wavelength Division Multiplexer. DWDM's allow you to multiplex or demultiplex more than one wavelength over one fiber similar to the CWDM mentioned in questions 3 and 4. The word "Dense" is referring to the very narrow channel spacing measured in Gigahertz (GHz) as opposed to nanometer (nm). DWDM's typically use channel spacing of 100GHz with a working channel passband of +/-12.5GHz from the wavelengths center. This allows you to add multiple wavelengths on to one fiber within the 1550nm band which are wavelengths between approximately 1525nm–1565nm (C band) and/or 1565nm–1625nm (L band) adhering to the DWDM ITU-T G.694.1 frequency grid. DWDM's will also use 200GHz spacing essentially skipping every other channel in the DWDM grid. They have also gone one step further using an Optical Interleaver to get down to 50GHz spacing doubling the channels capacity from 100GHz spacing.

6. What is a DWDM used for? Similar to CWDM's mentioned in questions 3 and 4 DWDM's are used to increase the amount of information or systems that can be transmitted over a single fiber. The DWDM's will allow for many more channels using much tighter channel spacing. Typical DWDM's will allow for but not limited to 32, 40 and 44 channels, while the 50GHz spacing will double that and allow for 64, 80 and 88 channels.

7. What is a Circulator? An optical circulator is a fiber-optic component that can be used to separate optical signals that travel in opposite directions over an optical fiber, as opposed to the operation of an electronic circulator. An optical circulator is a three-port device designed such that light entering any port exits from the next. Meaning when light enters port 1 it is emitted from port 2 only, not allowing it to pass to port 3. If light enters port 2 it is emitted from port 3 only. If light enters port 3 it is emitted from port 1 only.

8. What is a Circulator used for? Circulators can be used to achieve bi-directional transmission over a single fiber. Because of its high isolation of the input and reflected optical powers and its low insertion loss, optical circulators are widely used in advanced communication systems and fiber-optic sensor applications. Clearfield uses Circulators as a great way to create virtual fiber or fiber relief. By placing a Circulator at each end of a typical 2 fiber Transmit (TX)/Receive (RX) network you can free up one fiber by using bidirectional traffic over one fiber. See diagram below.



9. What is the difference between WBO & NBO? WBO stands for Wide Band Optics. Typically this is referred to standard WDM's using the much wider channel spacing having large channel passbands of +/-30nm, 40nm and 50nm. NBO stands for Narrow Band Optics. NBO refers to the CWDM 20nm channel spacing with a channel passband of +/-6.5nm.

10. What is an OADM? OADM stands for Optical Add Drop Multiplexing. This module is used to Add and Drop specific wavelengths while letting all other wavelengths continue to pass through. A typical OADM is a 4 port module that has East and West Common ports and a Drop port and Add Port. The first common port typically referred to as the East port will receive all of the wavelengths being transmitted through the single fiber. Using a filtered component it will then separate and drop one wavelength to the 2nd port, then allow the same wavelength to be transmitted on the 3rd port adding it to continue through the West Common port.

11. How many channels are available for CWDM and DWDM? Clearfield follows the standard ITU-T G694.2 for WDM/CWDM using the wavelengths 1270nm to 1610nm which gives us 18 CWDM wavelengths. Clearfield has also added 1630nm and 1650nm wavelengths that are used for live testing in newer model OTDR's. For the DWDM channels Clearfield follows the ITU-T G.694.1 Grid. Today's DWDM systems using 100GHz, 50GHz or even 25GHz channel spacing can get up to 160 channels of operation.

12. Does your CWDM/OADM accommodate OC-3/12/48/192, GigE, 10 GigE optical signals? The Clearfield passive optical components will accommodate OC-3/12/48/192, GigE, 10 GigE optical signals. The Passive Optical Components are typically not the limiting factor to what type of network or speed that can be run through it. This limiting factors are determined by the types of transmitters and receivers used in the network along with the quality of the fiber optic network being used.

13. What is the maximum fiber distance per fiber span when deploying CWDM/DWDM/Circulators? The maximum fiber distance is not determined by the optical component. Like any other fiber network the distance a signal can go is based on the output power of the laser/transmitter and the overall link loss acceptable for the equipment/receiver being used.

14. What is the added 1310nm Port and why is it used? The 1310nm added port is a (WBO) Wide Band Optic port added to other specific CWDM wavelengths in a module. For example if an 8 channel CWDM is called out it may use wavelengths 1470nm to 1610nm and request the added 1310WBO port. The 1310WBO port is used in some Legacy networks and sometimes as a return path. If an existing Legacy network is using 1310WBO and they have exhausted all fibers and are looking for ways to increase their network capacity they can add in other CWDM wavelengths on to the same fiber while still allowing the use of the 1310WBO.

15. What is the added Express Port and why is it used? An Express port allows all other wavelengths to pass or Express through in a Demux module or to be added in a Mux module. When a 4 channel CWDM Mux module uses wavelengths 1470nm to 1530nm and has the added Express port it will allow you to upgrade with no interruption other CWDM channels like 1550nm to 1610nm now allowing 8 channels to pass through the one dedicated fiber. The Express port can also be referred to as the Expansion port as well.

16. What is the added Test/Monitor Port and why is it used? The added Test or Monitor port is used to monitor or test the power signal coming out of a Muxed CWDM or before it gets demuxed from the signal coming through the fiber network. This is done by adding a 1x2 coupler onto the common port. The split ratio is typically very low around 5% to reduce the amount of loss introduced into the network. Network administrators will use this to test of monitor if a signal has failed or changed without having to interrupt the existing network.

17. What does Storage Temperature and Operating Temperature mean and why are they different? The Operating Temperature of an optical component is the actual temperature in which the component will work at within a specified temperature range at a specified optical performance level. The Storage Temperature of an optical component is the actual temperature in which an optical component could be stored at without causing any degradation or component failure when it is used in the components specified operating temperature limits. Some storage temperatures can exceed the actual operating temperature of the component.

18. What are the Storage and Operating temperatures for the Optical Components? See table below.

Optical Component	Operating Temperature	Storage Temperature
Circulators	-40c to +85c	-40c to +85c
Fused Biconic Tappered Splitters (FBT Couplers)	-40c to +85c	-40c to +85c
Plannar Lightwave Circuits (PLC Splitters)	-40c to +85c	-40c to +85c
Wavelength Division Multiplexing (WDM FBT or Thin-Film Filtered)	-40c to +85c	-40c to +85c
Course Wavelength Division Multiplexing (CWDM Thin-Film Filtered)	-40c to +85c	-40c to +85c
Dense Wavelength Division Multiplexing (DWDM Thin-Film Filtered)	-40c to +85c	-40c to +85c
Dense Wavelength Division Multiplexing (DWDM Athermal Wave Guide, Guassian Type)	-5c to +65c	-40c to +85c

19. What is the typical lead time for the more standard Optical Components? Clearfield tries to stock the more common couplers, splitters and WDM's. Unfortunately there are so many configurations and combinations for optical components it is hard to keep all of them in stock. If not in stock most of the couplers and splitters have about a 3 week lead time. WDM, CWDM's can be about 3 to 4 weeks. The higher channel count DWDM's can sometimes take around 4 to 5 weeks.

20. What are the different package sizes available for Optical Components? Clearfield offers a wide variety of Optical Component packages. There are the discrete components such as the 3mm tube style for the FBT couplers and 5.5x34mm Filtered style WDM/CWDM/DWDM's. The mini hard-case PLC splitters and the common black box style 100x80x10mm along with the 80x60x6mm smaller black box style. All of these discrete type packages can be loaded into the Clearfield Clearview Cassettes, LGX type cassettes along with the Clearfield xPAK. Clearfield has also offered many custom size packages. Please talk to your sales representative if you have any questions on package options.

21. What are some of the High Density package options Clearfield offers? Clearfield offers the ½ Wide LGX cassette for more density. Clearfield also offers all of the package sizes with LC Duplex adapters. This will double the port capacity in all of our cassettes reducing the footprint by half when using the SC design.

22. What determines which wavelengths are needed? The wavelengths that are used in a network are determined by the electronic equipment/lasers being used. In some of the earlier generation Telco equipment 1310nm and 1550nm Wide Band Optics are used. As networks become more complex and higher band width is needed network designers have moved towards using Small Form Factor Pluggable Transceivers (SFP) technology. The network designer can choose which wavelength or channel they want by selecting the SFP of their choice with whichever CWDM wavelength or DWDM channel they would like to use.