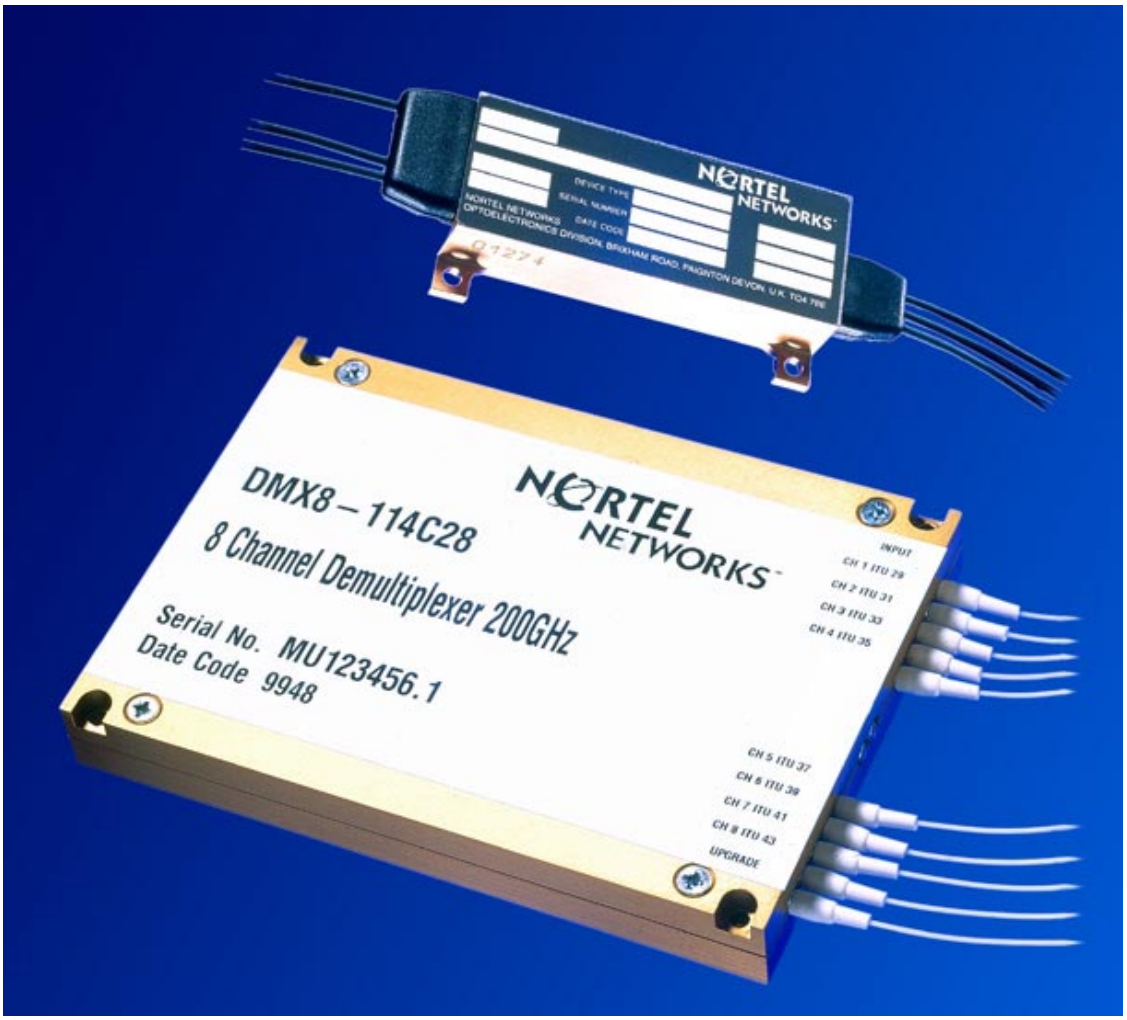
MX4/DMX4 113 Series
MX8/DMX8 114 Series

WDM Dielectric Filter Multiplexer and Demultiplexer Modules



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1.0 Introduction

The dielectric filter range is designed for multiplexing and demultiplexing signals within a DWDM (Dense Wavelength Division Multiplexing) network, in Long Haul, Metro and some Access applications. The module is capable of filtering large channel counts in the C band EDFA window, with filter channel spacing down to 200GHz.

To enable shorter lead times and non-custom solutions, a range of standard wave plans have been allocated for multiplexer and demultiplexer parts. This document details their construction, performance and how best to implement them in your system.

Other channel plans and wavelengths are available on request, including L band devices, wide filters and stepped filters.

2.0 Description

The dielectric filter technology has distinct advantages over other technologies: -

- Available in low channel counts - Low start up cost
- Freedom of filter choice - Choose your required wavelength plan
- High cross channel isolation - Enhanced system performance
- Excellent thermal stability - No temperature control required
- Flat topped Filter performance - Small optical power variation within passband

The Nortel Networks dielectric filter products are available in four channel building blocks with small footprint size, providing solutions for various DWDM multiplexing and demultiplexing applications. Features and benefits include: -

- Hermetically packaged - optimum long term performance and reliability
- Bellcore GR-1221 compliant - assured performance and reliability
- Small footprint - reduced PCB area
- Compatible with ITU grid - readily available compatible sources
- Optically reversible - enabling the implementation of bi-directional systems.
- Upgrade output - simple addition of upgrade devices, tap for OSC (Optical Service Channel) or 5^{th} channel.

2.1 Standard Package Layouts

2.1.1 4 Channel - Single Filtered

Shown in figure 1 below, used as either a multiplexer or a demultiplexer. Only pre filters are used in this device, therefore it should be used in multiplexers where channel isolation is not an issue, or in demultiplexers where the nearest neighbour (downstream) is at least 400GHz away from any of the channels. The single filters give the benefits of lower insertion loss and cost.

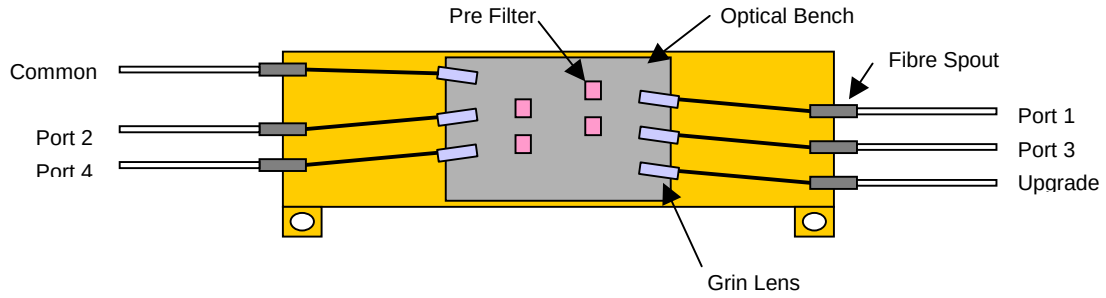

Figure 1 - MX4*-113 single filtered layout

Performance

Parameter	Min	Typ	Max	Units
Insertion loss (all ports) (including 1 connector loss)		1.5	2.2	dB
Insertion loss (upgrade)		1.2	1.6	dB
Isolation all channels		20		dB
Passband transmission variation (for 0.2nm source tolerance)			0.5	dB
Return loss	-40			dB
Differential channel loss			1.5	dB
PDL across passband		0.15	0.3	dB
Operating Temperature	0		55	ºC
Storage Temperature	-40		85	ºC

2.1.2. 4 Channel - Double Filtered

Shown in figure 2 below, used as a demultiplexer. Both pre and post filters are used in this device, therefore it can be used where nearest neighbour channels downstream are 200GHz away. The double filters give the benefit of higher adjacent channel isolation.

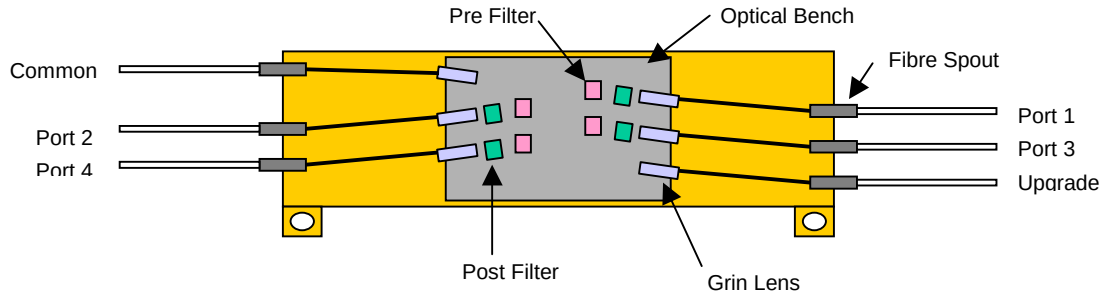

Figure 2 - DMX4*-113 all double filtered layout

Performance

Parameter	Min	Typ	Max	Units
Insertion loss (all ports) (including 1 connector loss)		1.7	2.6	dB
Insertion loss (upgrade)		1.2	1.6	dB
Crosstalk Adjacent Channel All other Channels	 -30 -45			 dB dB
Passband transmission variation (for 0.2nm source tolerance)			0.5	dB
Return loss			-40	dB
Differential channel loss			1.5	dB
PDL across passband		0.15	0.3	dB
Operating Temperature	0		55	ºC
Storage Temperature	-40		85	ºC

2.1.3 4 Channel - Single and Double filtered

Shown in figure 3 below, used as a demultiplexer or a bi-directional 2 channel multiplexer/demultiplexer. Ports 1 & 2 have pre and post filters, ports 3 & 4 have pre filters only. Port 1 & 2 filter out adjacent channels to port 3 & 4, leaving port 3 & 4 spaced by 400GHz meaning only single filters are necessary These devices combine the benefits of the lower cost of single filtered devices and also give higher channel isolation associated with a double filtered device.

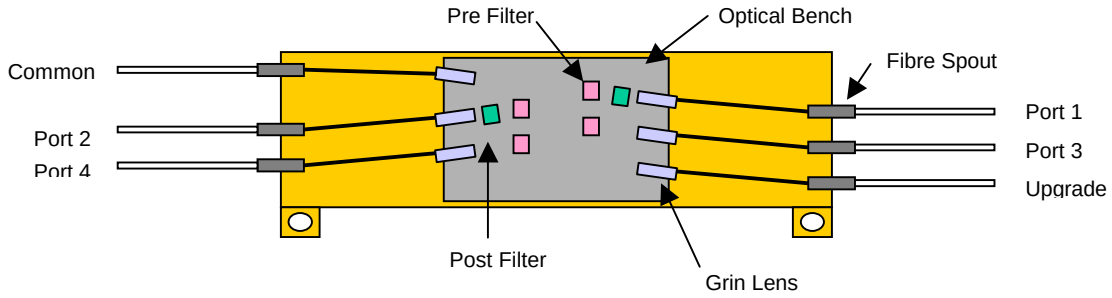

Figure 3 - DMX4*-113 Double and Single filtered layout

Note: For best channel isolation no upgrade channels passing through the device should less than 400GHz from port 3 or 4.

Performance

Parameter	Min	Typ	Max	Units
Insertion loss (including 1 connector loss) Port 1 & 2 Port 3 & 4		 1.7 1.5	 2.6 2.2	 dB dB
Insertion loss (upgrade)		1.2	1.6	dB
Crosstalk port 1 & 2 Adjacent Channel All other Channels	 -30 -45			 dB dB
Crosstalk port 3 & 4 Non adjacent Channels			 -45	 dB
Passband transmission variation (for 0.2nm source tolerance)			0.5	dB
Return loss	-40			dB
Differential channel loss			1.5	dB
PDL across passband		0.15	0.3	dB
Operating Temperature	0		55	ºC
Storage Temperature	-40		85	ºC

2.1.4 8 Channel Mux

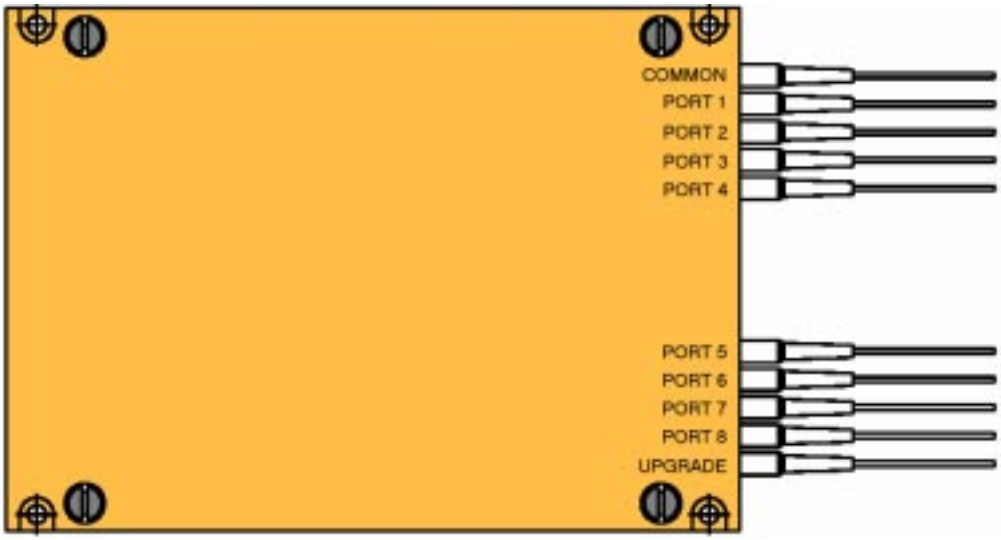

Figure 4 – MX8*-114

Performance

Parameter	Min	Typ	Max	Units
Insertion loss (ports 1-4) Insertion loss (ports 5-8) (including 1 connector loss)		1.5	2.2 3.8	dB dB
Insertion loss (upgrade)			3.5	dB
Isolation all channels		20		dB
Passband transmission variation (for 0.2nm source tolerance)			0.5	dB
Return loss	-40dB			dB
Differential channel loss (overall) Ports 1 – 4 Ports 5 – 8			2.0 1.5 1.5	dB dB dB
PDL across passband		0.15	0.3	dB
Operating Temperature	0		55	ºC
Storage Temperature	-40		85	ºC

2.1.5 8 Channel Demux

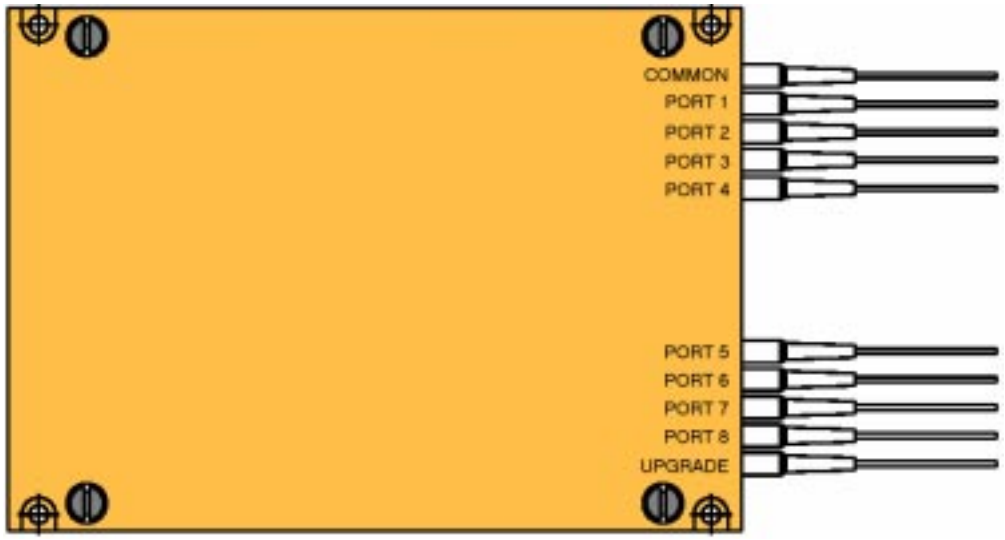

Figure 5 – DMX8*-114

Performance

Parameter	Min	Typ	Max	Units
Insertion loss (ports 1-4) Insertion loss (ports 5-8) (including 1 connector loss)		1.5	2.6 3.8	dB dB
Insertion loss (upgrade)			3.5	dB
Crosstalk Adjacent Channel All other Channels	 -30 -45			 dB dB
Passband transmission variation (for 0.2nm source tolerance)			0.5	dB
Return loss	-40			dB
Differential channel loss (overall) Ports 1 – 4 Ports 5 – 8			2.0 1.5 1.5	dB dB dB
PDL across passband		0.15	0.3	dB
Operating Temperature	0		55	ºC
Storage Temperature	-40		85	ºC

3.0 Standard Mux & Demux

3.1 Standard 4 channel plans

Below is a list of the standard 4 channel part numbers and their port assignments

3.1.1 MX41-113 & DMX41-113 Channel plan

MX41-113 uses a single filtered package (see figure 2), DMX41-113 uses a Single and Double filtered package which has double filters on ports 1 & 2 and single filters on ports 3 & 4 (see figure 3).

Port 1	Channel 59	1530.33nm
Port 2	Channel 55	1533.47nm
Port 3	Channel 57	1531.90nm
Port 4	Channel 53	1535.04nm

3.1.2 MX42-113 & DMX42-113 Channel plan

MX42-113 uses a single filtered package (see figure 2), DMX42-113 uses a Single and Double filtered package which has double filters on ports 1 & 2 and single filters on ports 3 & 4 (see figure 3).

Port 1	Channel 49	1538.19nm
Port 2	Channel 45	1541.35nm
Port 3	Channel 47	1539.77nm
Port 4	Channel 43	1542.94nm

3.1.3 MX43-113 & DMX43-113 Channel plan

MX43-113 uses a single filtered package (see figure 2), DMX43-113 uses a Single and Double filtered package which has double filters on ports 1 & 2 and single filters on ports 3 & 4 (see figure 3).

Port 1	Channel 35	1549.32nm
Port 2	Channel 31	1552.52nm
Port 3	Channel 37	1547.72nm
Port 4	Channel 33	1550.92nm

3.1.4 MX44-113 & DMX44-113 Channel plan

MX44-113 uses a single filtered package (see figure 2), DMX44-113 uses a Single and Double filtered package which has double filters on ports 1 & 2 and single filters on ports 3 & 4 (see figure 3).

Port 1	Channel 25	1557.36nm
Port 2	Channel 21	1560.61nm
Port 3	Channel 27	1555.75nm
Port 4	Channel 23	1558.98nm

3.1.5 MX45-113 & DMX45-113 Channel plan

MX45-113 uses a Single filtered package (see figure 1), DMX45-113 uses a Double filtered package (see figure 2). Channel spacing is at 400GHz but this gives advantages when upgrading to 8 channels as discussed in section 4.

Port 1	Channel 33	1550.92nm
Port 2	Channel 29	1554.13m
Port 3	Channel 25	1557.36nm
Port 4	Channel 21	1560.61nm

3.1.6 MX46-113 & DMX46-113 Channel plan

MX46-113 uses a Single filtered package (see figure 1), DMX46-113 uses a Double filtered package (see figure 2). Channel spacing is at 400GHz but this gives advantages when upgrading to 8 channels as discussed in section 4.

Port 1	Channel 35	1549.32nm
Port 2	Channel 31	1552.52nm
Port 3	Channel 27	1555.75nm
Port 4	Channel 23	1558.98nm

3.1.7 MX47-113 & DMX47-113 Channel plan

MX47-113 uses a Single filtered package (see figure 1), DMX47-113 uses a Double filtered package (see figure 2). Channel spacing is at 400GHz but this gives advantages when upgrading to 8 channels as discussed in section 4.

Port 1	Channel 57	1531.90nm
Port 2	Channel 53	1535.04nm
Port 3	Channel 49	1538.19nm
Port 4	Channel 45	1541.35nm

3.1.8 MX48-113 & DMX48-113 Channel plan

MX48-113 uses a Single filtered package (see figure 1), DMX48-113 uses a Double filtered package (see figure 2). Channel spacing is at 400GHz but this gives advantages when upgrading to 8 channels as discussed in section 4.

Port 1	Channel 59	1530.33nm
Port 2	Channel 55	1533.47nm
Port 3	Channel 51	1536.61nm
Port 4	Channel 47	1539.77nm

3.2 Standard 8 channel Mux & Demux

3.2.1 MX81-114

MX81-114 uses two single filtered packages (see figure 1).

Port 1	Channel 35	1558.98nm
Port 2	Channel 31	1555.75nm
Port 3	Channel 27	1555.75nm
Port 4	Channel 23	1558.98nm
Port 5	Channel 33	1550.92nm
Port 6	Channel 29	1554.13m
Port 7	Channel 25	1557.36nm
Port 8	Channel 21	1560.61nm

3.2.2 MX82-114

MX82-114 uses two single filtered packages (see figure 1).

Port 1	Channel 59	1530.33nm
Port 2	Channel 55	1533.47nm
Port 3	Channel 51	1536.61nm
Port 4	Channel 47	1541.35nm
Port 5	Channel 57	1531.90nm
Port 6	Channel 53	1535.04nm
Port 7	Channel 49	1538.19nm
Port 8	Channel 45	1541.35nm

3.2.3 DMX81-114

DMX81-114 uses one single filtered packages (see figure 1) and one double filtered package (see figure 2).

Port 1	Channel 33	1550.92nm
Port 2	Channel 29	1554.13nm
Port 3	Channel 25	1557.36nm
Port 4	Channel 21	1560.61nm
Port 5	Channel 35	1549.32nm
Port 6	Channel 31	1552.52nm
Port 7	Channel 27	1555.75nm
Port 8	Channel 23	1558.98nm

Note: To achieve Crosstalk performance Channel 37 should not pass through this DEMUX.

3.2.3 DMX82-114

DMX82-114 uses one single filtered packages (see figure 1) and one type 2 double filtered package (see figure 2)

Port 1	Channel 57	1531.90nm
Port 2	Channel 53	1535.04nm
Port 3	Channel 49	1538.19nm
Port 4	Channel 45	1541.35nm
Port 5	Channel 59	1530.33nm
Port 6	Channel 55	1533.47nm
Port 7	Channel 51	1536.61nm
Port 8	Channel 47	1539.77nm

Note: To achieve Crosstalk performance Channel 61 should not pass through this DEMUX.

4.0 Application

4.1 4 Channel DWDM systems MUX & DEMUX

4.1.1 400GHz spacing

If only 400GHz spacing is required then a MUX (single filtered) device can be used as both a Multiplexer and Demultiplexer. With 400GHz spacing adjacent channel isolation will be >40dB using the single filtered device type, usually sold as a multiplexer. 4 Standard parts are available suitable for this purpose: -

MX45-113
MX46-113
MX47-113
MX48-113

These devices have lower insertion loss and costs when used as a DEMUX.

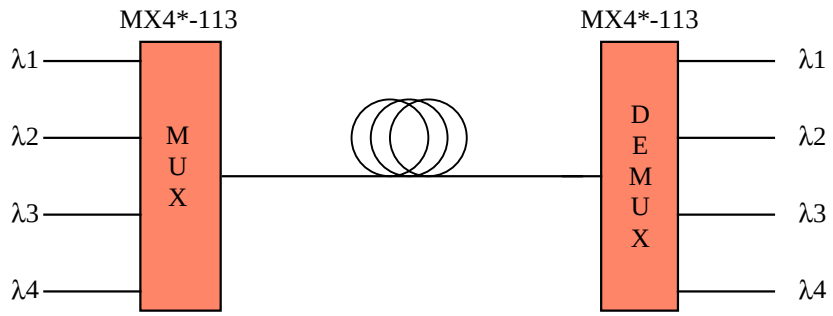

Figure 6 – 400GHz Spacing multiplexer/demultiplexer

This system may also be used bi-directionally if required.

4.1.2 200GHz spacing

If 200GHz spacing is required then double filtering needs to be performed in the demultiplexer. To reduce cost less filters can be used by having two channels double filtered and two channels single filtered. Care must be taken to ensure that no channel is passing through to the upgrade port that is less than 400GHz from a single filtered channel. 4 standard Multiplexer and Demultiplexer plans are available for this application: -

Multiplexer	Demultiplexer
MX41-113	DMX41-113
MX42-113	DMX42-113
MX43-113	DMX43-113
MX44-113	DMX44-113

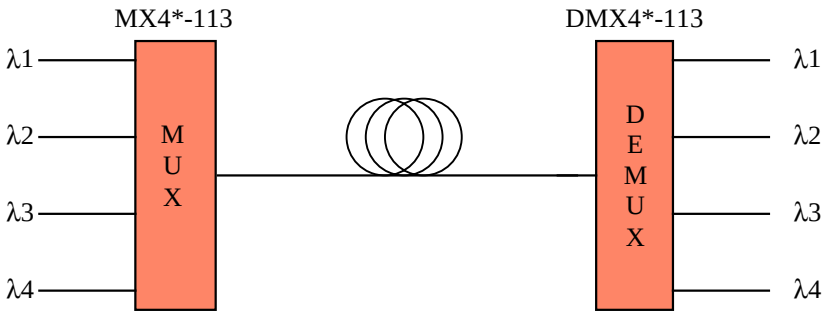

Figure 7 – 200GHz Spacing multiplexer/demultiplexer

The demultiplexer can also be implemented in a 2 Channel 200GHz spacing bi-directional system if required.

4.2 8 Channel DWDM systems MUX & DEMUX

8 channel 200GHz plans can implemented using either; two 4 channel parts - starting with 4 channels and upgrading to 8 when necessary; using the 8 channel mux/demux package which contains two standard primary packages.

4.2.1 2 x 4 channels at 200GHz spacing

This system is built with a single filtered multiplexer and a double filtered demultiplexer spaced at 400GHz a second pair is then added via the upgrade ports meaning channels can be added without interrupting transmission.

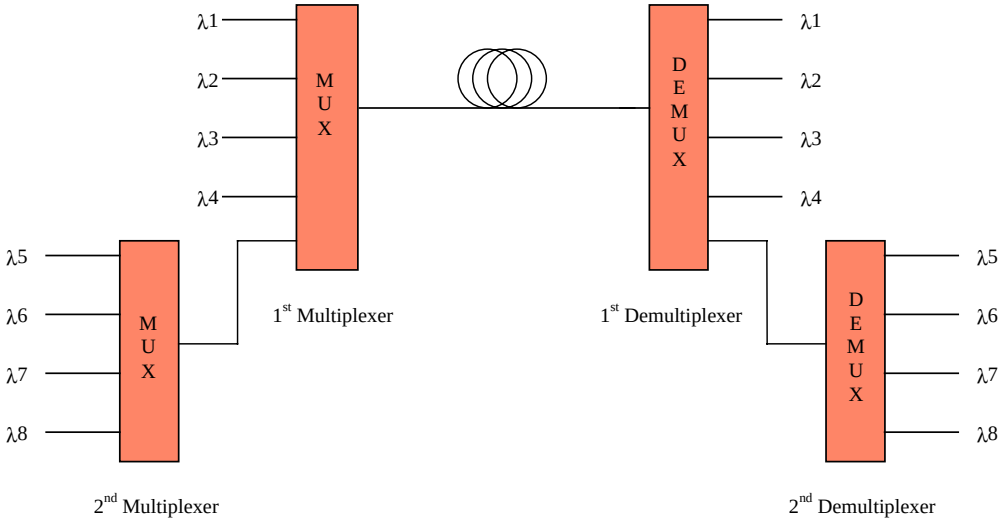

Figure 8 – 200GHz Spacing 8 channel multiplexer/demultiplexer

Part numbers are: -

1st Multiplexer	1st Demultiplexer	2nd Multiplexer	2nd Demultiplexer
MX45-113	DMX45-113	MX46-113	MX46-113
MX46-113	DMX46-113	MX45-113	MX45-113
MX47-113	DMX47-113	MX48-113	MX48-113
MX48-113	DMX48-113	MX47-113	MX47-113

The upgrade demultiplexers are only single filters and so compensate for some of the additional loss from the upgrade path. If transmission can be interrupted then the overall channel losses can be equalised by swapping the first and second multiplexers around.

4.2.2 4 channel Bi-directional at 200GHz spacing

A 4 channel bi-directional system with interleaved channels is achieved in the following manner: -

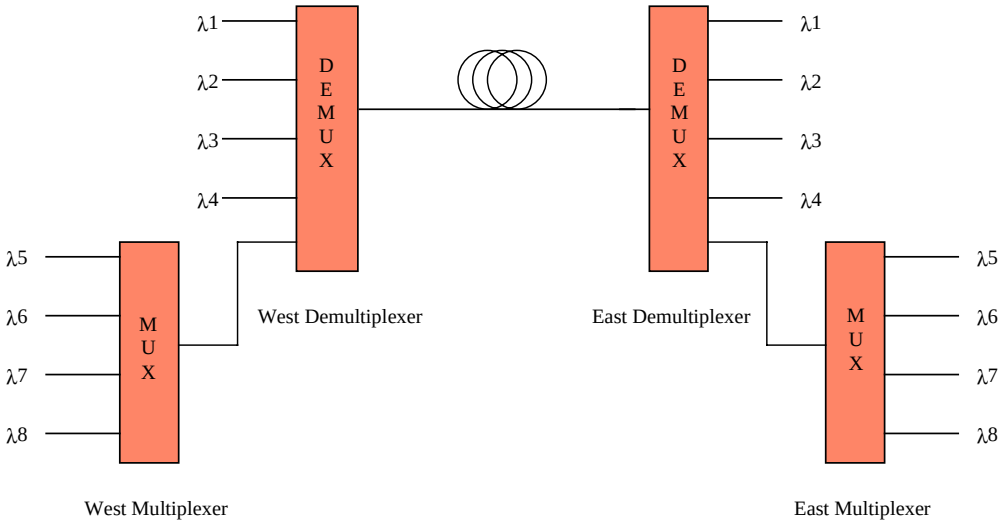

Figure 9 – 4 channel Bi-directional multiplexer/demultiplexer

Part numbers are: -

West Multiplexer	East Demultiplexer	East Multiplexer	West Demultiplexer
MX45-113	DMX45-113	MX46-113	DMX46-113
MX46-113	DMX46-113	MX45-113	DMX45-113
MX47-113	DMX47-113	MX48-113	DMX48-113
MX48-113	DMX48-113	MX47-113	DMX47-113

4.2.3 8 channel MUX/DEMUX at 200GHz spacing

Using the standard secondary housed 8 channel multiplexer/demultiplexer an 8 channel solution

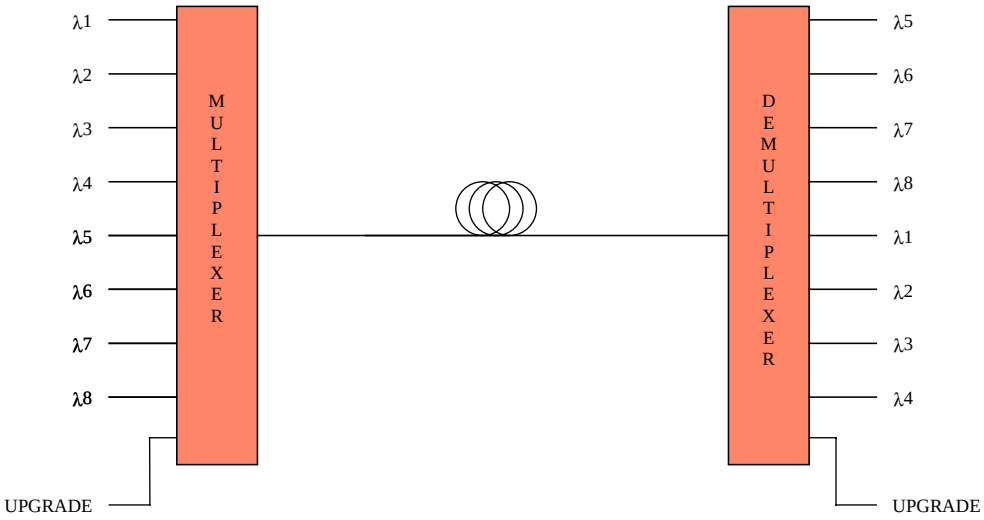

Figure 10 – 8 channel multiplexer/demultiplexer

Part numbers are: -

Multiplexer	Demultiplexer
MX81-114	DMX81-114
MX82-114	DMX82-114

4.3 16 Channel DWDM systems MUX & DEMUX

4.3.1 16 channel MUX/DEMUX at 200GHz spacing

Using the standard primary packaged 4 channel multiplexer/demultiplexer for a 16 channel solution

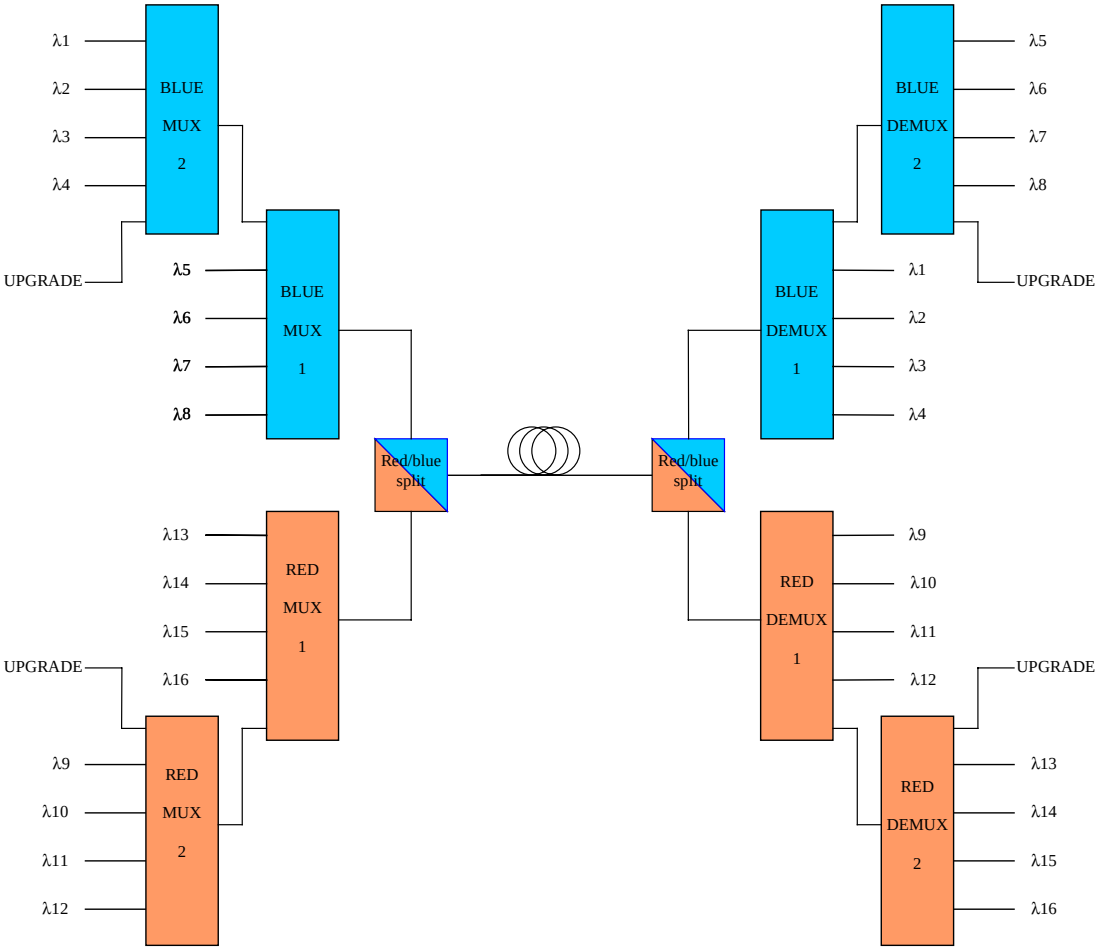

Figure 11 – 8 channel multiplexer/demultiplexer

Part numbers are: -

Multiplexer	Demultiplexer
RED MUX 1 – MX46-113	RED DEMUX 1 – DMX45-113
RED MUX 2 – MX45-113	RED DEMUX 2 – MX46-113
BLUE MUX 1 – MX48-113	BLUE DEMUX 1 – DMX47-113
BLUE MUX 2 – MX47-113	BLUE DEMUX 1 – MX48-113

4.3.2 16 channel MUX/DEMUX at 200GHz spacing

Using the standard secondary housed 8 channel multiplexer/demultiplexer for a 16 channel solution

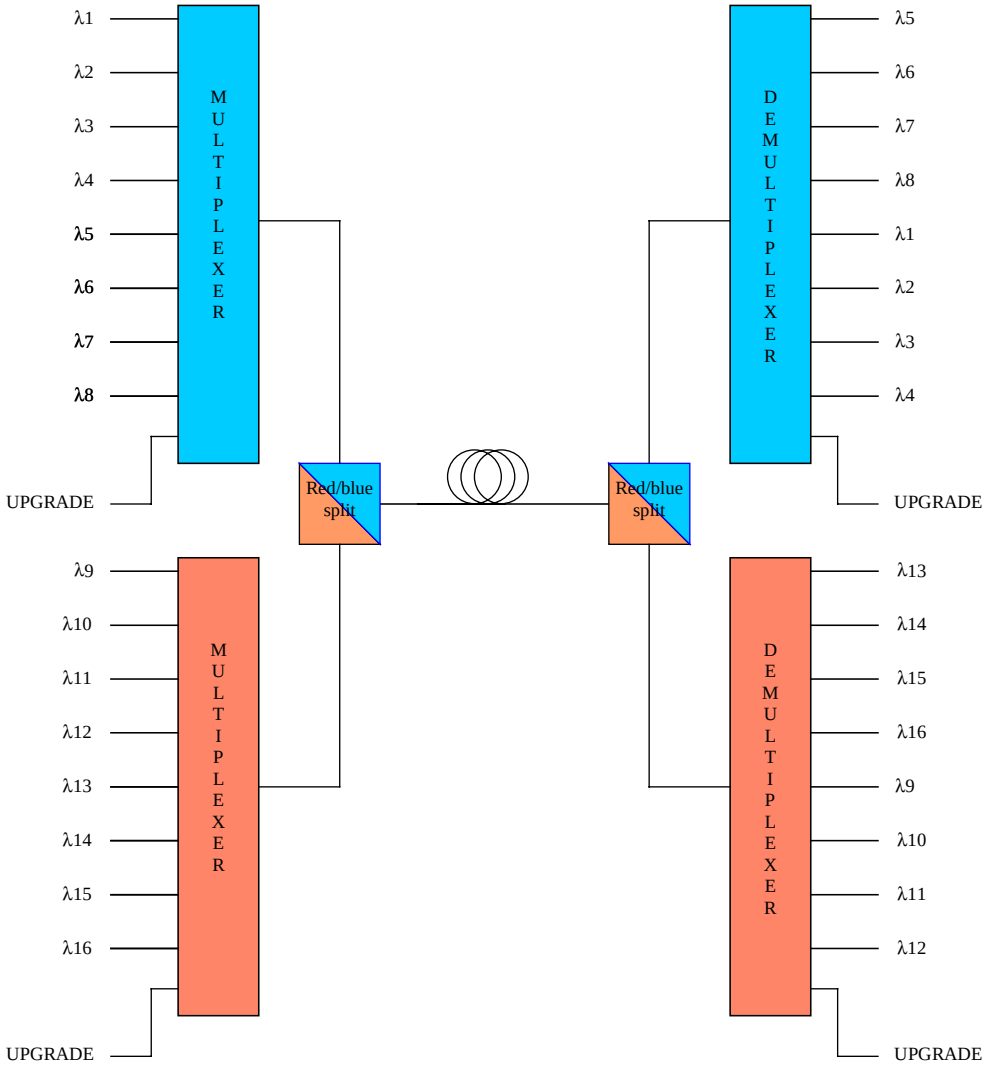

Figure 12 – 16 channel multiplexer/demultiplexer

Part numbers are: -

Multiplexer	Demultiplexer
MX81-114 & MX82-114	DMX81-114 & DMX82-114

4.3.3 8 channel bi-directional MUX/DEMUX at 200GHz spacing

Using the standard secondary housed 8 channel multiplexer/demultiplexers for a Bi-directional 8 channel solution.

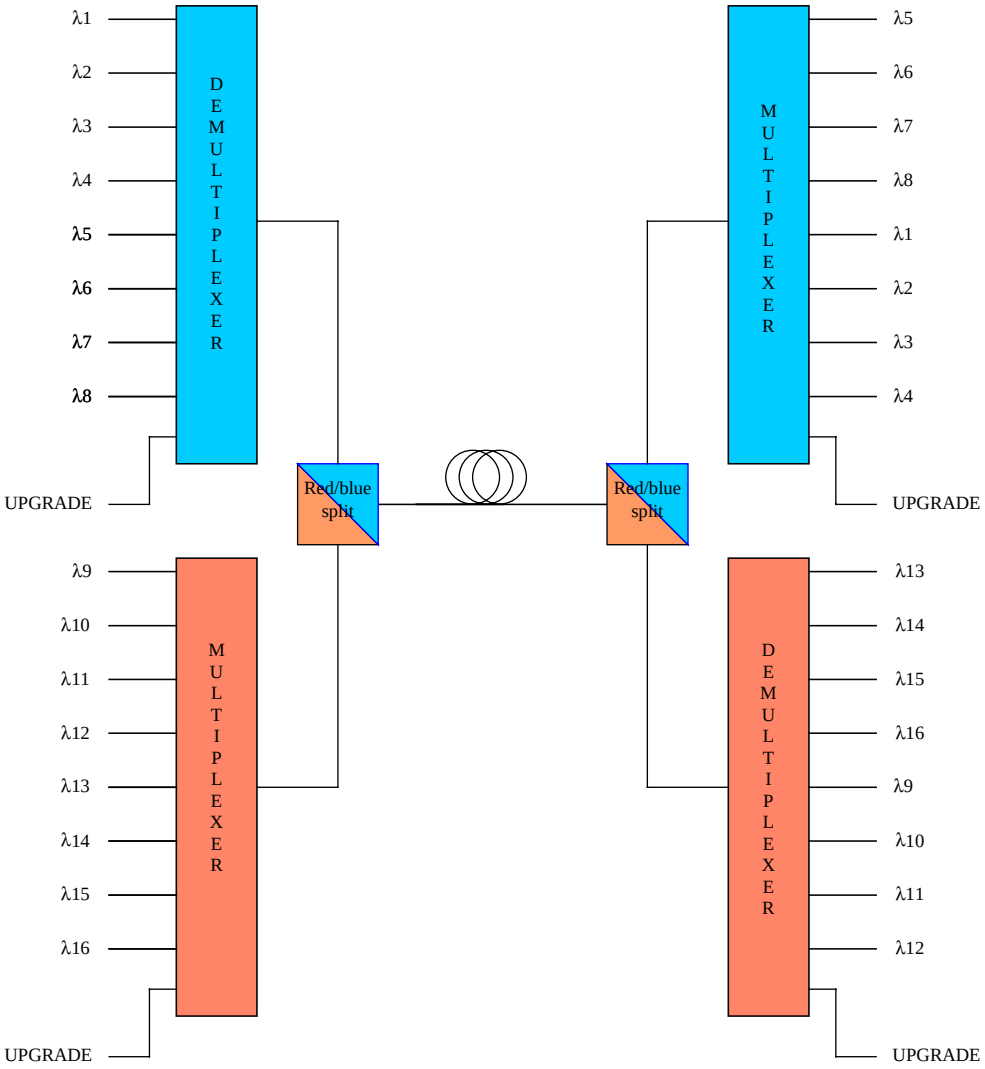

Figure 13 – 8 channel bi-directional multiplexer/demultiplexer

Part numbers are: -

Multiplexer	Demultiplexer
MX81-114 & MX82-114	DMX81-114 & DMX82-114

4.4 Add/Drop solutions

4.4.1 4 channel ADD/DROP at 200GHz spacing

Using the standard primary packaged 4 channel multiplexer/demultiplexer for an add/drop ring.

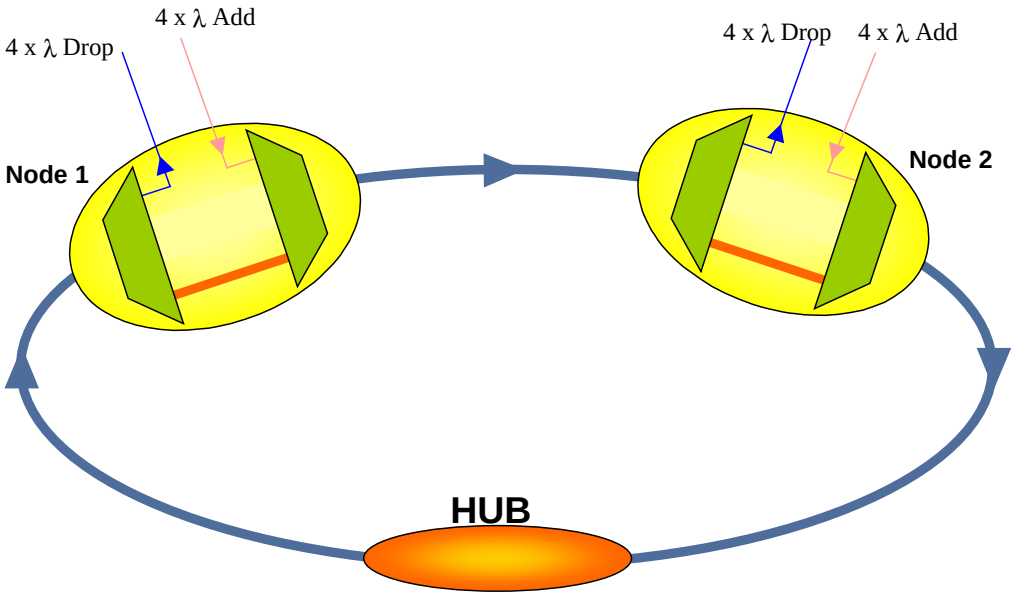

Figure 14 – 4 channel add/drop

Standard suitable part numbers are: -

Add	Drop
RED ADD 1 – MX45-113	RED DROP 1 – DMX45-113
RED ADD 2 – MX46-113	RED DROP 2 – MX46-113
BLUE ADD 1 – MX47-113	BLUE DROP 3 – DMX47-113
BLUE ADD 2 – MX48-113	BLUE DROP 4 – MX48-113

6.0 Dimensions

6.1 Dimensions and input/output

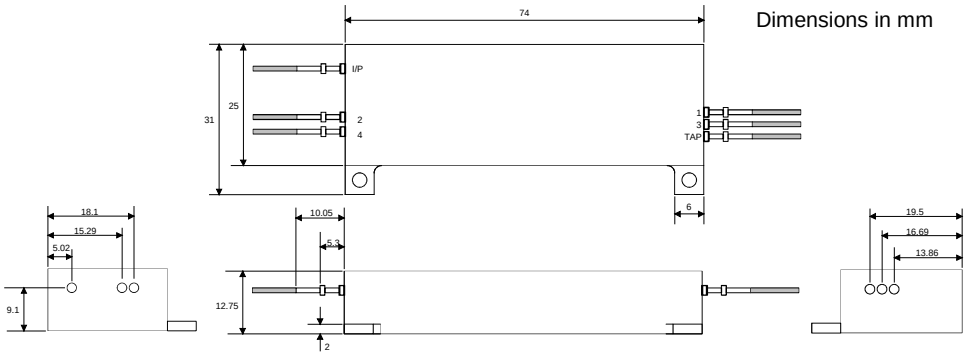

Figure 15 – 4 channel Outline drawing

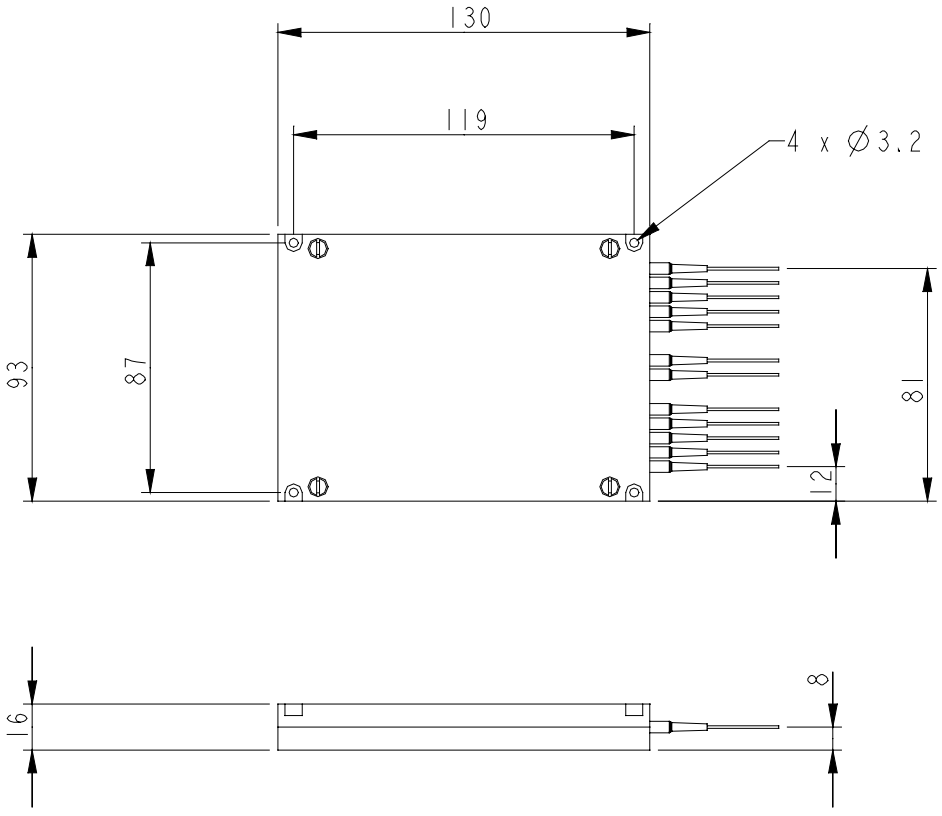

Figure 16 – 8 channel Outline drawing

7.0 Associated Nortel Networks documentation

Further details are available on request. These include documentation on product performance and testing.

The dielectric filter series datasheets PB0029 & PB0115 provide a detailed breakdown of parameters and ordering information.

The Qualification Report QR1334 details all qualification tests performed to Bellcore GR-1221-CORE, “Reliability Requirements for Passive Optical Components”.