O- and E-Band CWDM Optical Interleavers

Rev. 1.6

Revision History

Rev.	Date	Revision History	Originated	Signed by
1.0	7/12/2018	Initial Release	Nick Xiao	James Pang
1.1	8/21/2018	Removed the rubber boot and added 10cm loose tube. Updated Figure 6.1	Nick Xiao	James Pang
1.2	9/28/2018	Removed the loose tube. Updated Figure 6.1	Nick Xiao	James Pang
1.3	10/11/2018	Added signal wavelength -frequency table for CWDM channels	Nick Xiao	James Pang
1.4	10/18/2018	Added 1431 and 1451 channels Revised the stop-band width to CFC +/-8GHz for temperature range from -5ºC to +65ºC. Added Appendix A for Channel Plan	Nick Xiao	James Pang
1.5	10/26/2018	Per customer request, changed to Fiber length changed to >= 1.5m Metal package height 8.5mm Fiber type: ITU-T 657 A2	Nick Xiao	Gary Wang
1.6	04/02/2019	Revised IL in Table 5.5 to 1.6 Revised IL in Table 5.6 to 1.9 Revised 7. Label Requirements	Songtao Du	James Pang

Product Specification

1. Introduction

Optoplex's **Optical Interleaver** products are based on our patented *Step-Phase Interferometer* design. Used as a Demux (or Mux) device, an optical interleaver separates (or combines) the Even and Odd channel signals (see the schematic diagram below). Each optical interleaver device is optimized to cover either C-, L-, O-, or E-band wavelengths, with the option of covering C+L band. The current optical interleaver product family supports 100-200, 50-100, 25-50 GHz channel spacing, as well as other custom channel spacings. The Demux and Mux interleavers can be effectively co-packaged into a single box for easy handling and cost-saving. Dual-stage optical interleavers (such as 25-100 GHz) and asymmetric interleavers (Even and Odd channels have different passband widths) are also available.

Key Features and Benefits

- Wide and flat passband
- Minimal PDL
- High channel isolation
- Minimal thermal drift
- Low and customizable dispersion
- Low insertion loss & IL uniformity
- Dual C- and L-band coverage
- Demux/Mux copackaged solution available
- Asymmetric/uneven optical interleaver available
- Telcordia GR-1221/63 qualified

Figure 1, Photos of a standard interleaver device

Applications

- Extend existing network capacity
- Bridge existing & new DWDM platforms
- System upgrade
- Bi-directional networks
- Total signal power detection for Raman amplifier
- Multi-wavelength transponder
- Flat-top comb filter

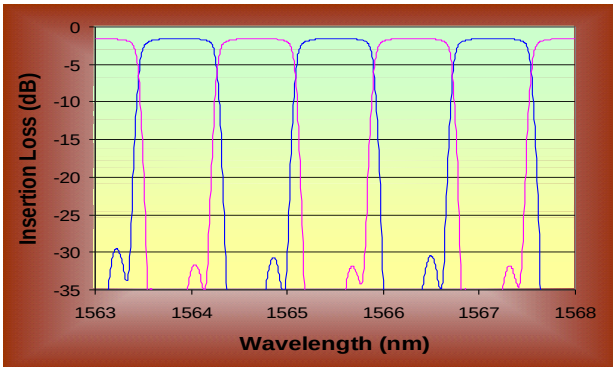

Figure 2, Typical optical spectra of 50-100GHz interleaver

This specification document is particularly for interleavers specially designed and manufactured for CWDM application operating in an extended temperature range from -30°C to +65°C.

2. Absolute Maximum Ratings

Table 2.1, Absolute Maximum Ratings

MSID	Parameter	Symbol	Unit	Conditions	Ratings		Notes
					Min	Max	
2.01	Total Input Optical Power	P_{in_Max}	*mW*		-	500	Common Port
2.02	Maximum optical input power per channel port	$P_{max,\ ch}$	*mW*			500	
2.03	Operating Temperature	T_c	*°C*		−40	+85	
2.04	Operating Humidity	-	*%RH*	T_c = +65°C, Non-condensing	0	95	
2.05	Storage Temperature	T_{stg}	*°C*		−40	+85	
2.06	Storage Humidity	-	*%RH*	T_c = +85°C, Non-condensing	0	95	
2.07	ESD, JEDEC Std, Method A114-D; Human Body Model Contact discharge		*kV*			16	

3. Operating Conditions

Table 3.1, Operating Conditions

MSID	Parameter	Symbol	Unit	Conditions	Ratings			Notes
					Min	Typ.	Max	
3.01	Input Optical Power	P_{in_Max}	*mW*		-		**300**	Common Port
3.02	Operating Temperature	T_c	*°C*		-30		+85	
3.03	Operating Humidity	-	*%RH*		0		85	
3.04	Storage Temperature	T_{stg}	*°C*		−40		+85	
3.05	Storage Humidity	-	*%RH*		0		85	
3.06	Module Weight	W	*kg*					

4. Performance Parameters and Definitions

Please note that in this Section, figures, tables and numbers are used to illustrate the definitions of parameters only. For the specific requirements of the interleaver product, the performance requirements are stated in Section-5

4.1 Optical configuration

Figure 4.1: Configuration of the optical interleaver

4.2 Optical Requirements

Unless noted otherwise, the optical specifications apply to a case temperature range of T_{OP} and for all polarization states.

4.2.1 Channel plan

The module must support the following nominal signal frequencies (ITU wavelength grid).

Table 4.1, channels plan

Interleaver – Type	Frequencies
50 GHz Interleaver for C-Band	f_{Ci} = (191.30 + i * 0.05) THz ***)**

*) for i ∈ {1, 2, 3, ..., n}; n = 96.

Frequencies resp. wavelength on **OUTPUT 1** are f_{ci} resp λ_i with **i = 1, 3, 5, …, 93, 95. [Odd Channels]**

Frequencies resp. wavelength on **OUTPUT 2** are f_{ci} resp λ_i with **i = 2, 4, 6, …, 94, 96. [Even Channels]**

Notes:

1) *Table 4.1 uses a 50GHz (FSR) as an example and assumes the channels are aligned with ITU grids.*
2) *Detail FSR and channel center frequency (CCF) alignment, for the product described in this document, please refer to Section 5.*

Wavelength range
Applicable for the whole specification if not mentioned otherwise

Table 4.2, Wavelength range

Interleaver – type	Wavelength range
50 GHz Interleaver for C-Band	1528.77 nm ≤ λ_S ≤ 1566.72 nm equivalent to 191.35 THz ≤ f_S ≤ 196.1 THz

Note: Table 4.2 is for parameter definition purpose ONLY. Detail requirements for the product, please refer to Section 5.

4.2.3 Optical requirement definitions

In this section the most important optical requirements and its definitions are described.

Specification Passband and Stopband
The specification passband B_{pi} is the spectral range around the respective ITU frequency f_{ci} over which associated specifications are defined.

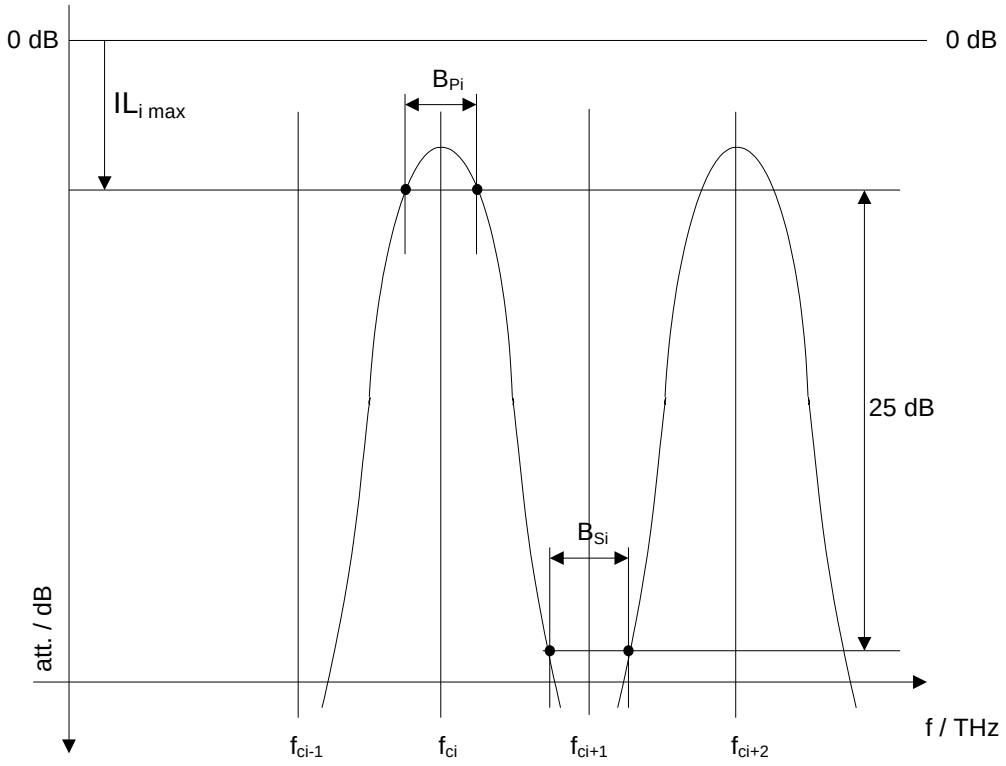

Figure 4.2: Definition of passband and stopband

Bandwidth (Clear Channel Passband) and Wavelength Accuracy
As shown in the following figure, the red and blue transmission bandwidths $\Delta\nu_{red}(n)$ and $\Delta\nu_{blue}(n)$ are defined as the widths of T_{ave} at n dB down from the peak, with respect to the ITU frequency. The n dB clear channel passband BW(n) and wavelength accuracy WA(n) are defined as

$$BW(n) = 2 \cdot \mathrm{MIN}\left[\Delta\nu_{red}(n), \Delta\nu_{blue}(n)\right]$$

$$WA\ (n) = \frac{1}{2}\left[\Delta\nu_{blue}(n) - \Delta\nu_{red}(n)\right]$$

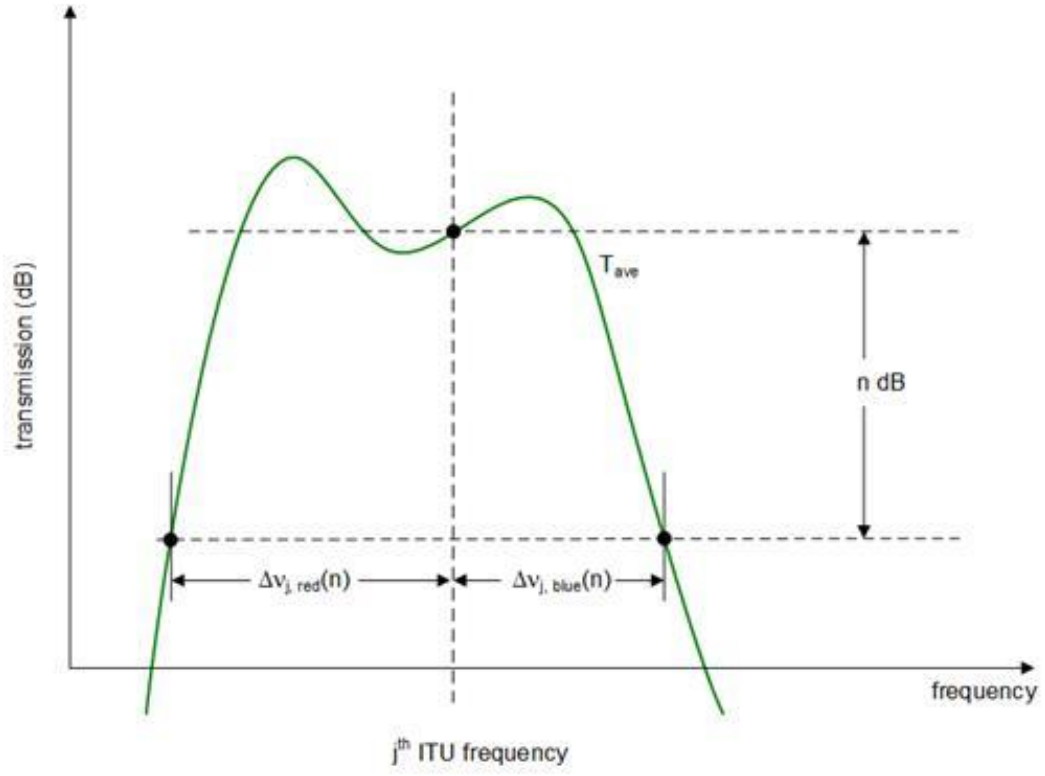

Figure **4.3**: Illustration of bandwidth parameter definitions

Insertion Loss (positive temperature coefficient assumed)
The insertion loss (IL) in [dB] is defined as the difference between the input power and the output power of each channel averaged over the specification passband.

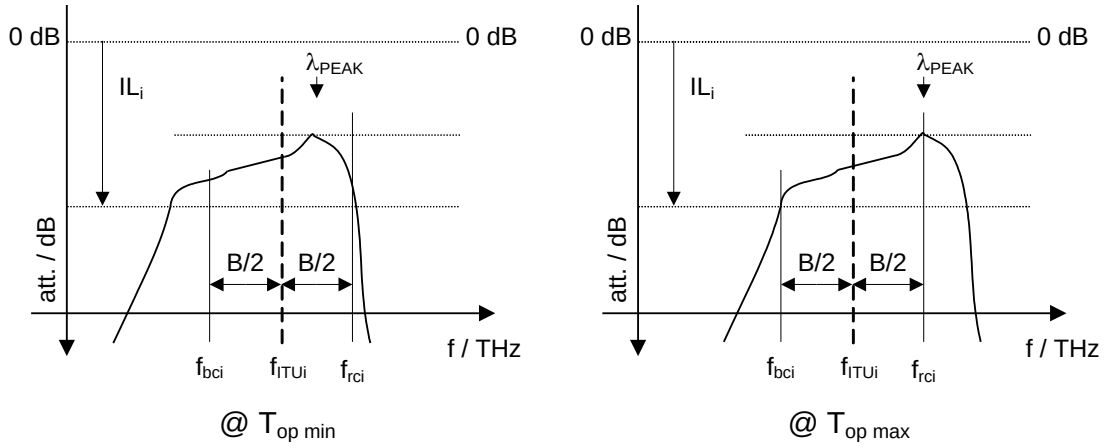

Figure 4.4: Definition of insertion loss

Best Case Insertion Loss

Best case insertion loss IL_{best} is defined as the minimum IL over all SOP across the BW_{SP}. This parameter is important for laser safety considerations.

Insertion Loss Uniformity

The insertion loss uniformity ($\Delta IL_{1\text{-}n}$) in [dB] is the total IL variation (difference between max and min values) across all channels, measured within the specification bandwidth.

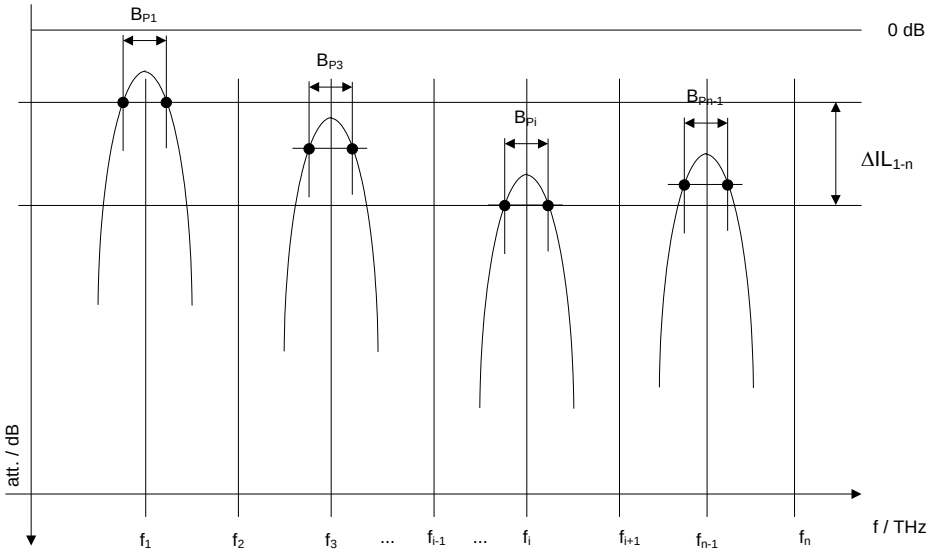

Figure **4.5**: Definition of insertion loss uniformity

Insertion loss ripple

The insertion loss ripple (ΔIL_{SP}) is the difference between the maximum and minimum optical power within the specification passband of a particular WDM channel.

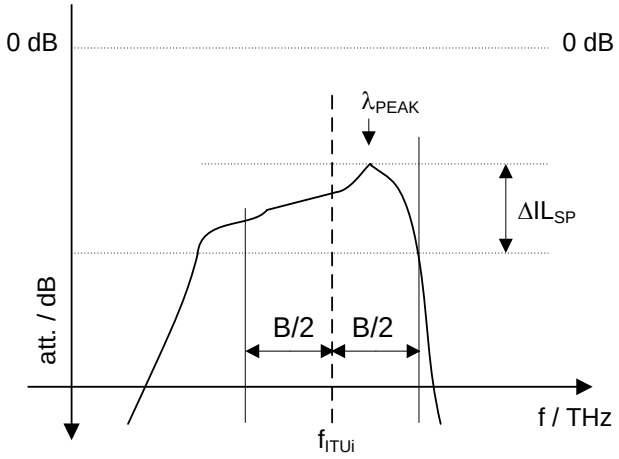

Figure 4.6: Definition of insertion loss ripple

Polarization Dependent Loss

Polarization dependent loss of channel j (PDL_j) is defined as the variation of transmission loss across the specification passband B_{Pj} over all SOP.

$$PDL_j = \underset{\nu \in B_{Pj}}{\mathrm{MAX}}\left[T_{\max}(\nu)/T_{\min}(\nu)\right]$$

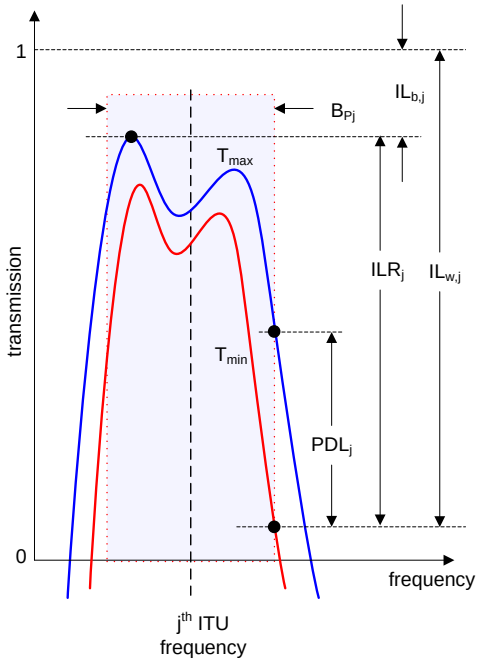

Figure **4.7**: Definition of IL_w, IL_b, ILR and PDL of j^{th} wavelength channel.

Isolation (Stopband)

The isolation ISO(x) is defined as the difference between the IL of a passband channel at $\nu_{ITU,j+1}$ around ITU frequency and the IL at the edge of the passband channel if the edges of the two passband channels ($\nu_{ITU,j-1}$ and $\nu_{ITU,j+1}$) next to the stopband $\nu_{ITU,j}$ are separated by ±x GHz.

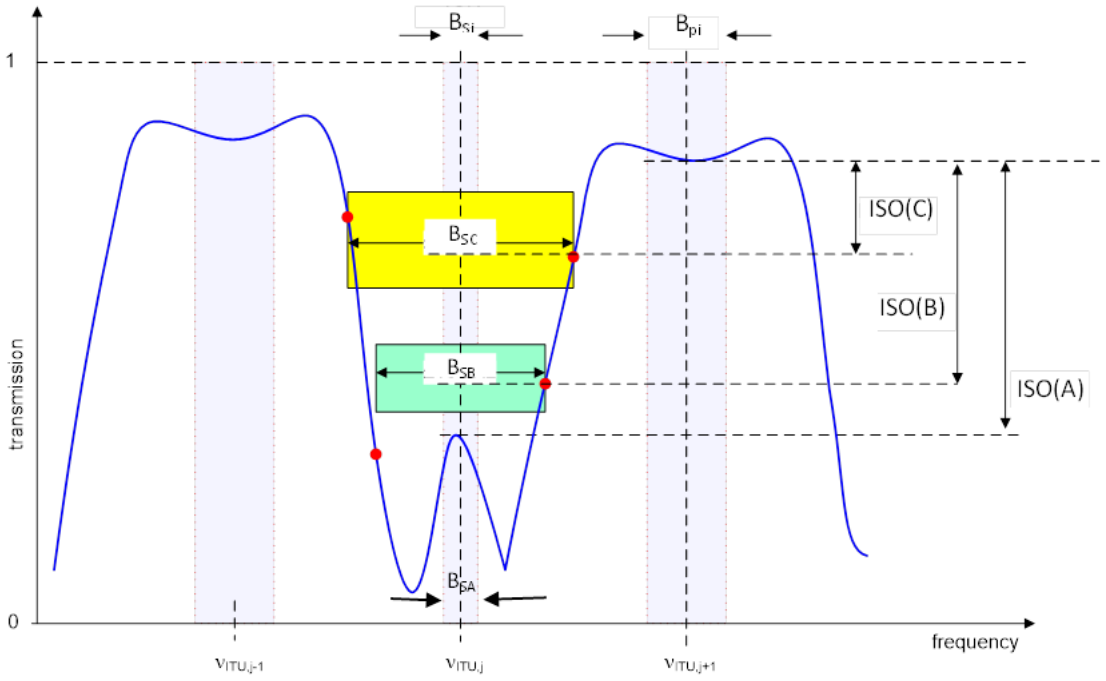

Figure **4.8**: Definition of isolation *(example for illustration)*

Return Loss

The return loss RL of a channel is the maximum reflected signal within the B_{Pi} of the selected channel for any SOP, referenced to the incident signal level.

Directivity

The directivity DI of a channel is the maximum signal from that channel port measured at any other than the selected channel ports within any B_{Pi} for all SOP, referenced to the incident signal level.

Polarization Mode Dispersion

The polarization mode dispersion PMD of a channel is the maximum difference in group delay between all SOP within the B_{Pi}.

Dispersion

The dispersion CD is determined from the group delay by using a polynomial of at least fourth order. The group delay is measured with a spectral resolution ≤ 2 GHz (modulation frequency ≤ 2 GHz, wavelength step size ≤ 4 pm) within the passband ±8 GHz.

5. Optical Performance Specification

5.1 List of Part Numbers

Table 5.1, Part number, Wavelength Range and FSR

CWDM	Interleaver MPN	Wavelegnth Range (nm)		FSR (GHz)			Note
Channel		Min	Max	Min	Max	Avg	
1271	IL-Q1RCXXC1271	1271	1278	68.02	68.57	68.3	
1291	IL-Q1RCXXC1291	1291	1298	65.94	66.47	66.2	
1331	IL-Q1RCXXC1331	1331	1338	62.05	62.53	62.3	
1351	IL-Q1RCXXC1351	1351	1358	60.24	60.7	60.5	
1431	IL-E1RCXXC1431	1431	1437	53.74	54.13	53.9	
1451	IL-E1RCXXC1451	1451	1457	52.28	52.25	52.3	

Notes

1) The customer signals are equally spaced in wavelength (nm), i.e., 0.37nm.
2) However, in interleaver design, the channel spacing (FSR) is equally spaced in frequency (GHz). So the interleaver FSR for each interleaver (each CWDM channel) will be specified in GHz as shown in Table 5.1 above, column “FSR – Avg).
3) Within each CWDM channel (each interleaver), the signals are equally spaced in wavelength at 0.37nm, however, as mentioned above, the interleaver channels are equally spaced in frequency (GHz). So there will be an offset of the signal’s center wavelength from the center frequency of interleaver channels, the max offset is about 0.6GHz.
4) Interleaver (Mux) Input Channel Spacing will be the FSR (Avg) x 2, while the Output Channel Spacing will be the FSR (Avg) as show in above Table 5.1

5.2 Interleaver (Mux) FSR and Channel Spacing

Table 5.2, Part number, Wavelength Range, FSR, and Channel Spacing

CWDM	Interleaver MPN	Wavelegnth Range (nm)		FSR	Input Channel Spacing	Output Channel Spacing
Channel		Min	Max	(GHz)	(GHz)	(GHz)
1271	IL-Q1RCXXC1271	1271	1278	68.30	68.30 x 2	68.30
1291	IL-Q1RCXXC1291	1291	1298	66.20	66.20 x 2	66.20
1331	IL-Q1RCXXC1331	1331	1338	62.30	62.30 x 2	62.30
1351	IL-Q1RCXXC1351	1351	1358	60.47	60.47 x 2	60.47
1431	IL-E1RCXXC1431	1431	1437	53.9	53.9 x 2	53.9
1451	IL-E1RCXXC1451	1451	1457	52.3	52.3 x 2	52.3

Notes:

1) So the interleavers are 52.44/104.88GHz to 68.30/136.60GHz
2) The interleavers will be designed and manufactured per above FSR and Channel Spacing.
3) The interleaver performance specification (except for FSR and channel spacing shown in Table 5.2) will be stated using 50/100GHz as reference, as show in Table 5.4

5.3 Wavelength Plan of the Interleavers for CWDM

Table 5.3, CWDM Interleaver Wavelength Range and Channel Center Wavelength (Frequency)

See Appendix I.

5.4 Bandwidth of Interleavers for CWDM

Table 5.4, Bandwidths of the Interleavers for CWDM
(-5°C to +65°C)

			BOL			EOL		
CWDM	**Interleaver MPN**	**FSR**	**0.5dB BW**	**1.0dB BW**	**3.0dB BW**	**0.5dB BW**	**1.0dB BW**	**3.0dB BW**
Channel		(GHz)	(GHz)	(GHz)	(GHz)	(GHz)	(GHz)	(GHz)
1271	IL-Q1RCXXC1271	68.3	21.5	23.5	29	20.5	22.5	28
1291	IL-Q1RCXXC1291	66.2	21	23	28.5	20	22	27.5
1331	IL-Q1RCXXC1331	62.3	20	22	27.5	19	21	26.5
1351	IL-Q1RCXXC1351	60.47	19.5	21.5	27	18.5	20.5	26
1431	IL-E1RCXXC1431	53.9	17.4	19.2	24.1	16.4	18.2	23.1
1451	IL-E1RCXXC1451	52.3	16.9	18.6	23.4	15.9	17.6	22.4

Notes:

For the interleavers working in extended temperature ranges from -30°C to -5°C and +65°C to +85°C, The effective bandwidth will be reduced about 1GHz from above number.

5.5 CWDM Interleaver Performance Specification (-5ºC to +65ºC)

Table 5.5, General Optical Performance Specification (Applied to All PNs in Table 5.1)[1)]

Parameter		Unit	Symbol	Conditions	Specification		
					Min	Typ.	Max
Operation Frequency (wavelength) Range		*nm*		Refer to Table 5.1			
Channel Center Frequency Alignment		*nm*	f_{Ci}	Refer to Table 5.3			
Input Channel Spacing		*GHz*	Δf_i	Refer to Table 5.2			
Output Channel Spacing		*GHz*	Δf_o	Refer to Table 5.2			
Specification Passband		*GHz*	B_{Pi}		±10		
Specification Stopband		*GHz*	B_{Si}		±8.0		
0.5 dB Bandwidth [2)]	BOL	*GHz*	BW(0.5)	0.5 dB clear channel passband, w.r.t f_{Ci}	±17		
	EOL				±16		
1 dB Bandwidth [2)]	BOL	*GHz*	BW(1)	1 dB clear channel passband, w.r.t f_{Ci}	±19		
	EOL				±18		
3 dB Bandwidth [2)]	BOL	*GHz*	BW(3)	3 dB clear channel passband, w.r.t f_{Ci}	±24		
	EOL				±23		
Frequency Offset (CCF Error)	BOL	*GHz*	f_{off}	Over T_{OP} and all channel frequencies, for information only	-3.0		+3.0
	EOL				-4.0		+4.0
Insertion Loss	BOL	*dB*	IL	within Passband over T_{OP}			**1.6**
	EOL						**1.8**
Insertion Loss Uniformity	BOL	*dB*	ΔIL_{1-n}	Total IL variation (difference between max and min values) for all channels within passband			0.3
	EOL						0.5
Insertion Loss Ripple		*dB*	ΔIL_{SP}	Within B_{Pi} (polarization averaged)			0.3
Polarization Dependent Loss		*dB*	PDL				0.3

Return Loss		*dB*	RL	Without connectors, excluding any contribution from directivity	45	-	-
Directivity		*dB*	DI		50	-	-
Dispersion		*ps/nm*	CD	Within f_{Ci} +/- 8.0GHz	-		±75
Polarization Mode Dispersion		*ps*	PMD	IN to OUT	-	0.1	0.2
Isolation		*dB*	ISO(x)	Within B_{Si} (±8.0 GHz), at room temperature	25		
				Within B_{Si} (±8.0 GHz), -5ºC to +65ºC	23		

Notes:

1) *Above performance valid for All operating conditions including all polarization states and the full operating temperature range*
2) *0.5dB, 1.0dB and 3dB BW stated above referred to standard 50/100GHz interleaver and applied 1451, 1431nm, and 1411 CWDM interleavers. For all other CWDM interleavers (1351nm down to 1271nm, these BW can be larger than stated above, with a proportional factor of about FSR/55. Refer to Table 5.4*

5.6 CWDM Interleaver Performance Specification (-30ºC to -5ºC, and +65ºC to +85ºC)

Table 5.6, General Optical Performance Specification (Applied to All PNs in Table 5.1)[1)]

Parameter		Unit	Symbol	Conditions	Specification		
					Min	Typ.	Max
Operation Frequency (wavelength) Range		*nm*		Refer to Table 5.1			
Channel Center Frequency Alignment		*nm*	f_{Ci}	Refer to Table 5.3			
Input Channel Spacing		*GHz*	Δf_i	Refer to Table 5.2			
Output Channel Spacing		*GHz*	Δf_o	Refer to Table 5.2			
Specification Passband		*GHz*	B_{Pi}		±10		
Specification Stopband		*GHz*	B_{Si}		±6.5		
0.5 dB Bandwidth [2)]	BOL	*GHz*	BW(0.5)	0.5 dB clear channel passband, w.r.t f_{Ci}	±17		
	EOL				±16		

1 dB Bandwidth [2]	BOL	*GHz*	BW(1)	1 dB clear channel passband, w.r.t f_{Ci}	±19		
	EOL				±18		
3 dB Bandwidth [2]	BOL	*GHz*	BW(3)	3 dB clear channel passband, w.r.t f_{Ci}	±24		
	EOL				±23		
Frequency Offset (CCF Error)	BOL	*GHz*	f_{off}	Over T_{OP} and all channel frequencies, for information only	-6.0		+6.0
	EOL				-5.0		+5.0
Insertion Loss	BOL	*dB*	IL	within Passband over T_{OP}			**1.9**
	EOL						**2.0**
Insertion Loss Uniformity	BOL	*dB*	ΔIL_{1-n}	Total IL variation (difference between max and min values) for all channels within passband			0.3
	EOL						0.5
Insertion Loss Ripple		*dB*	ΔIL_{SP}	Within B_{Pi} (polarization averaged)			0.3
Polarization Dependent Loss		*dB*	PDL				0.3
Return Loss		*dB*	RL	Without connectors, excluding any contribution from directivity	45	-	-
Directivity		*dB*	DI		50	-	-
Dispersion		*ps/nm*	CD	Within f_{Ci} +/-6.5GHz	-		±75
Polarization Mode Dispersion		*ps*	PMD	IN to OUT	-	0.1	0.2
Isolation		*dB*	ISO(x)	Within B_{Si} (±6.5 GHz), at room temperature	25		
				Within B_{Si} (±6.5 GHz), -5ºC to +65ºC	23		
				Within B_{Si} (±6.5 GHz), -30ºC ~ -5ºC, and +65ºC ~ +85ºC	21		

Notes:

1) *Above performance valid for All operating conditions including all polarization states and the full operating temperature range*
2) *0.5dB, 1.0dB and 3dB BW stated above referred to standard 50/100GHz interleaver and applied 1451, 1431nm, and 1411 CWDM interleavers. For all other CWDM interleavers (1351nm down to 1271nm, these BW can be larger than stated above, with a proportional factor of about FSR/55.*

6. Physical and Mechanical Specification

6.1 Device Dimension

Table 6.1, Device Dimensions

Parameter	Length	Width	Height	Unit
Value	27.7	27.7	8.5	*mm*

Note:

1. *Not including the fiber boots extending from one side. See the detailed drawing below.*

6.2 Mechanical Drawing (unit: inch [*mm*])

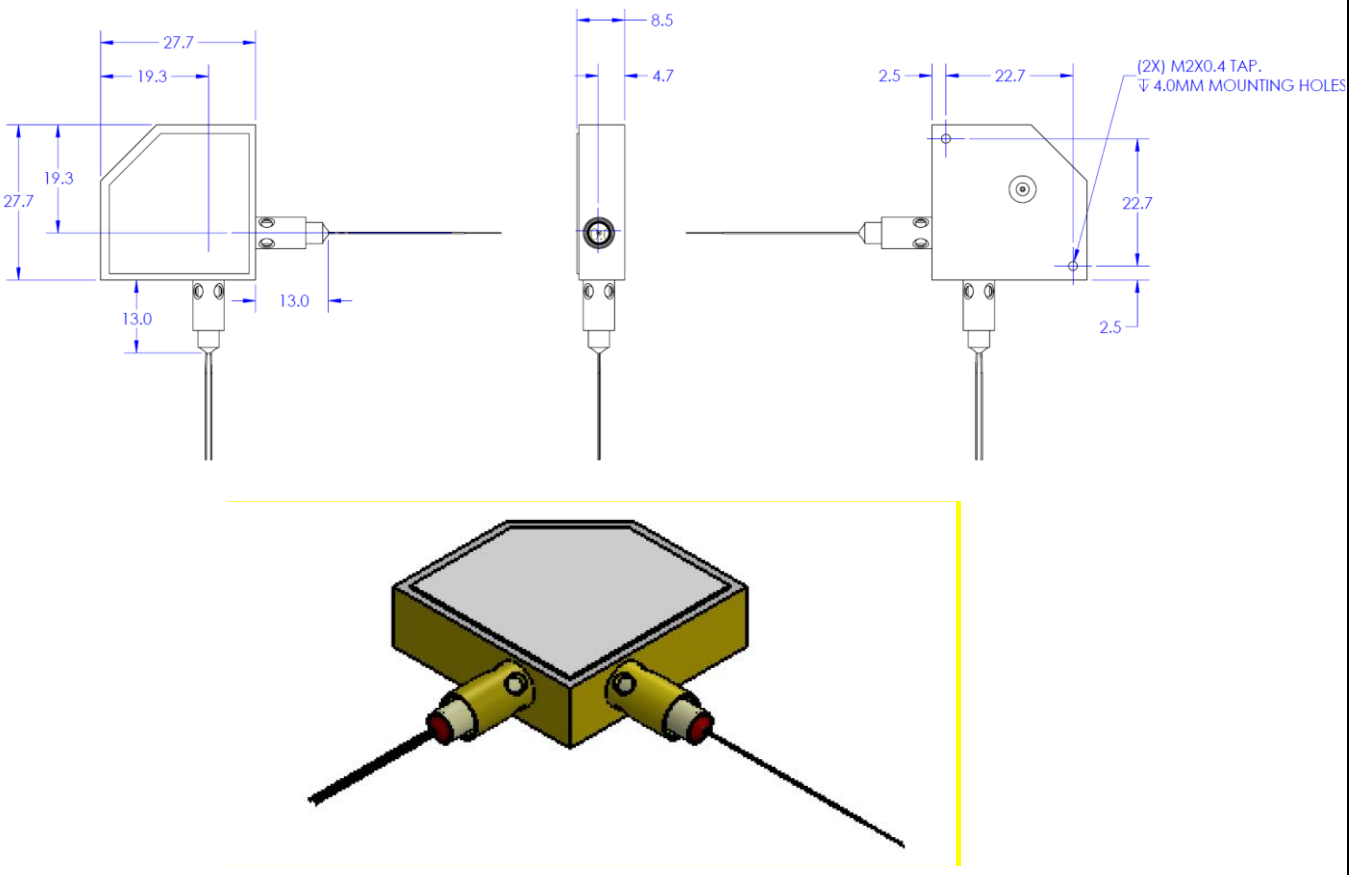

Figure 6.1. Mechanical drawings of the Interleaver device

6.3 Fiber and Connector

Table 6.2, Fiber and Connector Requirements

Item	unit	Description
Type of Optical Fiber	-	ITU-T G657.A2 or equivalent
Type of Fiber Pigtail	-	Bare fiber
Length of Fiber Pigtail	*m*	1.5 ~ 2.0
Connector Type	-	None

7. Label Requirements

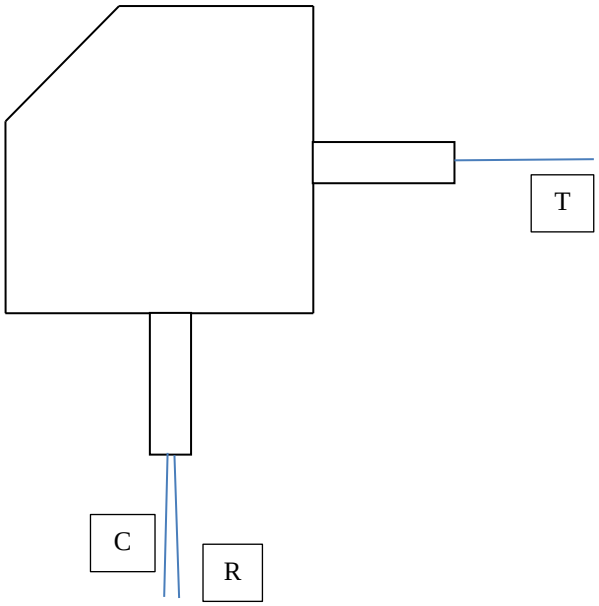

Figure 7.1, Port Labeling (Mux interleaver)

7.1 Port label — See Figure 7.1.

7.2 Pigtail label — Flag type near connector boot.

- "C" for Common Port (Output Port when configured as mux-interleaver)
- "R" for Output-1 (Odd Channels)
- "T" for Output-2 (Even Channels)

7.3 Device label — On top, contains the following information (see Figure 7.1).

Since this is an OEM product, Optoplex will not put its own label on top of the device. This leaves to the OEM customer.

a) OEM Customer logo

b) Product description:

c) Manufacturer P/N:

d) Manufacturer S/N: XXXPSyymmnnnn

- XXX – customer code
- P – Product Line. "L" for interleaver product
- S - denotes manufacturing location; "F" – Fremont, CA, USA; "W" – Wuhan, China
- *yy* - represents manufacturing year;
- mm – denotes channel; "27" – 1271, "29" – 1291, "33" – 1331, "35" – 1351, "43" – 1431, "45" - 1451
- *nnnn* sequential numbers)

Optoplex will put a paper label (removable) with S/N on it for traceability purpose. The OEM customer will put their own label on the interleaver device.

8. Quality and Reliability

- RoHS-6 compliant
- Telcordia 1221-CORE qualified

9. Ordering Information

CWDM Channel	Interleaver MPN	FSR (GHz)
1271	IL-Q1RCXXC1271	68.30
1291	IL-Q1RCXXC1291	66.20
1331	IL-Q1RCXXC1331	62.30
1351	IL-Q1RCXXC1351	60.47
1431	IL-E1RCXXC1431	53.9
1451	IL-E1RCXXC1451	52.3

10. Sales Contact

Optoplex Corporation
48500 Kato Road
Fremont, CA 94538, USA
Tel: (510) 490-9930
Fax: (510) 490-9330
E-Mail: sales@optoplex.com
Website: www.optoplex.com

11. Appendix A: Channel Wavelength /Frequency Table

No.	Frequency [THz]	Del. Freq. [GHz]	Wavelength [nm]
8	235.821	68.62	1271.27
7	235.753	68.58	1271.64
6	235.684	68.54	1272.01
5	235.616	68.50	1272.38
4	235.547	68.46	1272.75
3	235.479	68.42	1273.12
2	235.410	68.38	1273.49
1	235.342	68.34	1273.86
16	235.273	68.30	1274.23
15	235.205	68.26	1274.60
14	235.137	68.22	1274.97
13	235.069	68.18	1275.34
12	235.000	68.14	1275.71
11	234.932	68.10	1276.08
10	234.864	68.06	1276.45
9	234.796		1276.82

No.	Frequency [THz]	Del. Freq. [GHz]	Wavelength [nm]
8	232.169	66.51	1291.27
7	232.102	66.47	1291.64
6	232.036	66.43	1292.01
5	231.969	66.39	1292.38
4	231.903	66.35	1292.75
3	231.837	66.32	1293.12
2	231.770	66.28	1293.49
1	231.704	66.24	1293.86
16	231.638	66.20	1294.23
15	231.571	66.16	1294.60
14	231.505	66.13	1294.97
13	231.439	66.09	1295.34
12	231.373	66.05	1295.71
11	231.307	66.01	1296.08
10	231.241	65.98	1296.45
9	231.175		1296.82

No.	Frequency [THz]	Del. Freq. [GHz]	Wavelength [nm]
8	206.572	52.65	1451.27
7	206.520	52.63	1451.64
6	206.467	52.60	1452.01
5	206.415	52.57	1452.38
4	206.362	52.54	1452.75
3	206.309	52.52	1453.12
2	206.257	52.49	1453.49
1	206.204	52.46	1453.86
16	206.152	52.44	1454.23
15	206.100	52.41	1454.60
14	206.047	52.38	1454.97
13	205.995	52.36	1455.34
12	205.942	52.33	1455.71
11	205.890	52.30	1456.08
10	205.838	52.28	1456.45
9	205.786		1456.82

No.	Frequency [THz]	Del. Freq. [GHz]	Wavelength [nm]
8	203.764	51.23	1471.27
7	203.713	51.20	1471.64
6	203.662	51.18	1472.01
5	203.611	51.15	1472.38
4	203.560	51.13	1472.75
3	203.509	51.10	1473.12
2	203.457	51.08	1473.49
1	203.406	51.05	1473.86
16	203.355	51.02	1474.23
15	203.304	51.00	1474.60
14	203.253	50.97	1474.97
13	203.202	50.95	1475.34
12	203.151	50.92	1475.71
11	203.100	50.90	1476.08
10	203.050	50.87	1476.45
9	202.999		1476.82

No.	Frequency [THz]	Del. Freq. [GHz]	Wavelength [nm]
8	225.193	62.57	1331.27
7	225.130	62.54	1331.64
6	225.068	62.50	1332.01
5	225.005	62.47	1332.38
4	224.943	62.43	1332.75
3	224.880	62.40	1333.12
2	224.818	62.36	1333.49
1	224.756	62.33	1333.86
16	224.693	62.29	1334.23
15	224.631	62.26	1334.60
14	224.569	62.22	1334.97
13	224.506	62.19	1335.34
12	224.444	62.16	1335.71
11	224.382	62.12	1336.08
10	224.320	62.09	1336.45
9	224.258		1336.82

No.	Frequency [THz]	Del. Freq. [GHz]	Wavelength [nm]
8	221.860	60.73	1351.27
7	221.799	60.70	1351.64
6	221.738	60.67	1352.01
5	221.678	60.63	1352.38
4	221.617	60.60	1352.75
3	221.556	60.57	1353.12
2	221.496	60.53	1353.49
1	221.435	60.50	1353.86
16	221.375	60.47	1354.23
15	221.314	60.43	1354.60
14	221.254	60.40	1354.97
13	221.194	60.37	1355.34
12	221.133	60.34	1355.71
11	221.073	60.30	1356.08
10	221.013	60.27	1356.45
9	220.952		1356.82

No.	Frequency [THz]	Del. Freq. [GHz]	Wavelength [nm]
8	212.427	55.68	1411.27
7	212.372	55.65	1411.64
6	212.316	55.62	1412.01
5	212.260	55.59	1412.38
4	212.205	55.56	1412.75
3	212.149	55.53	1413.12
2	212.094	55.50	1413.49
1	212.038	55.47	1413.86
16	211.983	55.45	1414.23
15	211.927	55.42	1414.60
14	211.872	55.39	1414.97
13	211.817	55.36	1415.34
12	211.761	55.33	1415.71
11	211.706	55.30	1416.08
10	211.651	55.27	1416.45
9	211.595		1416.82

No.	Frequency [THz]	Del. Freq. [GHz]	Wavelength [nm]
8	209.459	54.13	1431.27
7	209.405	54.11	1431.64
6	209.351	54.08	1432.01
5	209.297	54.05	1432.38
4	209.243	54.02	1432.75
3	209.189	53.99	1433.12
2	209.135	53.97	1433.49
1	209.081	53.94	1433.86
16	209.027	53.91	1434.23
15	208.973	53.88	1434.60
14	208.919	53.85	1434.97
13	208.865	53.83	1435.34
12	208.811	53.80	1435.71
11	208.757	53.77	1436.08
10	208.704	53.74	1436.45
9	208.650		1436.82