Product Catalogue
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Optoplex Corporation

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Table of Contents

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DPSK Phase Demodulator

Optoplex's **Optical DPSK Demodulator**, also known as **Delay Line Interferometer** (DLI), converts *phase modulation* to *amplitude modulation* over the entire C+L band in support of data transmission rates of 2.5, 10 or 40 Gb/s. The DPSK demodulator is designed for phase modulated optical communication systems utilized in commercial, defense and space exploration markets. The device plays a key role in improving signal quality and performance to meet the expanding demand for higher data rates and more complex transmission formats within current and next generation systems without major capital expenditure. Optoplex's DPSK Demodulator is based on a patented free-space optical design, which is compact, athermal and polarization-independent. The measured frequency drift over temperature is only ~0.02 GHz/°C for our standard passive device. Further, this DPSK Demodulator exhibits a total polarization-dependent phase shift of less than 2 degrees over the entire operating temperature range with a high extinction ratio. Optoplex's DPSK Demodulators can be configured to be fully tunable, colorless tunable or purely passive. Dual-Rate DPSK Demodulator is also available.

Since its release of the DPSK products in 2006, Optoplex has been the dominant supplier of DPSK DLIs in the global market for optical communications for terrestrial, subsea and aerospace applications.

Table 1, DPSK Performance Specifications

Parameter	*Unit*	Specification
Wavelength Range[1]	*nm*	See Table 2
Free Spectral Range (FSR)[2]	*GHz*	See Table 3
FSR Error[3]	*%*	< 1
Insertion Loss (including two connectors)	*dB*	1.8
Extinction Ratio	*dB*	> 18
PMD	*ps*	< 0.1
Return Loss	*dB*	> 40
PDL	*dB*	< 0.2
PDFS	*deg*	< 3
TDFS[4]	*MHz/C*	< 20
Optical Path Delay (between the two receiving ports)	*ps*	<1.0
Tuning Time Constant[5]	*sec*	< 1.0
Tuning Range[6]	*FSR*	1.5 ~ 3
Tuning Voltage[6]	*V*	0 ~ 5
Power Consumption[6]	*W*	0.5
Maximum Input Optical Power	*mW*	300
Operating Temperature8	*°C*	-5 ~ +70

Table 2, Wavelength Bands

Wavelength Band	Wavelength Range (nm)
C-Band	1525 ~ 1570
L-Band	1570 ~ 1610
C+L Band	1525 ~ 1610
O-Band-1	1250 ~ 1310
O-Band-2	1310 ~ 1370
O-Band	1260 ~ 1360
1064	1064 +/-5

Table 3, Available FSRs

Data Rate (Gb/s)	Typical FSR (GHz)
40	66.67, 57, 50
20	21.5, 21.9
10	12.5, 12.25, 11.4, 10.7, 10
5	5
3	3.33
2.5	2.88, 2.67, 2.50, 2.488
1	1.25, 1.0

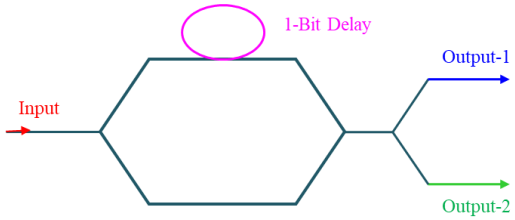

Fig 1. Schematic of DPSK DLI

Notes

1) Wavelength bands available from C-, L-, C+L, and O-Band. Other wavelength ranges can be made upon request
2) Listed FSRs are the standard offers. Custom FSR available upon request.
3) Standard FSR error is 1%. More precise FSR can be made. Contact Optoplex for your requirements.
4) TDFS are applied to PASSIVE and Semi-Tunable versions. It is not required in Tunable version.
5) Time constant, or tuning speed, is measured at the output from 0 ~ 50% of the output amplitude. Faster tuning can be made. Contact Optoplex.
6) For standard design with tuning range of 1.5 ~ 3 FSR at driving voltage from 0 ~ 5V and power consumption of 0.5W typically. Wider tuning range, such as 5FSR or even 10FSR (+/-5FSR) can be made at higher driving voltage (0 ~ 7V) and therefore higher power consumption. Contact Optoplex for more details about larger tuning range.

A. By default, single mode fiber (SMF-28e or equivalent) is used. Options are bare fiber, 900um tight buffer, or 900um loose tube.
B. B: The device dimension varies depending on the FSR. Contact Optoplex for details.

Designs of DPSK

Tunable – the output spectrum of the DPSK can be tuned (shifted) when a driving voltage is applied (VDC: 0 ~ 5V). The default design has a tuning range of >1.5 FSR.

Semi-Tunable: The output spectrum of the DPSK can be slightly tuned (shifted). The max range is usually 0.5GHz.

Passive – There is no tuner built-in the DPSK device. The spectrum can not be tuned (shifted). In manufacturing, we will align the spectral peak to customer specific frequency position. By default, it will be aligned to ITU grids. This is good when the DPSK is used in colorless DWDM system.

Applications

- 2.5, 10, 20 or 40 Gb/s commercial DPSK signal reception
- Customized data rate for advanced applications
- Data rate optimization
- Extend transmission distance
- Free-space laser communication
- Satellite optical communication
- Quantum Cryptographic
- Doppler Lidar Application
- Precise optical measurement
- Optical spectroscopy

Key Features and Benefits

- Athermal design
- C+L band coverage by a single device
- Low temperature-dependent frequency shift (TDFS)
- Low polarization-dependent frequency shift (PDFS)
- Low insertion loss & PDL
- High power handling
- Passive, colorless tunable (both aligned to ITU Grid) or fully tunable
- Telcordia GR-1221 qualified

Fig 1. Standard package design

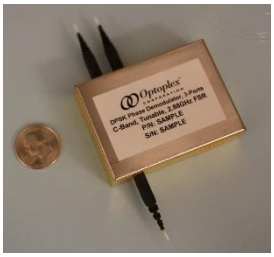

Fig 3. Standard package design

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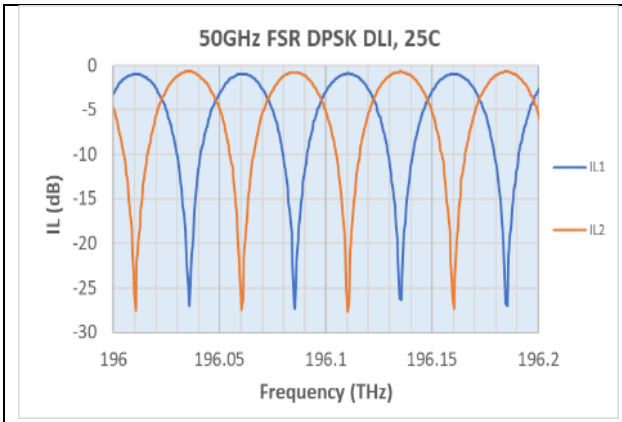


Fig 6. DPSK Output Spectra

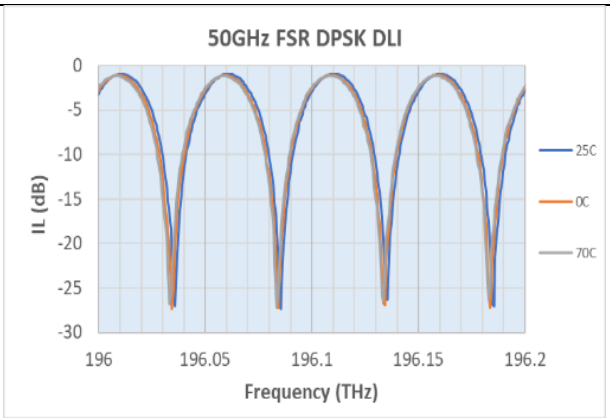
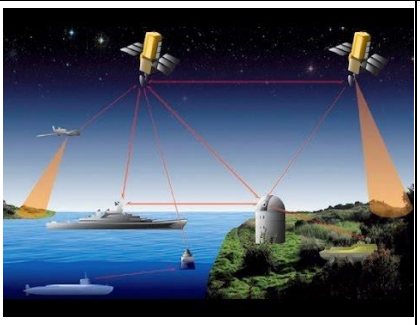


Fig 7. Schematic of DPSK DLI

Special DPSK and Applications

Satellite and Aerospace Applications	Quantum Optical Communications	Precise Motion Control
		
Today, 2.5Gbps DPSK DLI is widely used in satellite and other aerospace optical communications. Available FSRs are 2.488, 2.50, 2.65 and 2.88GHz. Among them, 2.88GHz is the most popular one. A smaller FSR, 1.25GHz, is also available for such application. 3-Port or 4-Port Configuration is available For special doppler application in aerospace, very large tuning range, such as 5, 7, or even 10FSR, is required. With proprietary design, Optoplex's DPSK DLI can be specially made to meet the requirements.	DPSK Delay Line Interferometer with a delay of 1ns (1GHz FSR) is now being used in Quantum Cryptographic application. Very accurate FSR (or delay in time) is necessary and extremely environmentally stable a must.	Precise measurement and motion control in sub-nanometer is demanding such as in today's most advanced lithography system in semiconductor process where transistor linewidth of 7nm or 5nm is fabricated. With DPSK DLI, extremely small distance (length) change is transferred into the optical phase shift, enabling the precise measurement (and therefore the control) of sub-nanometer possible. Optoplex's athermal design of DPSK is an ideal DLI for such cutting-edge application.

Military and Aerospace-Grade DPSK DLIs

Optoplex has developed manufacturing process compliant with MIL- and AS- standards and the 2.5Gbps DPSK DLIs have been qualified for aerospace (including GEO satellite) applications).
Contact Optoplex for details.

Product Ordering Information

DI	–	W	F	X	Y	Y	Z	n	n	n

W - Wavelength
C = C -Band
L = L -Band
T = C+L-Band
Q = O-Band
A = 1064nm

F - FSR (GHz)
1 = 40 ~ 67
0 = 20 ~ 25
A = 10 ~ 12.5
B = 5 ~ 6.5
C = 2.5 ~ 3
D = 1 ~ 1.25

X: Type
C = Passive
D = Semi-Tunable
E = Tunable

YY: Connector
FA = FC/APC
FC = FC/UPC
LA = LC/APC
LC = LC/UPC
SC = SC/UPC

Z: Made
S = Standard
C = Custom

nnn: Sequential
(to be assigned by Optoplex)

Fig 6. 4-Port DPSK

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Popular Product Part Numbers

DPSK Phase Demodulators

FSR	MPN	Product Description
1.25 [1)]	DI-CDEFAC523	DPSK, C-Band, 1.25GHz FSR, Tunable, SMF, FC/APC
2.488	DI-CCEFCC457	DPSK, C-band, 2.488G FSR, Tunable, SMF, FC/UPC
2.5	DI-CCEFCC520	DPSK, C-Band, 2.5GHz FSR, Tunable, SMF, FC/APC
2.67	DI-CCEFCC485	DPSK, C-band, 2.67G FSR, Tunable, SMF, FC/APC
2.88	DI-CCEFCC415	DPSK, C-Band, 2.88GHz FSR, 4-port, SMF, FC/UPC
	DI-CCEFAC437	DPSK, C-Band, 2.88GHz FSR, Tunable, SMF, FC/APC.
	DI-CCEFCC461	DPSK, C-band, 2.88G FSR, Push-Pull Tuning for +/-5 FSR, SMF, FC/UPC
	DI-CCEFAC463	DPSK, C-band, 2.88G FSR, Tuning range >=4.2 FSR, SMF, FC/APC
3.33	DI-CCEFAC519	DPSK, C-Band, 3.33GHz FSR, Tunable, SMF, FC/APC
5	DI-LBESCS002	DPSK, L-Band, 5GHz FSR, Tunable, SMF, SC/UPC
	DI-CBEFAC451	DPSK, C-Band, 5GHz FSR, Tunable, SMF, FC/APC
5.76	DI-CCEFCC420	DPSK, C-Band, FSR 5.76G, Tunable, 4-port, SMF, FC/UPC
6.25	DI-CBEFCS001	DPSK, C-band, 6.25GHz FSR, Tunable, SMF, FC/UPC
7.83	DI-CAELCC359	DPSK, C-Band, 7.83GHz FSR, Tunable, SMF, LC/UPC
8.125	DI-CAESCS001	DPSK, C-Band, 8.125GHz FSR, Tunable, SMF, SC/UPC
10	DI-CAELCC426	DPSK, C-Band, 10GHz FSR, Tunable, SMF, LC/UPC
	DI-CADLCC427	DPSK, C-Band, 10GHz FSR, Semi-Tunable, SMF, LC/UPC
	DI-CACLCC428	DPSK, C-Band, 10GHz FSR, Passive, SMF, LC/UPC
	DI-TAEFAC465	DPSK, C+L Bband, 10GHz FSR, Tunable, FC/APC
	DI-QAEFAC501	DPSK, O-Band, 10GHz FSR, Tunable, SMF, FC/APC
	DI-CAEFAS522	DPSK, C-Band, 10GHz FSR, Tunable, SMF, FC/APC
10.24	DI-CAEFCS006	DPSK, C-Band, 10.24GHz FSR, Tunable, SMF, FC/UPC
	DI-CADFCC448	DPSK, C-Band, 10.24GHz FSR, Semi-Tunable, SMF, FC/UPC
10.7	DI-CAEFAC435	DPSK, C-band, 10.7GHz FSR, Tunable, SMF, FC/APC
	DI-CAELCC438	DPSK, C-band, 10.7GHz FSR, Tunable, SMF, LC/UPC
	DI-TAMSCS525	DPSK, C+L Band, 10.7GHz FSR, Tunable, SMF, SC/UPC
11.3	DI-CAELCM509	DPSK, C-Band, 11.3GHz FSR, Tunable, SMF. LC/UPC
12.25	DI-CAEFAS505	DPSK, C-Band, 12.25GHz FSR, Tunable, SMF, FC/APC
	DI-CAELCM510	DPSK, C-Band, 12.25GHz FSR, Tunable, SMF, LC/UPC
12.4	DI-CAExxC349	DPSK, C-Band, 12.4GHz FSR, Tunable, SMF, No Connector
12.5	DI-CAEFCS425	DPSK, C-Band, 12.5GHz FSR, Tunable, SMF, FC/APC
	DI-CAELCS524	DPSK, C-Band, 12.5GHz FSR, Tunable, SMF, LC/UPC
13.375	DI-TAEFCS008	DPSK, C+L Band, 13.375GHz FSR, Tunable, SMF, FC/UPC
20	DI-C0ELCC429	DPSK, C-Band, 20GHz FSR, Tunable, SMF, LC/UPC
	DI-C0DLCC430	DPSK, C-Band, 20GHz FSR, Semi-Tunable, SMF, LC/UPC
	DI-C0CLCC431	DPSK, C-Band, 20GHz FSR, Passive, SMF, LC/UPC
	DI-C0EFAC499	DPSK, C-Band, 20GHz FSR, Tunable, SMF, FC/APC
21.5	DI-T0EFCS003	DPSK, C+L Band, 21.5GHz FSR, Tunable, SMF, FC/UPC
	DI-C0ELCS515	DPSK, C-Band, 21.5GHz FSR, Tunable, SMF, LC/UPC
23	DI-C0EFCS001	DPSK, C-Band, 23GHz FSR, Tunable, SMF, FC/UPC
23.75	DI-C0ELCC378	DPSK, C-Band, 23.75GHz FSR, Tunable, SMF, LC/UPC
24	DI-C0JFCC343	DPSK, C-Band, 24GHz FSR, Tunable, SMF, FC/UPC
25	DI-C0ELCC001	DPSK, C-Band, 25GHz FSR, Tunable, SMF, LC/UPC
	DI-C0EFCS424	DPSK, C-Band, Tunable, 25GHz FSR, FC/APC
	DI-L0ELCS002	DPSK, L-Band, 25GHz FSR, Tunable, SMF, LC/UPC
	DI-C1EFAM512	DPSK, C-Band, 25GHz FSR, Tunable, SMF, FC/APC
	DI-T0ESCS002	DPSK, C+L Band, 25GHz FSR, Tunable, SMF, SC/UPC
	DI-T0EFCC456	DPSK, C+L Band, 25GHz FSR, Tunable, FC/UPC
	DI-QCEFAS491	DPSK, O-Band, 25GHz FSR, Tunable, FC/APC

DPSK Phase Demodulators – Cont.

FSR	MPN	Product Description
26.75	DI-T0EFCS005	DPSK, C+L Band, 26.75GHz FSR, Tunable, SMF, FC/UPC
27.75	DI-C0DFAC001	DPSK, C-Band, 27.75GHz FSR, Tunable, SMF, FC/APC
	DI-C0ESCS007	DPSK, C-Band, 27.5GHz FSR, Tunable, SMF, SC/UPC
	DI-C0DFAC001	DPSK, C-Band, 27.75GHz FSR, Semi-tunable, PM Fiber, FC/APC
28	DI-C0EFAC464	DPSK, C-band, 28GHz FSR, Tunable, FC/APC
	DI-C0ELCS009	DPSK, L-Band, 28GHz FSR, Tunable, SMF, LC/UPC
31.75	DI-C0ESCS008	DPSK, C-Band, 31.75GHz FSR, Tunable, SMF, SC/UPC
32.5	DI-C0EFCS006	DPSK, C-Band, 32.5GHz FSR, Tunable, SMF, FC/UPC
33.33	DI-C0ELCS495	DPSK, C-Band, 33.33GHz FSR, Tunable, SMF, LC/UPC
40	DI-C1CFCS002	DPSK, C-Band, 40GHz FSR, Tunable, SMF, FC/UPC
	DI-C1CSCS002	DPSK, C-Band, 40GHz FSR, Tunable, SMF, SC/UPC
	DI-L1ESCS003	DPSK, L-Band, 40GHz FSR, Tunable, SMF, SC/UPC
	DI-T1EFCC421	DPSK, C+L Band, 40GHz FSR, Tunable, SMF, FSC/UPC
	DI-A1EFAP521	DPSK, 1064nm, 40GHz FSR, Tunable, PMF (PM780-HP), FC/APC
40.96	DI-C1EFCS006	DPSK, C-Band, 40.96GHz FSR, Tunable, SMF, FC/UPC
43	DI-C1EFCS003	DPSK, C-Band, 43GHz FSR, Tunable, SMF, FC/UPC
	DI-C1ELCC003	DPSK, C-Band, 43GHz FSR, Tunable, SMF, LC/UPC
	DI-T1EFCS003	DPSK, C+L Band, 43GHz FSR, Tunable, SMF, FC/UPC
44.4	DI-C1EFCS004	DPSK, C-Band, 44.4GHz FSR, Tunable, SMF, FC/UPC
50	DI-T1ESCS001	DPSK, C+L Band, 50GHz FSR, Tunable, SMF, SC/UPC
	DI-C1MLCS503	DPSK, C-Band, 50GHz FSR, Tunable, SMF, LC/UPC
	DI-C1EFAS506	DPSK, C-Band, 50GHz FSR, Tunable, SMF, FC/APC
	DI-A1EFAS517	DPSK, 1064nm, 50GHz FSR, Tunable, PMF (PM780-HP), FC/APC
53.5	DI-T1EFCS007	DPSK, C+L Band, 53.5GHz FSR, Tunable, SMF, FC/UPC
	DI-C1MFCS007	DPSK, C-Band, 53.5GHz FSR, Tunable, SMF, FC/UPC
55	DI-C1EFCS021	DPSK, C-Band, 55GHz FSR, Tunable, SMF, FC/UPC
57	DI-C1ELCS005	DPSK, C-Band, 57GHz FSR, Tunable, SMF, LC/UPC
	DI-C1CLCS005	DPSK, C-Band, 57.14GHz FSR, Tunable, SMF, LC/UPC
60	DI-C1ELCS008	DPSK, C-Band, 60GHz FSR, Tunable, SMF, LC/UPC
65	DI-C1MLCC392	DPSK, C-Band, 65GHz FSR, Tunable, SMF, LC/UPC
66.67	DI-C1MLCP010	DPSK, C-Band, 66.67GHz FSR, Tunable, PM Fiber, LC/UPC
	DI-L1MLCC407	DPSK, L-Band, 66.67GHz FSR, Tunable, SMF, LC/UPC
	DI-C1MLCC447	DPSK, C-Band, 66.67GHz FSR, Tunable, SMF, LC/UPC
	DI-A1EFAS518	DPSK, 1064nm, 67GHz FSR, Tunable, PMF (PM780-HP), FC/APC
80	DI-C2EFCS002	DPSK, C-Band, 80GHz FSR, Tunable, SMF, FC/UPC
	DI-C2DFCS001	DPSK, C-Band, 80GHz FSR, Semi-Tunable, SMF, FC/UPC
100	DI-C3DLCS002	DPSK, C-Band, 100GHz FSR, Semi-Tunable, SMF, LC/UPC
	DI-Q2EFCC467	DPSK, O-Band, 100GHz FSR, Tunable, SMF, FC/UPC
125	DI-C3DFCS001	DPSK, C-Band, 125GHz FSR, Semi-Tunable, SMF, LC/UPC
159.25	DI-C4EFCS001	DPSK, C-Band, 159.25GHz FSR, Tunable, SMF, FC/UPC
163.84	DI-C4EFCS002	DPSK, C-Band, 163.84GHz FSR, Tunable, SMF, FC/UPC
500	DI-C5ESCC453	DPSK, C-Band, 500GHz FSR, Tunable, SMF, SC/UPC
Dual-FSR DPSK		
43/66.67	DI-C1NLCC005	DPSK, C-Band, 42.8/66.67GHz Dual-FSR, Tunable, SMF, LC/UPC
50/65	DI-C1NLCC002	DPSK, C-Band, 50/65GHz Dual-FSR, Tunable, SMF, LC/UPC
50/66.67	DI-C1NLAC380	DPSK, C-Band, 50/66.7GHz Dual-FSR, Tunable, SMF, LC/APC

Notes:

1) *1.25GHz and 1.0GHz FSR DPSK DLIs are still in engineering phase, not officially released to production yet.*

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DQPSK DLIs

Optoplex's **Optical DQPSK demodulator** converts *differential quadratural phase modulation* to *amplitude modulation* over the entire C+L band in support of data transmission rates of 20 or 40 Gb/s. DQPSK demodulator is designed for the next generation optical communications systems utilized in commercial, defense and space exploration markets. The device plays a key role in improving signal quality and performance to meet the expanding demand for higher data rates and more complex transmission formats within current and next generation systems without major capital expenditure.

- DQPSK demodulator uses half the transmission rate to achieve the same data rate (20-Gb/s system for 40-Gb/s data rate, with four phase states as compared to two in DPSK format).
- A lower transmission rate saves cost on many other components and electronics and is more tolerant to dispersion.
- 20-Gb/s system is the highest transmission rate possible for the 50-GHz channel spacing system.
- Optoplex's fully integrated DQPSK demodulator combines a power splitter and both I- and Q-arms.

Table 1, DQPSK Performance Specifications

Parameter	*Unit*	Specification
Wavelength Range	*nm*	See Table-1
Free Spectral Range[1] (FSR)	*GHz*	See Table-2
FSR Error[2]	*%*	< 1
Insertion Loss[2] (including all connectors)	*dB*	~5.7
Extinction Ratio[2]	*dB*	> 18
PMD[2]	*ps*	< 0.1
Return Loss	*dB*	> 40
PDL[2]	*dB*	< 0.2
PDFS[2]	*deg*	< 3
Optical Path Delay[2] (Skew, among Input → I_1, I_2, Q_1, Q_2)	*ps*	< 1.0
Tuning Time Constant[3]	*sec*	< 1.0
Tuning Range	*FSR*	> 1.5
Tuning Voltage (for each of I- & -Q)	*V*	0 ~ 5
Power Consumption (total for I- & -Q)	*W*	~1.0
Max Input Optical Power	*mW*	300
Operating Temperature	*°C*	−5 ~ 65

Table 2, Wavelength Bands

Wavelength Band	Wavelength Range (nm)
C-Band	1525 ~ 1570
L-Band	1570 ~ 1610
C+L Band	1525 ~ 1610
O-Band-1	1250 ~ 1310
O-Band-2	1310 ~ 1370
O-Band	1260 ~ 1360
1064	1064 +/-5

Table 3, Available FSRs

Data Rate (Gb/s)	Typical FSR (GHz)
100	50
40	21.5, 21.9
20	12.5, 12.25, 11.4, 10.7, 10
10	5.7, 5
5	2.88, 2.67, 2.50, 2.488
2.5	1.25, 1.0

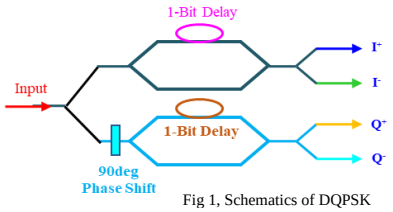

Fig 1, Schematics of DQPSK

Notes

7) Wavelength bands available from C-, L-, C+L, and O-Band. Other wavelength ranges can be made upon request
8) Listed FSRs are the standard offers. Custom FSR available upon request.
9) Standard FSR error is 1%. More precise FSR can be made. Contact Optoplex for your requirements.
10) TDFS are applied to PASSIVE and Semi-Tunable versions. It is not required in Tunable version.
11) Time constant, or tuning speed, is measured at the output from 0 ~ 50% of the output amplitude. Faster tuning can be made. Contact Optoplex.
12) For standard design with tuning range of 1.5 ~ 3 FSR at driving voltage from 0 ~ 5V and power consumption of 0.5W typically. Wider tuning range, such as 5FSR or even 10FSR (+/-5FSR) can be made at higher driving voltage (0 ~ 7V) and therefore higher power consumption. Contact Optoplex for more details about larger tuning range.

C. By default, single mode fiber (SMF-28e or equivalent) is used. Options are bare fiber, 900um tight buffer, or 900um loose tube.
D. B: The device dimension varies depending on the FSR. Contact Optoplex for details.

Designs of DQPSK

Tunable – the output spectrum of the DPSK can be tuned (shifted) when a driving voltage is applied (VDC: 0 ~ 5V). The default design has a tuning range of >1.5 FSR.

Semi-Tunable: The output spectrum of the DPSK can be slightly tuned (shifted). The max range is usually 0.5GHz.

Passive – There is no tuner built-in the DPSK device. The spectrum can not be tuned (shifted). In manufacturing, we will align the spectral peak to customer specific frequency position. By default, it will be aligned to ITU grids. This is good when the DPSK is used in colorless DWDM system.

Features

- Athermal design
- Low (TDFS, PDFS, IL & PDL)
- Fully and semi-tunable, independent I- and Q-control
- Wide bandwidth
- High power handling
- Telcordia GR-1221 qualified

Applications

- High-speed optical comm. (DQPSK)
- Free-space laser communication
- Satellite optical communication
- Quantum Cryptographic
- Fiber sensing (phase shift Measurement)
- Precise optical measurement
- Optical spectroscopy

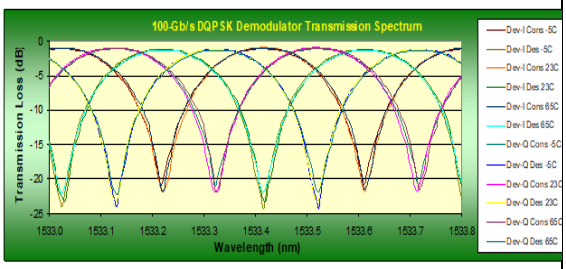

Fig 2. Standard package design

Fig 2. Standard package design

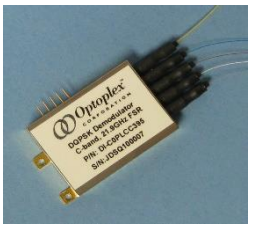

Fig 3. Standard package design

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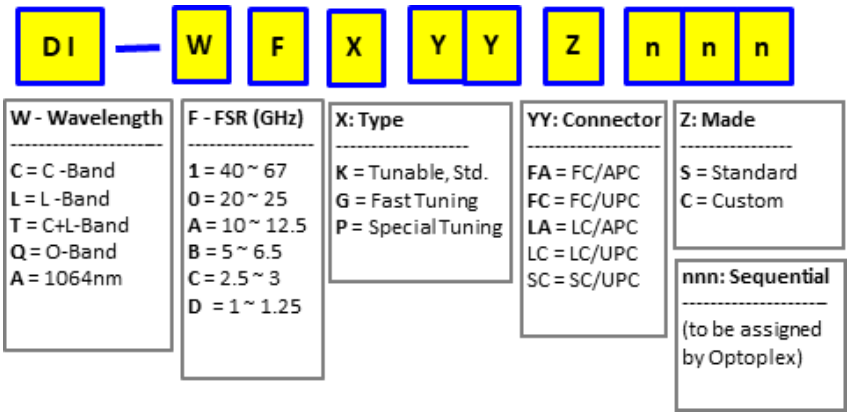
Product Ordering Information



DQPSK Phase Demodulators

FSR	MPN	Product Description
1	DI-CDKLC433	DQPSK, C-Band, 1GHz FSR, Tunable, LC/UPA
5	DI-CBKFAS526	DQPSK, C-Band, 5.0GHz FSR, Tunable, SMF, FC/APC
5.7	DI-CBKSCS001	DQPSK, C-Band, 5.7GHz FSR, Tunable, SMF, SC/UPC
10	DI-CAKFAS015	DQPSK, C-Band, 10GHz FSR, Tunable, SMF, FC/APC
10.7	DI-CAKFAS470	DQPSK, C-Band, 10.7GHz FSR, Tunable, SMF, FC/APC
11.4	DI-CAKFCC350	DQPSK, C-Band, 11.4GHz FSR, Tunable, SMF, FC/UPC
12.25	DI-CAKLCS013	DQPSK, C-Band, 12.25GHz FSR, Tunable, SMF, LC/UPC
	DI-CAKSCC400	DQPSK, C-Band, 12.5GHz FSR, Tunable, SMF, SC/UPC
21.5	DI-C0KLCS473	DQPSK, C-Band, 21.5GHz FSR, Tunable, SMF, LC/UPC
	DI-C0KFAS508	DQPSK, C-Band, 21.5GHz FSR, Tunable, SMF, FC/APC
21.9	DI-C0KFAS469	DQPSK, C-Band, 21.9GHz FSR, Tunable, SMF, FC/APC
22.3	DI-C0KFCC406	DQPSK, C-Band, 22.3GHz FSR, Tunable, SMF, FC/UPC
23.7	DI-C0KFCC440	DQPSK, C-Band, 23.7GHz FSR, Tunable, SMF, FC/UPC
23.76	DI-C0KFAC439	DQPSK, C-Band, 23.76GHz FSR, Tunable, SMF, FC/APC
28	DI-C0KFAC404	DQPSK, C-Band, 28GHz FSR, Tunable, SMF, FC/APC
31.8	DI-C0KSCC385	DQPSK, C-Band, 31.8GHz FSR, Tunable, SMF, SC/UPC
32	DI-C0KLCS487	DQPSK, C-Band, 32GHz FSR, Tunable, SMF, LC/UPC
32.5	DI-C0KFAC441	DQPSK, C-Band, 32.5GHz FSR, Tunable, SMF, FC/APC
40	DI-C1KFAC471	DQPSK, C-Band, 40GHz FSR, Tunable, SMF, FC/APC
43	DI-C1KFCC394	DQPSK, C-Band, 43GHz FSR, Tunable, SMF, FC/UPC
50	DI-C1KLCS001	DQPSK, C-Band, 50GHz FSR, Tunable, SMF, LC/UPC
53	DI-C1KFAS003	DQPSK, C-Band, 53GHz FSR, Tunable, SMF, FC/APC
56	DI-C1KFCS002	DQPSK, C-Band, 56GHz FSR, Tunable, SMF, FC/UPC
58.5	DI-C1KSCC382	DQPSK, C-Band, 58.5GHz FSR, Tunable, SMF, SC/UPC

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90deg Optical Hybrid

Optoplex's **Optical DQPSK demodulator** converts *differential quadratural phase modulation* to *amplitude modulation* over the entire C+L band in support of data transmission rates of 20 or 40 Gb/s. DQPSK demodulator is designed for the next generation optical communications systems utilized in commercial, defense and space exploration markets. The device plays a key role in improving signal quality and performance to meet the expanding demand for higher data rates and more complex transmission formats within current and next generation systems without major capital expenditure.

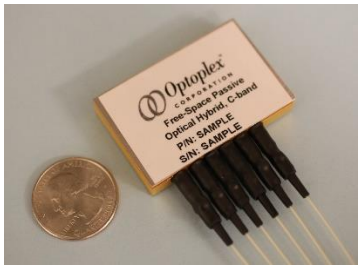
- DQPSK demodulator uses half the transmission rate to achieve the same data rate (20-Gb/s system for 40-Gb/s data rate, with four phase states as compared to two in DPSK format).
- A lower transmission rate saves cost on many other components and electronics and is more tolerant to dispersion.
- 20-Gb/s system is the highest transmission rate possible for the 50-GHz channel spacing system.
- Optoplex's fully integrated DQPSK demodulator combines a power splitter and both I- and Q-arms.

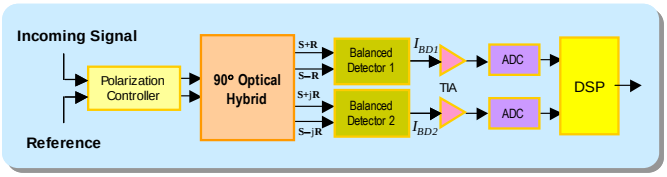
Table 1, 90deg Optical Hybrid Performance Specifications

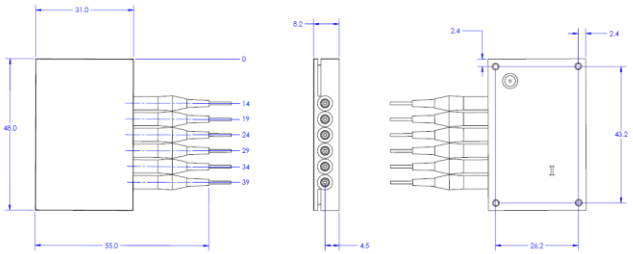
Parameter		Unit	Specification
Wavelength Range [1]		*nm*	C-band, or
Phase Difference[1,2] (between M_1, M_2 and M_3, M_4)		*deg*	90 ± 10
Insertion Loss	S→I	*dB*	< 9.0
	L→Q	*dB*	< 9.0
Insertion Loss Difference	betwn S→I_1 and S→I_2	*dB*	< 1.2
	btwn S→Q_1 and S→Q_2	*dB*	< 1.2
	btwn L→I_1 and L→I_2	*dB*	< 1.2
	btwn L→Q_1 and L→Q_2	*dB*	< 1.2
Optical Return Loss		*dB*	> 27
Optical Path Difference (skew, between M_1 and M_2 and between M_3 and M_4)		*ps*	< 1
Optical Path Difference (skew, between any ports)			< 1

Notes:
1) Available Wavelength Bands: C-, L-, C+L, O-bands, and 1064+/-5nm.

MP/N	Products
HB-C0AFAS002	90-degree Optical Hybrid, C-Band, SMF for All Ports, Phase 90±10°
HB-C0AFAS013	90-degree Optical Hybrid, C-Band, SMF for All Ports, Phase 90±5°
HB-C0AFAC016	90-degree Optical Hybrid, C-Band, PMF for Input Ports (both Signal- and Lo-), SMF for All Output Ports, Phase 90±10°
HB-C0AFAC057	90-degree Optical Hybrid, C-Band, PMF for Input Ports (both Signal- and Lo-), SMF for All Output Ports, Phase 90±5°
HB-C0AFAC055	90-degree Optical Hybrid, C-Band, PMF for All Input and Output Ports, Phase 90±10°
HB-C0AFAS066	90-degree Optical Hybrid, C-Band, PMF for All Input and Output Ports, Phase 90±5°
HB-L0AFAS094	90-degree Optical Hybrid, L-Band, SMF for All Ports, Phase 90±10°
HB-T0AFAS095	90-degree Optical Hybrid, C+L Band, SMF for All Ports, Phase 90±10°
HB-Q0AFAS1310	90-degree Optical Hybrid, O-Band, SMF for All Ports, Phase 90±10°
HB-A0AFAP1064	90-degree Optical Hybrid, 1064+/-5nm, HI1060 SMF for All Ports, Phase 90±10°





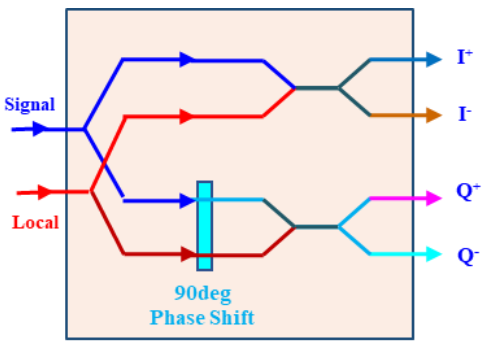


Features

- Athermal design
- Low (TDFS, PDFS, IL & PDL)
- Fully and semi-tunable, independent I- and Q-control
- Wide bandwidth
- High power handling
  Telcordia GR-1221 qualified

Applications

- High-speed optical comm. (DQPSK)
- Free-space laser communication
- Satellite optical communication
- Quantum Cryptographic
- Fiber sensing (phase shift Measurement)
- Precise optical measurement
  Optical spectroscopy



Ordering Information:

HB	—	W	0	X	Y	Y	Z	n	n	n

W - Wavelength
C = C -Band
L = L -Band
T = C+L-Band
Q = O-Band
A = 1064nm

X: Type
A = 90deg Hybrid
B = 2x4 Mixer
G = 2x8 Mixer

YY: Connector
FA = FC/APC
FC = FC/UPC
LA = LC/APC
LC = LC/UPC
SC = SC/UPC

Z: Made
S = Standard
C = Custom

nnn: Sequential
(to be assigned by Optoplex)

Optoplex will assign "nnn" for each MPN in which tge type of fiber, pigtails, ..., etc., will be defined

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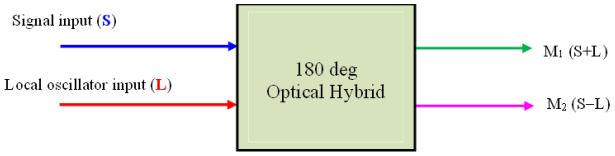
180deg Optical Hybrids



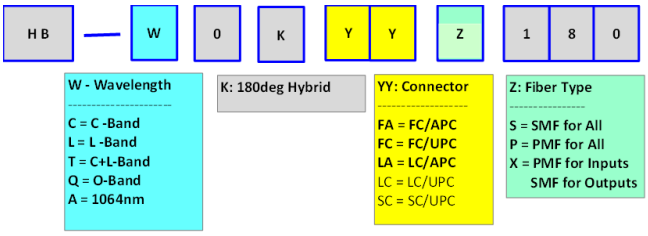
Port	Function	Phase Difference	Value
1	Local		L
2	Signal		S
3	M_1	0	S + L
4	M_2	π	S - L

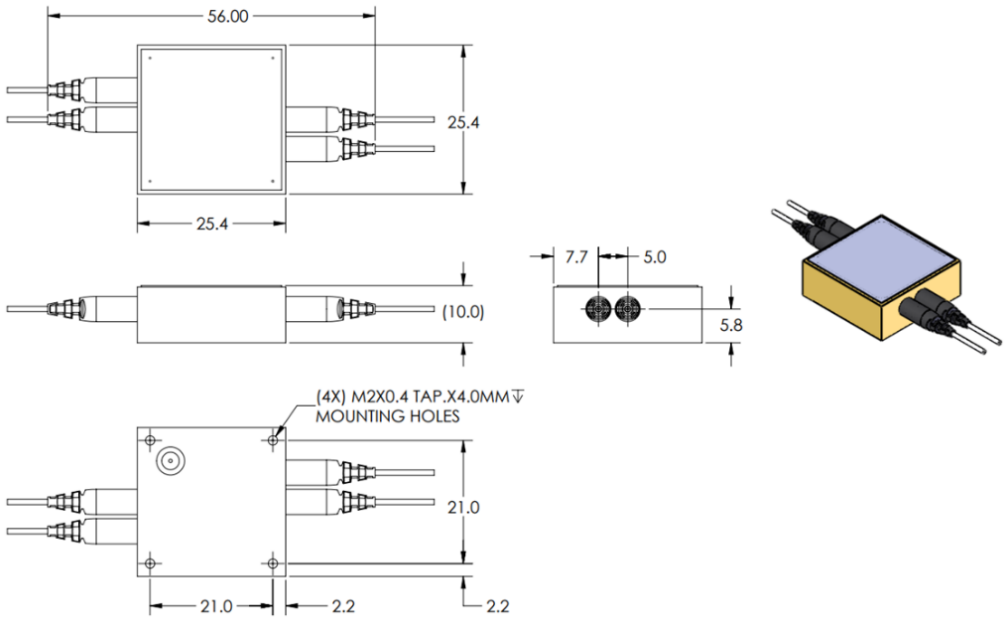
Device Dimension	*Unit*	Spec
L×W×H	*mm*	25.4 x 25.4 x 10

Parameter		Unit	Specification
Wavelength Range (C- or L-Band)		*nm*	1527 ~ 1567
Phase Difference[1] (between M_1, M_2 and M_3, M_4)		*deg*	**180 ± 5**
Insertion Loss[1] (without connector)	S→M_i	*dB*	**< 5.5**
	L→M_i	*dB*	**< 5.5**
Insertion Loss Difference[1]	S→M_1 and S→M_2	*dB*	< 0.5
	L→M_1 and L→M_2	*dB*	< 0.5
	Between all other ports	*dB*	< 0.7
Optical Return Loss		*dB*	> 27
Optical Path Difference (skew, between M_1)		*ps*	< 5
Fiber Type	Signal Input Port	/	SMF-28 with 900-μm tight buffer
	Local Input Port	/	SMF-28 with 900-μm tight buffer
	Outputs	/	SMF-28 with 900-μm tight buffer
Pigtail Length	Signal Input Port	*mm*	1000 ± 100
	Local Input Port	*mm*	1000 ± 100
	Outputs	*mm*	1000 ± 100
Type of Connector	Signal Input Port		FC/APC
	Local Input Port		FC/APC
	Outputs	-	FC/APC

MPN	Description	Note
HB – C0KFAS180	180 Optical Hybrid, C-Band, SM Fiber for all ports, FC/APC for all-ports	
HB – C0KFAP180	180 Optical Hybrid, C-Band, PM Fiber for all ports, FC/APC for all-ports	
HB – C0KFAX180	180 Optical Hybrid, C-Band, PM Fiber for both Signal- and Lo- Input ports, SM Fiber for Output Ports; FC/APC for all-ports	

See below selection guide for other wavelength bands and type of connectors





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2x4 Coherent Mixer

Optoplex's 2x4 polarization diversified optical hybrid (aka QPSK Mixer) mixes an incoming signal with a local oscillator. The device features a monolithic optical core integrating a PBS with an interferometer which is also widely used in Optoplex's interleavers and DPSK-demodulators. This device is athermal, colorless, data-rate independent and compact size. The four outputs of this device can be coupled with four single-ended detectors (see the function diagram below). This platform can also be extended to a 2x8 polarization diversified hybrid to incorporate with 4 pairs of balanced detectors.

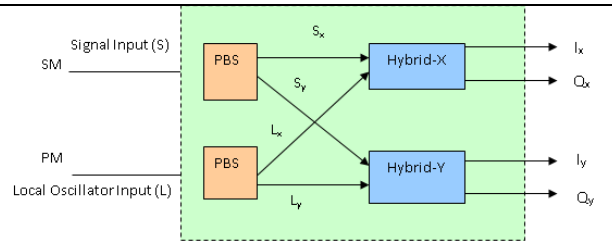
The QPSK mixer is a key building block in the ever-popular polarization- and phase-diversified QPSK modulation scheme which is not only one of the leading contenders for the 100-Gb/s systems but also a significant cost-effective alternative for the 40-Gb/s systems where 10-Gb/s modulator and electronics can be used.

Table 1, 2x4 Coherent Mixer Performance Specifications

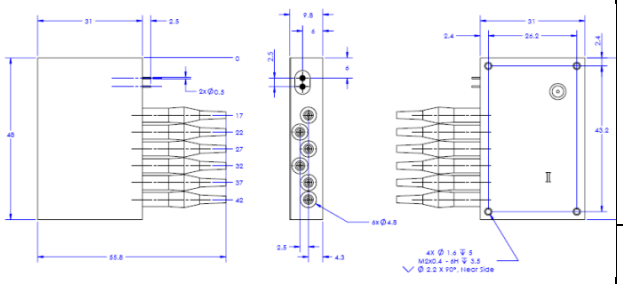
Parameter		Unit	Specification
Wavelength Range (C-Band)		*nm*	See Table 2
Phase Difference[1] (between I_k and Q_k), k=x or y		*degree*	90±10
Insertion Loss[1] (not including connector)	S (polarization scrambled) → All Outputs	*dB*	9.5 ~ 11
	L (45° linear polarized) → All Outputs	*dB*	9.5 ~ 11
Insertion Loss Uniformity[1]	Among S → All Outputs; Among L → All Outputs	*dB*	<0.7
	Among All Others	*dB*	<1.0
Optical Return Loss		*dB*	>27
Optical Path Difference[1] (Skew, among S→ All Outputs)		*ps*	<1
Optical Path Difference[1] (Skew, among L→ All Outputs)		*ps*	<1
Polarization extinction ratio[1] (for either S or L)		*dB*	>18
Max. Input Optical Power		*mW*	300
Operating Temperature Range		*°X*	0 ~ 65

Notes:

1) Available wavelength bands: C-,



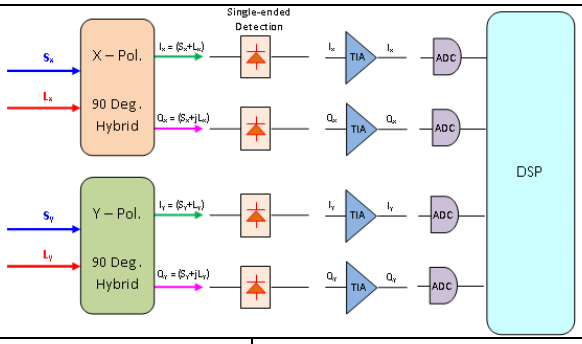
Mechanical Drawing



Popular Part Numbers

HB-C0BSCS001	2x4 QPSK Mixer, C-band, 90+/-10deg, PMF for Lo-, SMF for ALL other ports, SC/UPC for ALL
HB-C0BFAC083	2x4 QPSK Mixer, C-band, 90+/-10deg, PMF for Lo-, SMF for ALL other ports, FC/APC for ALL
HB-C0BFAC084	2x4 QPSK Mixer, C-band, 90+/-5deg, PMF for Lo-, SMF for ALL other ports, FC/APC for ALL

Application (Optical Coherent Detection)



Features

- Athermal design
- Low (TDFS, PDFS, IL & PDL)
- Fully and semi-tunable, independent I- and Q-control
- Wide bandwidth
- High power handling

Telcordia GR-1221 qualified

Applications

- High-speed optical comm. (coherent detection)
- Free-space laser communication
- Satellite optical communication
- Quantum Cryptographic
- Fiber sensing (phase shift Measurement)
- Precise optical measurement

Optical spectroscopy

Ordering Information

HB	—	W	0	X	Y	Y	Z	n	n	n

W - Wavelength
C = C -Band
L = L -Band
T = C+L-Band
Q = O-Band
A = 1064nm

X: Type
A = 90deg Hybrid
B = 2x4 Mixer
G = 2x8 Mixer

YY: Connector
FA = FC/APC
FC = FC/UPC
LA = LC/APC
LC = LC/UPC
SC = SC/UPC

Z: Made
S = Standard
C = Custom

nnn: Sequential
(to be assigned by Optoplex)

Optoplex will assign "nnn" for each MPN in whichtge type of fiber, pigtails, ..., etc., will be defined

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2x8 Coherent Mixer

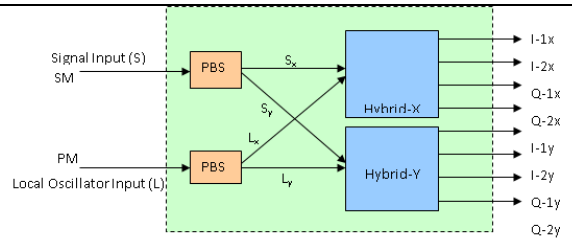
To be used for optical coherent detection such as DP-QPSK receivers, Optoplex's ten-port **2x8 Coherent Mixer** (aka QPSK mixer) combines the incoming signal with a local oscillator to generate eight light states in the complex-field space. The eight light output signals can then be coupled into four pairs of balanced photodetectors. The block diagram below shows the application of a **2x8 coherent mixer** in a DP-QPSK receiver. Since the mixing process is data rate independent, the devices can be used for any data rate in applications such as 40Gb/s or 100Gb/s transmission systems.Optoplex's **2x8 Coherent Mixer** is free-space micro-optics-based and patent pending. The device exhibits highly athermal behavior in terms of insertion loss and phase error. When the output signals are detected by four pairs of balanced receivers, both the amplitudes and the relative phase information of the input signal can be extracted for signal amplification and for cost-effective compensation to optical transmission impairments, such as dispersion and PMD, in the electronic domain.

Table 1, 2x8 Coherent Mixer Performance Specifications

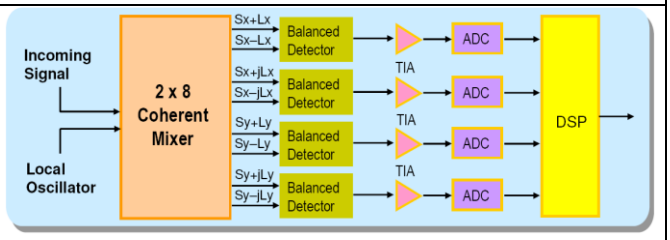
Parameter		Unit	Specification
Wavelength Range (C-Band)		*nm*	C-Band, or1
Phase Difference[1] (between I-1k and Q-1k), k=x or y		*degree*	90 ± 10
Insertion Loss[1] (not including connector)	S (polarization scrambled) à All Outputs	*dB*	9 ~ 12
	L (45° linear polarized) à All Outputs	*dB*	9 ~ 12
Insertion Loss Uniformity[1]	Between S à I-1k and S à I-2k; between S à Q-1k and S à Q-2k; between L à I-1k and L à I-2k; between L à Q-1k and L à Q-2k; k=x or y	*dB*	<0.7
	Among All Others	*dB*	<1.5
Optical Return Loss		*dB*	> 27
Optical Path Difference[1] (Skew, among Sà All Outputs)		*ps*	<1
Optical Path Difference[1] (Skew, among Là All Outputs)		*ps*	<1
Polarization extinction ratio[1] (for either S or L)		*dB*	>18
Max. Input Optical Power		*mW*	300
Operating Temperature		*°X*	0 ~ 65

Notes:

2) Available wavelength bands: C-, L, C+L, O-, and 1064nm



Application (Optical Coherent Detection)

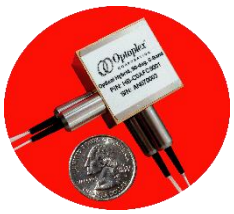


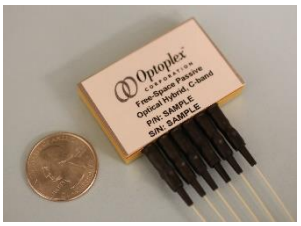
Features

- Purely passive (no temperature control)
- Compact size
- Low insertion loss
- Low phase error
- <1 ps skew
- Colorless (wavelength independent)
- Data-rate independent

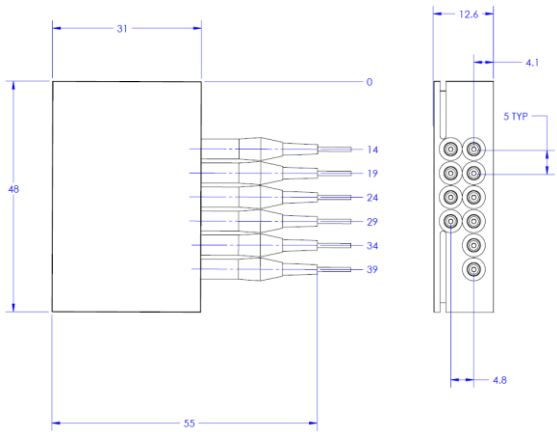
Applications

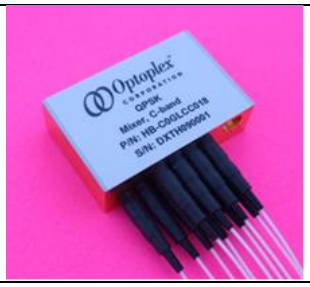
- Optical coherent detection
- DP-QPSK demodulation
- Transmission at 100Gb/s (preferred modulation format)
- Polarization diversified coherent Doppler Lidar
- Polarization diversified coherent DAS
- Polarization diversified OCT





Mechanical Drawing





Ordering Information

HB	—	W	0	X	Y	Y	Z	n	n	n

W - Wavelength
C = C -Band
L = L -Band
T = C+L-Band
Q = O-Band
A = 1064nm

X: Type
A = 90deg Hybrid
B = 2x4 Mixer
G = 2x8 Mixer

YY: Connector
FA = FC/APC
FC = FC/UPC
LA = LC/APC
LC = LC/UPC
SC = SC/UPC

Z: Made
S = Standard
C = Custom

nnn: Sequential
(to be assigned by Optoplex)

Optoplex will assign "nnn" for each MPN in whichtge type of fiber, pigtails, ..., etc., will be defined

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Integrated 90deg Hybrid Coherent Receivers

This document describes one of Optoplex's innovated products, a 90deg optical hybrid integrated with balanced photo-receivers, which can be used in optical sensing applications, particularly the coherent Doppler wind LIDAR (light detection and ranging). A photo of the product can be seen in Figure 1.1.

Coherent detection has been widely found in applications for RF and optical communications. In the past few years, coherent technology has been advanced dramatically in high-speed optical communications. With this advancement, key parts and components are commercially available and cost-effective for many applications beyond telecommunications, such as narrow linewidth lasers, optical hybrid, balanced photo-receivers, and DSP, etc.

High-performance 90deg optical hybrid is an important part in optical coherent detection. Optoplex's free-space, micro-optics-based, and passive 90deg Optical Hybrid is a mixer in *coherent detection* and has been widely used in both 40Gbps and 100Gbps coherent transmission systems in optical communications. In addition to 90deg optical hybrid, 2x4 coherent mixer and 2x8 coherent mixer, Optoplex has developed and supplied integrated 40G and 100G coherent receivers as well.

In Doppler LIDAR applications, 90deg optical hybrid is a must-have component. Compared to conventional mixer using fiber optic couplers, it won't be able to provide information about wind vector. While, because 90deg optical hybrid provides the 90deg phase information between I- and Q- paths, it can yield to the wind vector information.

Figure 1.2 below illustrates the functional block diagram of the integrated 90deg optical hybrid with balanced photoreceivers.

The integrated 90deg hybrid receiver could have 3dB electrical bandwidth of 15, 100, 200, 400MHz, or 1.6GHz. The default RF output mode is AC-coupled. DC coupled version is also available.

1. Optical Performance of 90deg Hybrid. Refer to 90deg Optical Hybrid.
2. Electrical Performance. See below table.

Parameter	Unit	Min	Typ.	Max
Type of Detector			InGaAs	
Wavelength Range	*nm*	1510		1670
Responsivity, Typical	*V/W*		8	
RF Output Bandwidth (3dB)	*MHz*	DC		100
Common Mode Rejection Ratio (CMRR)	*dB*	20	30	
Transmission Gain	*V/A*		$50x10^3$	
Conversion Gain RF Output	*V/A*		$50x10^3$	
CW Saturation Power	*μΩ*		72	
NEP (DC - 10MHz)	*pW/*		3.8	
Integrated Noise (DC - 100MHz)	nW_{RMS}		65	
Overall Output Voltage Noise	mV_{RMS}		2.2	
RF Output Impedance	*Ω*		50	
RF Output Voltage Swing	*V*			-3.6
DC Offset RF Output	*mV*			+/-3
Max Optical Input Power	*mW*			20
Power Supply, Voltage	*V*			+/-12
Power Supply, Current	*mA*			200
Electrical Output Interface			SMA	

Notes:

1) The 90deg hybrid is independent of speed
2) The above table is for 100MHz BW of the Balanced Photoreceivers. For other bandwidths, such as 200, 350, 700 and 1200, and 1700MHz, please contact Optoplex for details.

Features

- Free-space optics based 90deg optical hybrid
- Accurate 90deg phase difference, small temperature, wavelength and polarization dependence
- Superior optical performance (IL, TDL, PDL, Skew, etc.)
- Low dark current
- High CMRR
- High PER

Applications

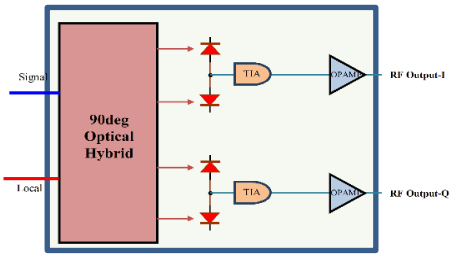
- Coherent Doppler LIDAR system
- Coherent detection in fiber sensing
- Coherent detection in OCT and other biomedical sensing/imaging systems
- Coherent spectroscopy instrumentation
- Coherent detection in optical communications

BW, Input Fiber	P/N of 90deg Hybrid Rx	Notes
15MHz BW, PMF	RX-KC0015P811	
15MHz BW, SMF	RX-KC0015S812	
100MHz BW, PMF	RX-KC0100P801	
100MHz BW, SMF	RX-KC0100S802	
200MHz BW, PMF	RX-KC0200P803	
200MHz BW, SMF	RX-KC0200S804	
350MHz BW, PMF	RX-KC0350P805	
350MHz BW, SMF	RX-KC0350S806	
400MHz BW, PMF	RX-KC0400P807	
400MHz BW, SMF	RX-KC0400S808	
700MHz BW, PMF	RX-KC0700P809	
700MHz BW, SMF	RX-KC0700S810	
1.6GHz BW, PMF	RX-KC1600P815	
1.6GHz BW, SMF	RX-KC1600S816	

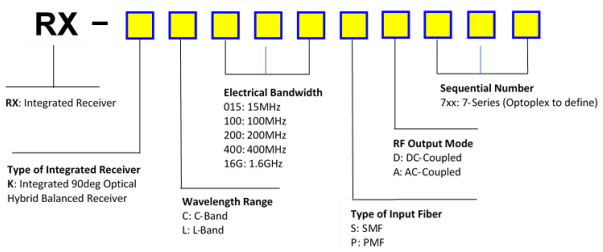
Notes:

1) for 90deg hybrid, we also offer for O-Band.
2) For the balanced receiver output, options are either DC- or AC-coupled RF Output.
3) For 1.6GHz one, only AC-coupled output available

Functional Block Diagram of Integrated 90deg Hybrid with Balanced Receiver



Ordering Information



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2x8 Coherent Receivers

2x8 Polarization Diversified 90deg Hybrid (aka 2x8 Coherent Mixer) with Integrated Balanced receiver

3. Optical Performance of 90deg Hybrid. Refer to 90deg Optical Hybrid.
4. Electrical Performance. See below table.

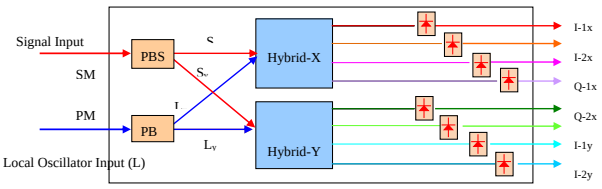
Parameter	Unit	Min	Typ.	Max
Type of Detector		InGaAs		
Wavelength Range	*nm*	1510		1670
Responsivity, Typical	*A/W*		0.9	
RF Output Bandwidth (3dB)	*MHz*	DC		100
Common Mode Rejection Ratio (CMRR)	*dB*	20	30	
Transmission Gain	*V/A*		$25x10^3$	
Conversion Gain RF Output	*V/W*		$22.5x10^3$	
CW Saturation Power	*μΩ*		110	
NEP (DC - 10MHz)			3.8	
Integrated Noise (DC - 200MHz)	nW_{RMS}		65	
Overall Output Voltage Noise	mV_{RMS}		2.2	
RF Output Impedance	*Ω*		50	
RF Output Voltage Swing	*V*			-3.6
DC Offset RF Output	*mV*			+/-3
Max Optical Input Power	*mW*			25
Power Supply, Voltage	*V*			+/- 12
Power Supply, Current	*mA*			200
Output Coupling		AC-coupled output		
Electrical Output Interface		SMA		

Notes:

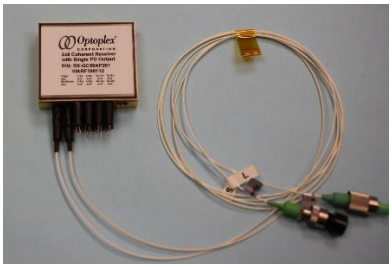
3) The 90deg hybrid is independent of speed

4) The above table is for 100MHz BW of the Balanced Photoreceivers. For other bandwidths, such as 200, 350, 700 and 1200, and 1700MHz, please contact Optoplex for details.

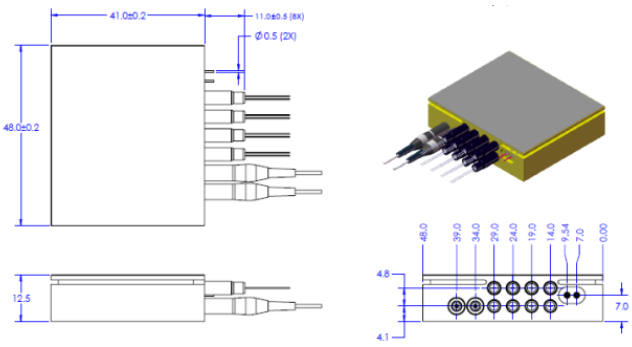
2x8 Coherent Mixer wit Single-ended Photodetector



Parameter	*Unit*	*Min*	*Max*
Storage temperature range	*°C*	-40	85
Storage humidity	*%*	5	95
Accumulated maximal optical input power	*dBm*	17	-
	dBm	17	-
Photodiode bias voltage	*V*	-0.3	5.6
Photodiode (reverse) bias current	*mA*		5
Electro static discharge (ESD) voltage	*V*	250	-
	C = 100pF; *R* = 1.5 kΩ; Human Body Model		



Functional Block Diagram of Integrated 90deg Hybrid with Balanced Receiver



Ordering Information:

Product: 2x8 Coherent Mixer with Single-ended Photodetector Output
MPN: RX-GC50AP201

Product: Integrated 2x8 DP-QPSK Coherent Receiver

Part Number	Description
RX-KC0100S901AC	Integrated 2x8 DP-QPSK Coherent Mixer with Balanced Receiver, 100MHz BW, AC-Coupled Output, SMA
RX-KC0200S903AC	Integrated 2x8 DP-QPSK Coherent Mixer with Balanced Receiver, 200MHz BW, AC-Coupled Output, SMA
RX-KC0350S905AC	Integrated 2x8 DP-QPSK Coherent Mixer with Balanced Receiver, 350MHz BW, AC-Coupled Output, SMA

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Balanced Photoreceivers

Coherent detection has been found increasing applications in fiber sensing as well as in conventional RF and optical communications. In the past several years, coherent technology has been advanced dramatically in high-speed optical communications. Whit this, key parts and components (such as narrow linewidth lasers, optical hybrid, balanced photo-receivers and DSP, etc.) are commercially available and cost-effective for many applications beyond telecommunications.

Optoplex has developed a series of products for coherent applications. They are

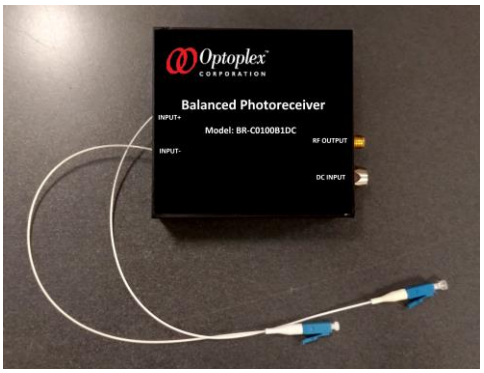
- 90deg optical hybrid
- 2x8 coherent mixer
- Integrated 40G coherent receiver (40G ICR)
- Integrated 100G coherent receiver (100G ICR)
- 90deg optical hybrid integrated with balanced receiver
- 2x8 coherent mixer with photodiode outputs, and
- Balanced Photoreceivers

Optoplex's balanced photoreceiver is designed for optical coherent detection for non-telecom applications. It features a pair of photodiodes that are well matched and balanced in responsivity, bandwidth and noise, etc. The outputs of the photodiodes are amplified by low-noise TIA to produce a single RF output that is proportional to the difference between the photo-currents from the two photodiodes.

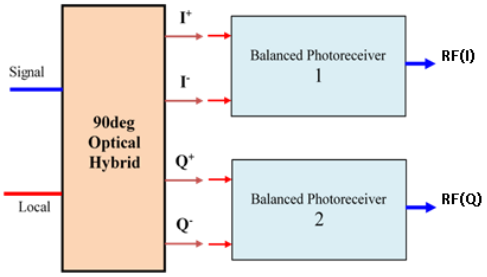
The photoreceiver has a 3dB bandwidth of about 100MHz. The RF output swing is +/-3.6V for high impedance load (±1.8 V into 50 Ω). The CMRR is better than 20dB (with a typical value of 30dB).

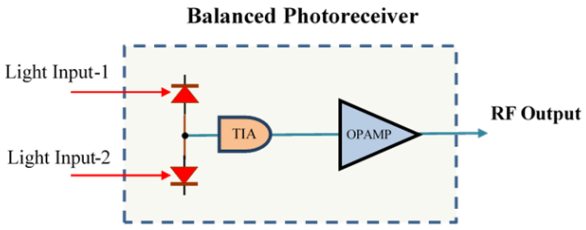
Specification of 100MHz Balanced Receiver

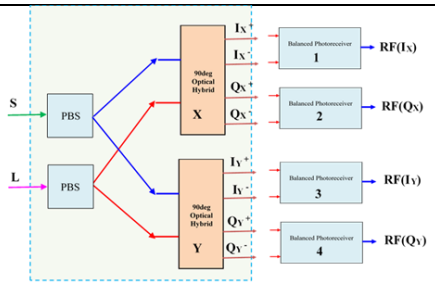
Parameter	Unit	Min	Typ.	Max
Type of Detector		InGaAs		
Wavelength Range	*nm*	**1310**		**1670**
Responsivity, Typical	*V/W*		8	
RF Output Bandwidth (3dB)	*MHz*	DC		100
Common Mode Rejection Ratio (CMRR)	*dB*	20	30	
Transmission Gain	*V/A*		$25x10^3$	
Conversion Gain RF Output	*V/W*		$25x10^3$	
CW Saturation Power	*μΩ*		72	
NEP (DC - 10MHz)			3.8	
Integrated Noise (DC - 100MHz)	nW_{RMS}		65	
Overall Output Voltage Noise	mV_{RMS}		2.2	
RF Output Impedance	*Ω*		50	
RF Output Voltage Swing	*V*			-3.6
DC Offset RF Output	*mV*			+/-3
Max Optical Input Power	*mW*			20
Power Supply, Voltage	*V*			+/-12
Power Supply, Current	*mA*			200
Output Coupling		AC-coupled output		
Electrical Output Interface		SMA		



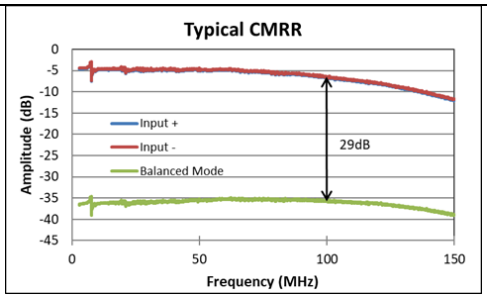
Applications:







Part Number	Description
BR-C0100B1AC	Balanced Photoreceivers, 100MHz, SMF, FC/APC Inputs, SMA Outputs, AC-Coupled, 12VDC
BR-C0100B1DC	Balanced Photoreceivers, 100MHz, SMF, FC/APC Inputs, SMA Outputs, DC-Coupled, 12VDC
BR-C0200B1AC	Balanced Photoreceivers, 200MHz, SMF, FC/APC Inputs, SMA Outputs, AC-Coupled, 12VDC
BR-C0200B1DC	Balanced Photoreceivers, 200MHz, SMF, FC/APC Inputs, SMA Outputs, DC-Coupled, 12VDC
BR-C0350B1AC	Balanced Photoreceivers, 350MHz, SMF, FC/APC Inputs, SMA Outputs, AC-Coupled, 12VDC
BR-C0350B1DC	Balanced Photoreceivers, 350MHz, SMF, FC/APC Inputs, SMA Outputs, DC-Coupled, 12VDC



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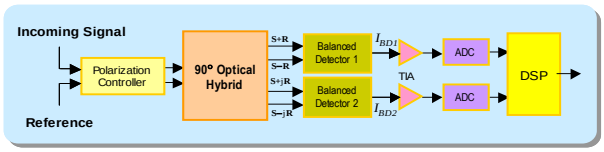
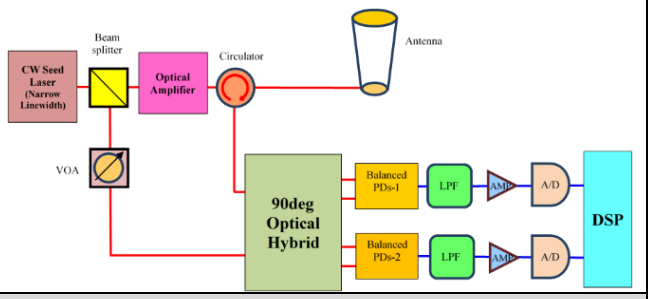
Examples of Coherent Detections

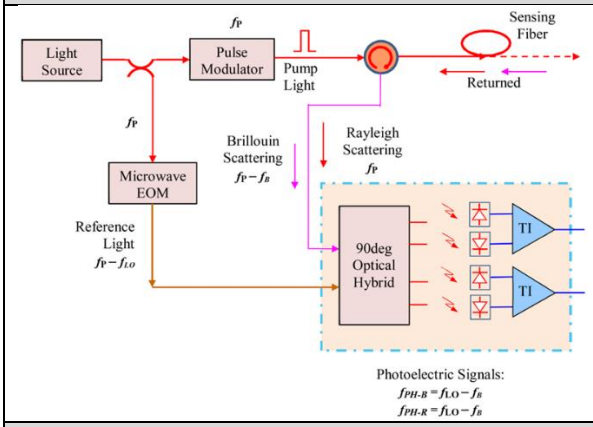
Optical Communications



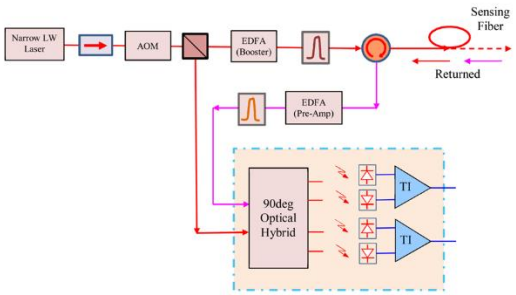
Coherent Lidar



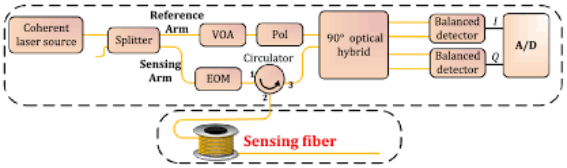
Fiber Sensing Application



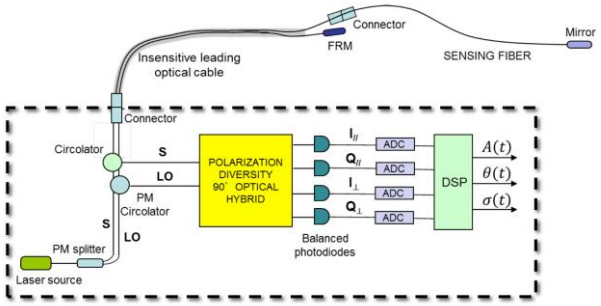
Coherent OTDR



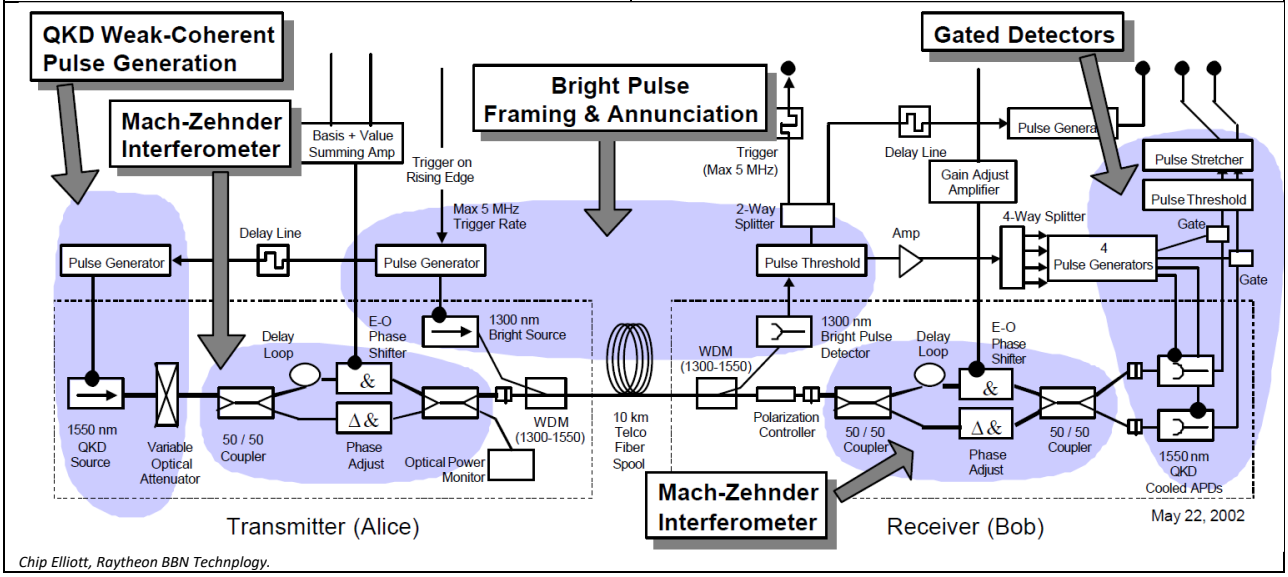
Distributed Acoustic Sensing System (DAS)



A Software-Defined Coherent Fiber Optic Sensor for Manufacturing Machine Diagnostic



M. Ferrario, et al., Politecnico di Milano, Italy



Chip Elliott, Raytheon BBN Technplogy.

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Optical Interleavers

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 diagrams in Figure 1 below). Each optical interleaver device is optimized to cover either C-, L-, C+L, or O-Band wavelengths. Other wavelength bands can be made upon request. The current optical interleaver product family supports 200-400, 100-200, 50-100, 25-50, and 12.5-25 GHz and other custom channel spacings, such as 75-150, 66.67-133.33, 40-80, 375.-75, 33.33-66.67, and 20-40GHz. 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 channel spacing) and asymmetric interleavers (Even and Odd channels have different passband bandwidths) are also available.

Optoplex is the technology and marker leader on optical interleavers. It was the first one to produce 25-50GHz one in volume production; the first one to provide Mux/DeMux co-package solution; the first one to offer Super Interleaver ("super-wide passband"), the first one to supply O-Band interleavers for 5G front-haul mux/demux application, … etc.. Optoplex has been supplying optical interleaver to all major global telecom equipment manufacturers for optical communications including terrestrial, subsea and aerospace applications.

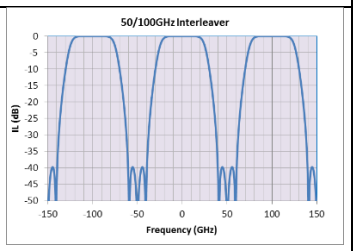
Design Platforms

Optoplex has three types of the optical interleaver designs:

A) Standard Design

It is based on free-space optics micro-interferometer design that offers very good performance, low IL< wide-passband and excellent thermal stability

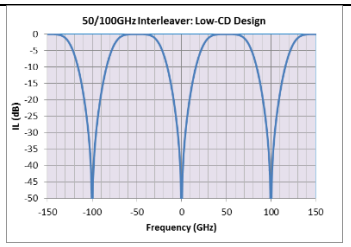
For instance, the 0.5dB BW of a 50/100GHz interleaver is about +/-15GHz, compared to +/-10GHz by other competitive technologies.



B) Low-CD Design

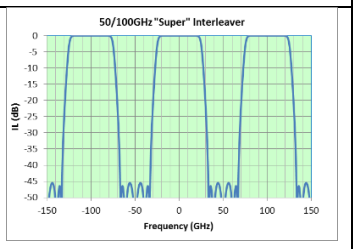
Normally, the CD (Chromatic Dispersion) of a 50/100GHz ITLV is about 75ps/nm. To achieve lower CD, usually additional DCM is required.

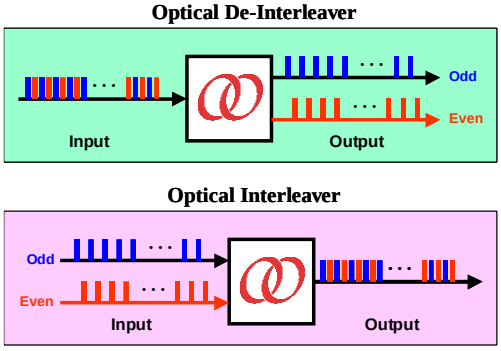
Optoplex has a special Low-CD design that can offer the CD of 30ps/nm and no additional CDM is required for most application, without significant cost increase and the device form factor is same as the standard one.



C) "Super" Wide-Bandwidth Design

Optoplex released the super-wide-bandwidth design in 2012 to meet the demanding 100 and 400Gbps applications. The super design offers a "squared-wave" like spectral profile. Its 0.5dB BW (in a 50/100GHz ITLV) reaches +/-19GHz, almost 2X of the conventional one's (+/-10GHz) of other competitive technologies' .





Features

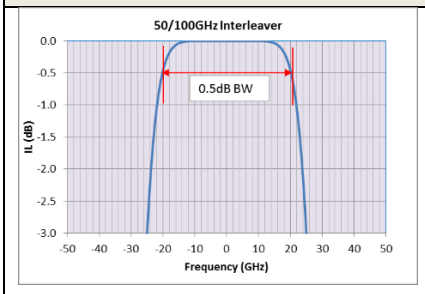
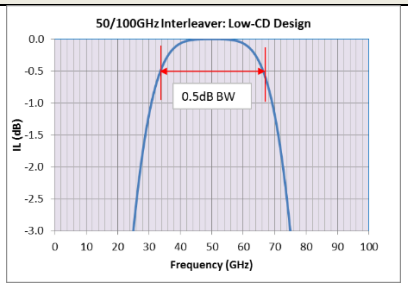
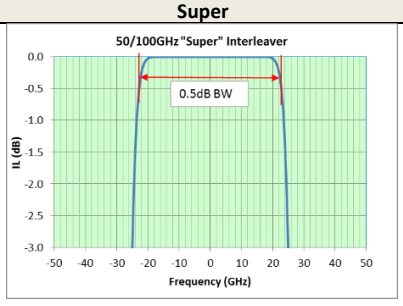
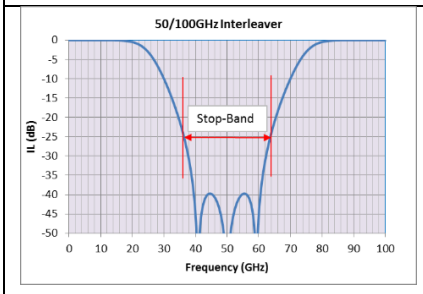
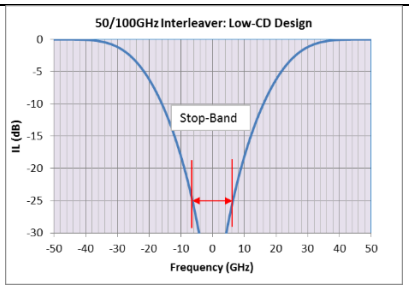
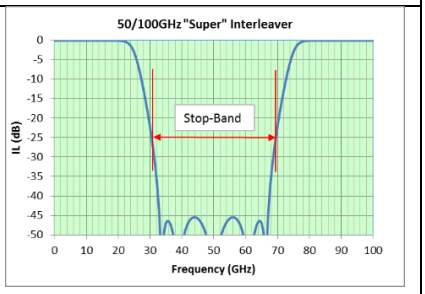
- Wide and flat passband
- Low IL, PDL, CD, TDFS, etc.
- High channel isolation
- Dual C- and L-band coverage
- DeMux/Mux co-packaged solution available
- Asymmetric/uneven optical interleaver available

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

ITLV Device:

ITLV Module:

Standard	Low-CD	Super
		
		

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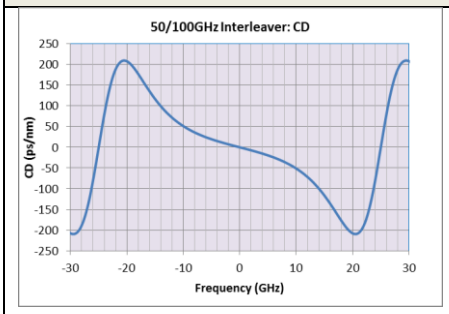
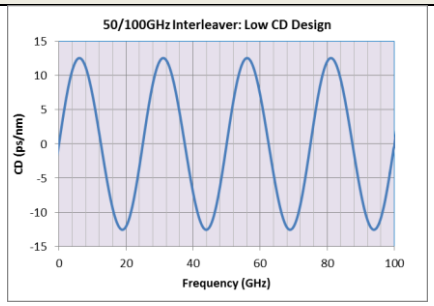
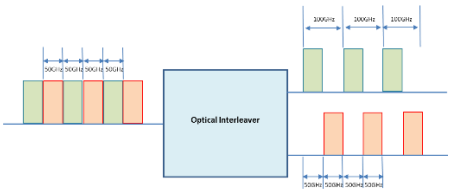
Standard	Low-CD	Super
		

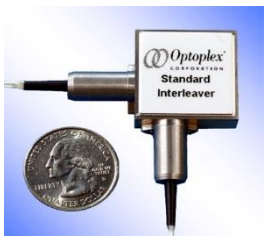
Asymmetric Interleaver

Usually, an optical interleaver offers symmetric optical spectral profiles for both odd- and even- output ports (except for the frequency off-set applied on one port with respect to the other). Optoplex is able to design "asymmetric interleaver" from which the odd and even output spectra is asymmetric, for instance, 70% bandwidth for the odd channel and 30% for the even channel. The ratio can be custom designed to satisfy your demanding applications.
Normally, the signal spectral profiles (bandwidths) are different for signals of different data rates. For instance, 100Gbps signal's spectrum is wider than 40Gbps', and 40Gbps' is wider than 10Gbps'. With Optoplex's Asymmetric Interleavers, one can easily Mux different data rates' signals together, or oppositely DeMux different data rates' signals.
Asymmetric interleaver can be made for any channel spacing.

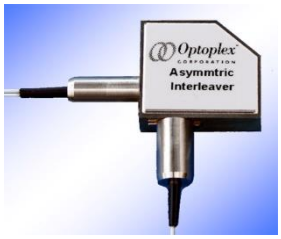
Symmetric Interleaver



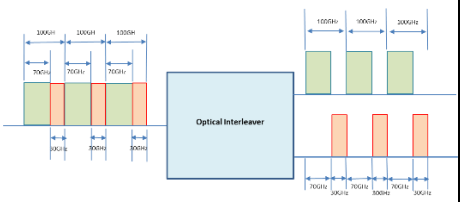
Symmetric Interleaver

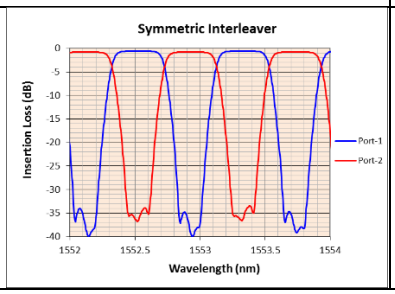


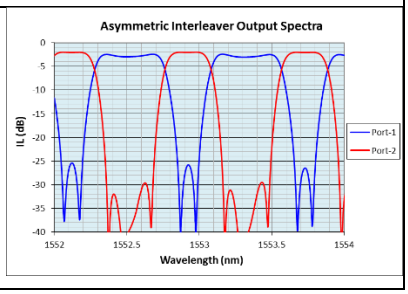
Asymmetric Interleaver



Asymmetric Interleaver





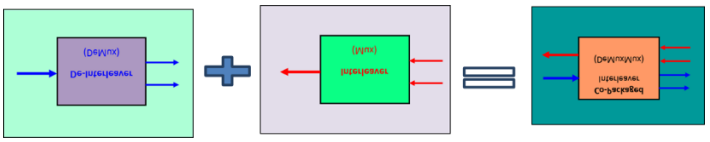


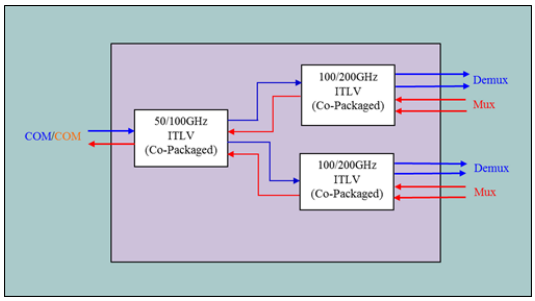
Co-Packaged Solution

Optoplex has proprietary technology to design and manufacture "co-packaged" interleaver – that is a Mux and a DeMux interleavers share the same optics in a package with the same form factor as used in an individual interleaver. Compare to discrete (using two individual interleavers, one as a Mux and another one as a DeMux) approach, Optoplex's Co-Packaged solution offers below:

Features

- Save 50% space (compared to that of individual solution where a separate Mux and DeMux are used)
- At least 30% of cost-saving than the individual solution
- Same performance (as individual approach)
- Same reliability (as individual approach)
- Proven track records





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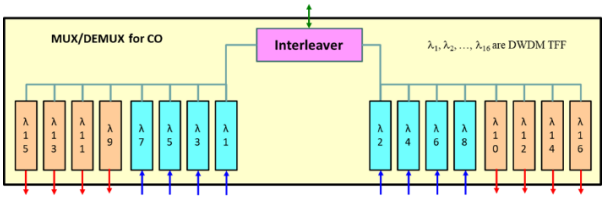
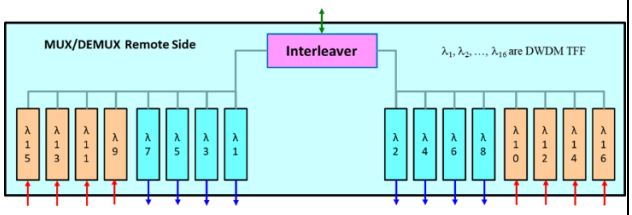
Multiple-Staged Interleaver

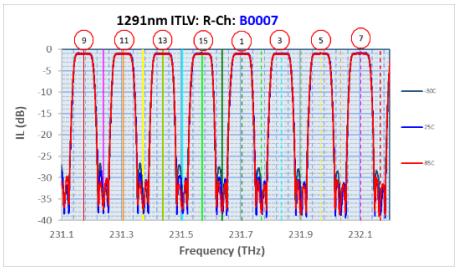
		**Two-Stages:** • 25/100GHz • 33.3/133.34GHz • 50/200GHz • 75/300GHz • 100/400GHz • Other customer specific	**Three-Stages:** • 12.5/100GHz • 25/200GHz • 37.5/300GHz • 50/400GHz • Other customer specific

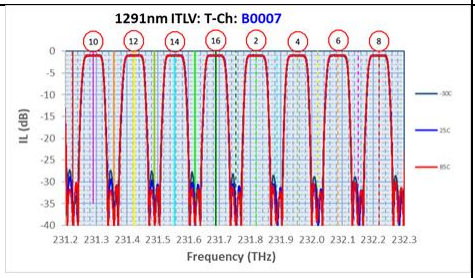
O-Band Interleavers





CWDM Channel	High-Band MPN	High-Band Wavelegnth Range (nm) Min	High-Band Wavelegnth Range (nm) Max	Low-Band MPN	Low-Band Wavelegnth Range (nm) Min	Low-Band Wavelegnth Range (nm) Max
1271	IL-Q1RCXXH1271	1271	1278	IL-Q1RCXXL1271	1264	1270
1291	IL-Q1RCXXH1291	1291	1298	IL-Q1RCXXL1291	1284	1290
1311	IL-Q1RCXXH1311	1311	1318	IL-Q1RCXXL1311	1304	1310
1331	IL-Q1RCXXH1331	1331	1338	IL-Q1RCXXL1331	1324	1330
1351	IL-Q1RCXXH1351	1351	1358	IL-Q1RCXXL1351	1344	1350
1371	IL-E1RCXXH1371	1371	1378	IL-E1RCXXL1371	1364	1370
1411	IL-E1RCXXH1411	1411	1418	IL-E1RCXXL1411	1404	1410
1431	IL-E1RCXXH1431	1431	1438	IL-E1RCXXL1431	1426	1430
1451	IL-E1RCXXH1451	1451	1458	IL-E1RCXXL1451	1346	1450
1471	IL-S1RCXXH1471	1471	1478	IL-S1RCXXL1471	1464	1470





IL - ☐☐☐☐☐☐☐☐☐☐

Band
C = C-Band
L = L-Band
T = C+L Band

Channel Spacing
0 = 25-50 GHz
1 = 50-100 GHz
2 = 100-200 GHz
3 = 200-400 GHz
A = 12.5-25 GHz
B = 37.5-75 GHz
D = 6.25-12.5 GHz
E = 20-40 GHz
T = 33.3-66.7 GHz
F = 40-80 GHz
G = 66.7-133.3GHz

Design Type
S = Super
R = Regular
L = Low CD

Package Type
C = Compact
B = Box

Connector Type
FC = FC/UPC
FA = FC/APC
LC = LC/UPC
SC = SC/UPC
MU = MU/UPC
XX = No connector

Specification
C = Custom
S = Standard

Sequential Number
Starts from 001

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Etalons

Optoplex's Inline Fabry-Perot Air-Gap Etalon is based on its proprietary free-space optics technology that offers superior optical performance and excellent environmental stability. With in-situ monitoring and adjustment in manufacturing, the FSR (free-spectrum range) can be made very accurately to the required spec (such as 50, or 100GHz). Also, the peak wavelength can be aligned very precisely to what the customers need.

Optoplex provides a wide selection of F-P Etalons covering different wavelength ranges for C-, L-, C+L, or O-band with different FSR from 200GHz, 100GHz, 50GHz, 25GHz, 12.5GHz to 6.25GHz.

Parameter	Symbol	Unit		FSR (GHz)					
Free Spectral Range (FSR)	FSR	*GHz*	***400***	**200**	**100**	**50**	**25**	**12.5**	**6.5**
FSR Tolerance	ΔFSR	*GHz*	±0.3	±0.2	±0.1	±0.05	±0.05	±0.03	±0.02
Center Frequency Alignment at room temperature	$\Delta\phi$	*GHz*	±3.0	±2.5	±1.5	±1.0	±0.5	±0.4	±0.3
Temperature dependent frequency shift	TDFS	*MHz/° C*	*50*	40	30	30	30	N/A	N/A

Features

- Low insertion loss
- Precise peak wavelength (frequency) setting
- Extremely environmental stability (+/-1.5GHz lifetime)
- Compact size
- Wide selections of wavelength coverages
- Large selections of FSR: 200, 100, 50, 25, 12.5, 6.25 or customer specific

Option with PM fiber available

Applications

- DWDM filtering
- Comb light source
- Inter-channel noise suppression
- Wavelength reference
- Signal shaping
- Spectroscopic Optical instrumentation

Type-A: Single-Transmission

Insertion Loss (dB)

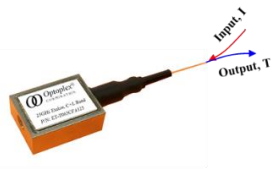
Mirror Reflectance	400GHz	200 GHz	100 GHz	50 GHz	25 GHz	12.5GHz	6.25GHz
31%	1.2	1.2	1.2	1.5	1.5	2.0	2.5
45%	1.2	1.2	1.2	1.5	1.5	2.0	2.5
50%	1.2	1.2	1.2	1.8	1.5	2.0	3.0
64%	1.2	1.2	1.2	2.0	2.0	2.5	3.5
70%	1.5	1.1	1.1	2.5	2.5	3.0	4.0
80%	1.5	1.1	1.1	2.0	2.5	3.5	4.5
90%	2.0	2.0	2.0	3.0	3.0	4..5	5.0
94%	2.5	2.5	3.0	3.5	4.0	5.5	6.0
97%	3.0	3.0	3.5	4.0	5.0	6.5	7.0

3dB BW

FSR (GHz)	Mirror Reflectance								
	0.31	0.45	0.5	0.64	0.7	0.8	0.9	0.94	0.97
6.25	2.66	1.68	1.44	0.90	0.72	0.45	0.21	0.12	0.06
12.5	5.32	3.36	2.88	1.81	1.43	0.89	0.42	0.25	0.12
25	10.64	6.72	5.75	3.61	2.87	1.78	0.84	0.49	0.24
50	21.27	13.45	11.50	7.22	5.74	3.57	1.68	0.99	0.48
100	42.54	26.89	23.01	14.45	11.48	7.13	3.36	1.97	0.97
200	85.09	53.78	46.01	28.90	22.95	14.27	6.71	3.94	1.94
400	170.18	107.56	92.02	57.79	45.90	28.53	13.43	7.88	3.88

Mirror Reflectance	Finesse	Peak-to-Valley Contrast Ratio (dB)
31%	2.5	5
45%	3.5	8
50%	4	9
64%	7	12
70%	8.5	14
80%	14	18
90	30	23
94	50	26
97	100	33

Type-B: Double Transmission



Insertion Loss (dB)

Mirror Reflectance	400GHz	200 GHz	100 GHz	50 GHz	25 GHz	12.5GHz	6.25GHz
31%	2.4	2.4	2.4	3.0	3.0	4.0	N/A
45%	2.4	2.4	2.4	3.0	3.0	4.0	N/A
50%	2.4	2.4	2.4	3.6	3.0	4.0	N/A
64%	2.4	2.4	2.4	4.0	4.0	5.0	N/A
70%	3.0	2.2	2.2	5.0	5.0	6.0	N/A
80%	3.0	2.2	2.2	4.0	5.0	7.0	N/A
90%	4.0	4.0	4.0	6.0	6.0	9.0	N/A
94%	5.0	5.0	6.0	7.0	8.0	N/A	N/A
97%	6.0	6.0	7.0	8.0	N/A	N/A	N/A

3dB BW

FSR (GHz)	Mirror Reflectance								
	0.31	0.45	0.5	0.64	0.7	0.8	0.9	0.94	0.97
6.25	1.63	1.06	0.91	0.58	0.46	0.29	0.13	0.08	0.08
12.5	3.26	2.12	1.82	1.15	0.92	0.57	0.27	0.16	0.17
25	6.51	4.24	3.65	2.31	1.84	1.14	0.54	0.32	0.34
50	13.03	8.48	7.29	4.62	3.67	2.29	1.08	0.63	0.67
100	26.06	16.96	14.58	9.23	7.35	4.58	2.16	1.27	1.34
200	52.12	33.92	29.17	18.46	14.69	9.15	4.31	2.53	2.69
400	104.23	67.85	58.34	36.93	29.39	18.30	8.62	5.06	5.38

Mirror Reflectance	Finesse	Peak-to-Valley Contrast Ratio (dB)
31%	3.5	**10**
45%	6	**16**
50%	7	**18**
64%	10	**24**
70%	14	**27**
80%	22	**35**
90	46	**40**
94	79	**45**
97	74	**55**

Notes:

- Type-A is the standard design of the free-space optics-based etalon.
- Type-B is a special design to provide higher peak-to-valley contrast ratio (almost 2X). The bandwidth of Type-B is slightly narrower (~0.7X of Type-A's). The insertion loss of Type-B is higher than Type-A's (~1.5 -2.0X)
- Please note that the 3dB BWs in above table are the ideal simulation results assuming insertion loss (IL) = 0deb. In practice, the IL varies from etalon to etalon, depending on FSR and R% coating. See above Table. For detail explanation of the FWHM, see next page.

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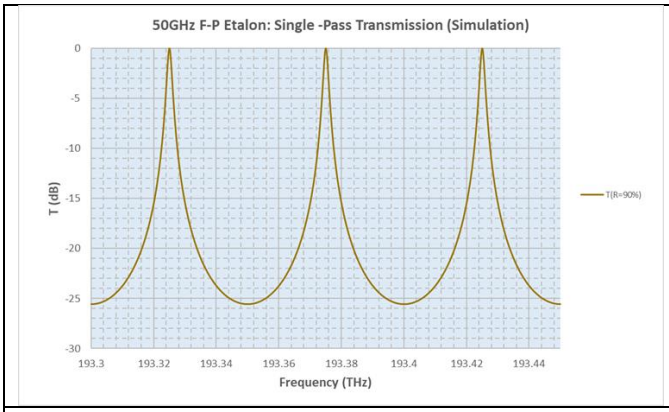
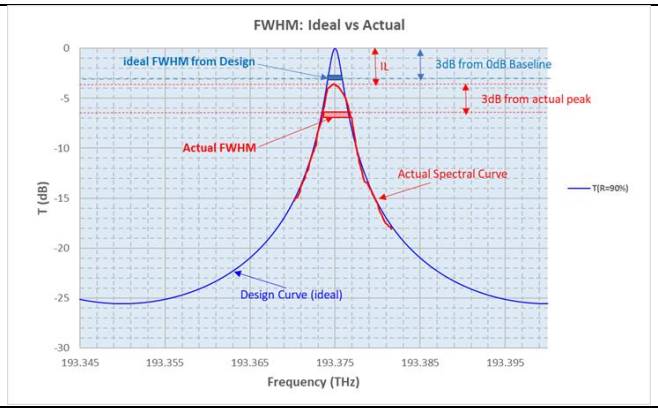
FWHM (3dB BW) of Etalons

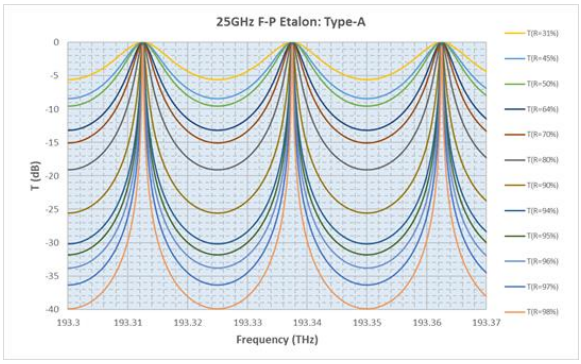


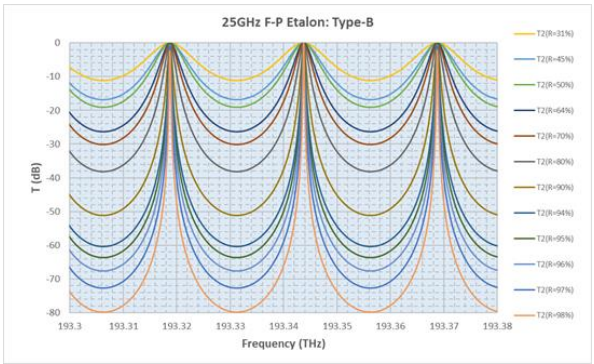
Example of a 50GHz SFR etalon at ideal condition (IL = 0dB)
(also refer to the blue curve and the blue texts at the right chart)

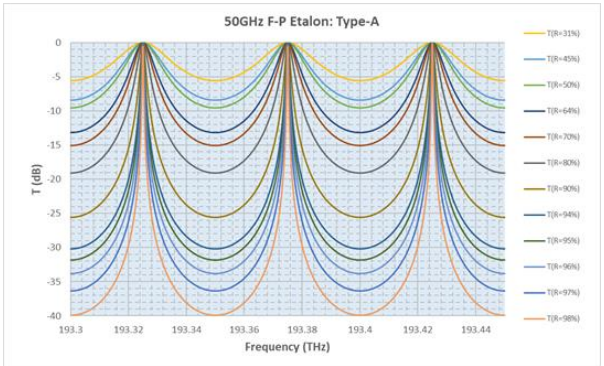


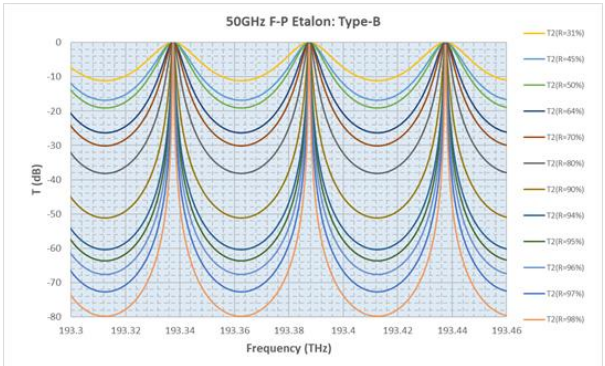
In practice, the FWHM (3dB) is measured from the spectral peak down 3dB. (See the red curve and red texts)

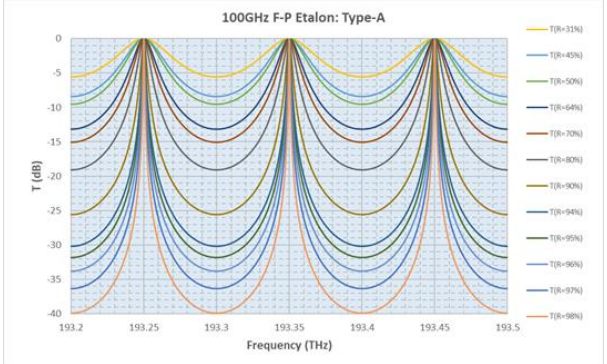
Simulation Spectra (ideal Situation, IL = 0deB), for reference only

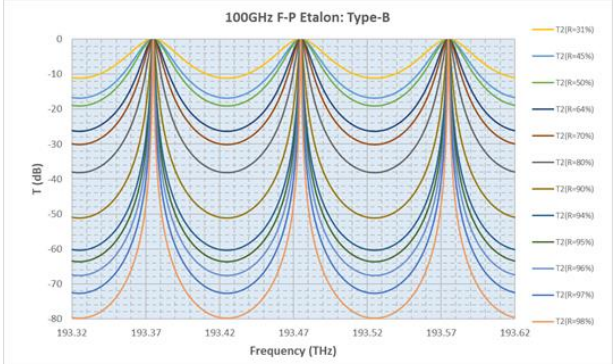












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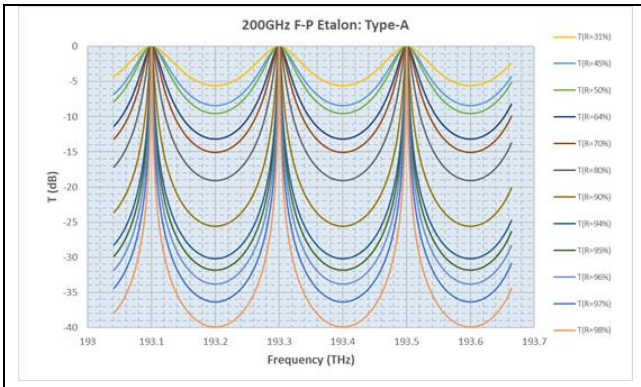
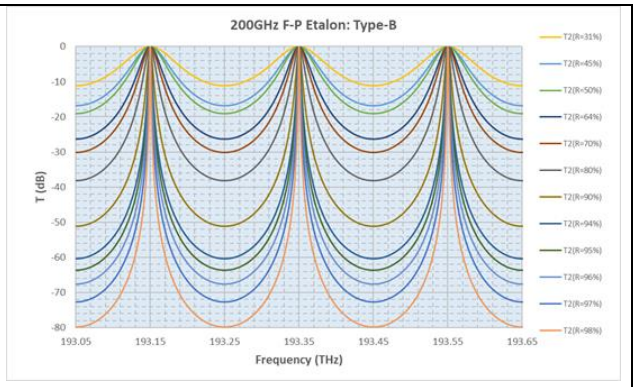
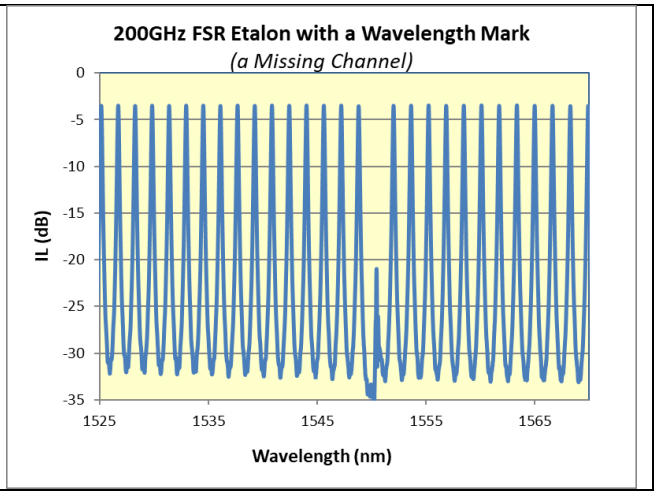




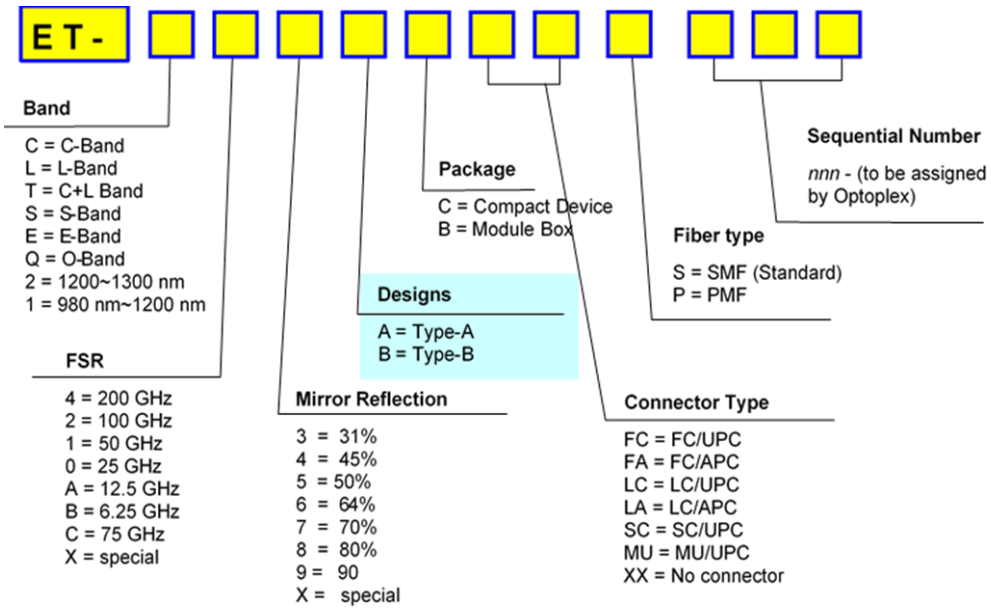
Etalon with a Built-in Wavelength Reference

Optoplex has a special design for etalon with a built-in wavelength reference (a missing channel). The missing channel can be used as an ABSOLUTE wavelength reference.

This is particularly useful in fiber sensing system with swept light source. With this wavelength ruler, one can measure the signal's wavelength very precisely.
Contact Optoplex for details.



Model and Part Number Definition



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Flat-Top Comb Filter

Optoplex provides customized **flat-top optical comb filter** based on its optical interleaver technology. In contrast with traditional Fabry-Perot cavity-based comb filter, Optoplex's **comb filter** is capable of transmitting modulated DWDM signals with its passband width available anywhere down to a few GHz. Both the filter channel spacing (FSR) and filter duty cycle (3-dB bandwidth to FSR ratio) can be specified by customers.
Based on Optoplex's patented technologies of micro-optics and phase modulation through thin-film coating, the flat-top comb filter is a purely passive device characterized by minimal temperature dependence, flat-top passband, high channel isolation, low PDL, and uniform insertion loss. The product is Telcordia GR-1221 qualified.

Features

- Wide and Flat Passband
- Minimal PDL
- High Isolation
- Minimal Thermal Drift
- Low and Customizable Dispersion
- Dual C- and L-Band Coverage
- Telcordia GR-1221/63 Qualified

Applications

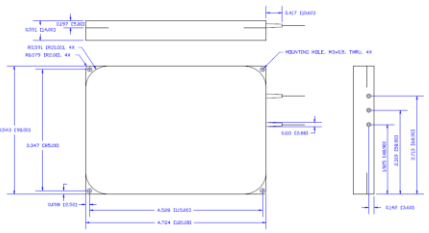
- Noise Suppression in DWDM System
- Reshape Signal Passband
- Optical Ruler in DWDM System
- Passband Reduction of Signals with High Modulation Rate

			Type-S: Standard					Type-D: Dual-Stage Design				
Parameter	**Symbol**	**Unit**	**200GHz**	**100GHz**	**50GHz**	**25GHz**	**12.5GHz**	**200GHz**	**100GHz**	**50GHz**	**25GHz**	**12.5GHz**
Operating Wavelength Range		nm	C-B, L, C+L, or O-Band					C-B, L, C+L, or O-Band				
Free-Specral Range	FSR	GHz	200	100	50	25	12.5	200	100	50	25	12.5
Passband Width @0.5dB	BW_1	*GHz*	76	36	18	9	4.5	75	35	17	8	4
Passband Width @ 1.0 dB	BW_1	*GHz*	*82*	42	22	11	5	*80*	40	20	10	4.5
Passband Width @ 3.0 dB	BW_3	*GHz*	***95***	**47**	**23**	**11.5**	**5.5**	***93***	**45**	**22**	**11**	**5**
Passband Width @ 10 dB	BW_{10}	*GHz*	*120*	60	30	15	7.5	*105*	50	27	13	6.5
Passband Width @ 20 dB	BW_{20}	*GHz*	*140*	70	35	20	10	*120*	60	30	15	8
Passband Width @ 30 dB	BW_{30}	*GHz*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*135*	65	33	17	10
Passband Width @ 40 dB	BW_{40}	*GHz*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*145*	70	35	20	12
Spectral Peak Alignment		*GHz*	*ITU, or customer specific*					*ITU, or customer specific*				
Channel Center Frequency Error (CCFE)	CCFE	*GHz*	*+/-1.0*	*+/-1.0*	*+/-0.75*	*+/-0.5*	*+/-0.5*	*+/-1.0*	*+/-1.0*	*+/-0.75*	*+/-0.5*	*+/-0.5*
Peak Insertion Loss	IL	*dB*	*2*	*2.2*	*2.2*	*2.5*	*2.5*	*4*	*4.2*	*4.2*	*4.5*	*4.5*
IL Uniformity	dIL	*dB*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*
Peak-to-Valley Isolation	ISO	*dB*	**>20**	**>20**	**>20**	**>20**	**>20**	***> 40***	***> 40***	***> 40***	***> 40***	***> 40***
PDL	PDL	*dB*	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Return Loss	ORL	*dB*	> 40	> 40	> 40	> 40	> 40	> 40	> 40	> 40	> 40	> 40

			Type-A: Special Design				
Parameter	**Symbol**	**Unit**	**200GHz**	**100GHz**	**50GHz**	**25GHz**	**12.5GHz**
Operating Wavelength Range		nm	C-B, L, C+L, or O-Band				
Free-Specral Range	FSR	GHz	200	100	50	25	12.5
Passband Width @0.5dB	BW_1	*GHz*	20	10	4.5	2	1
Passband Width @ 1.0 dB	BW_1	*GHz*	*25*	12	6.0	3	1.5
Passband Width @ 3.0 dB	BW_3	*GHz*	***43***	**21**	**10**	**5**	**2.5**
Passband Width @ 10 dB	BW_{10}	*GHz*	*60*	30	15	8	4
Passband Width @ 20 dB	BW_{20}	*GHz*	*90*	45	22	12	7
Passband Width @ 30 dB	BW_{20}	*GHz*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Passband Width @ 40 dB	BW_{20}	*GHz*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Spectral Peak Alignment		*GHz*	*ITU, or customer specific*				
Channel Center Frequency Error (CCFE)	CCFE	*GHz*	*+/-1.0*	*+/-1.0*	*+/-0.75*	*+/-0.5*	*+/-0.5*
Peak Insertion Loss	IL	*dB*	*4.0*	*4.0*	*4.0*	*4.5*	*4.5*
IL Uniformity	dIL	*dB*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*
Peak-to-Valley Isolation	ISO	*dB*	**>20**	**>20**	**>20**	**>20**	**>20**
PDL[1]	PDL	*dB*	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Return Loss[1]		*dB*	> 40	> 40	> 40	> 40	> 40

Fomb Filter Device

Comb Filter Module



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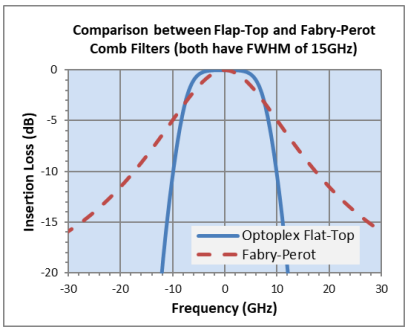
Comb Filter vs. F-P Etalon Filter

Both filters are periodic optical filters. The periodicity is defined by the channel spacing or called free-spectral-range (FSR). Etalon has a gaussian-like spectral top, while Optoplex's comb filter has a flat-top and much-square-like spectral shape that offers much better peak-to-valley isolation (or contrast ratio, or side-band rejection ratio). See the Figure at the right.

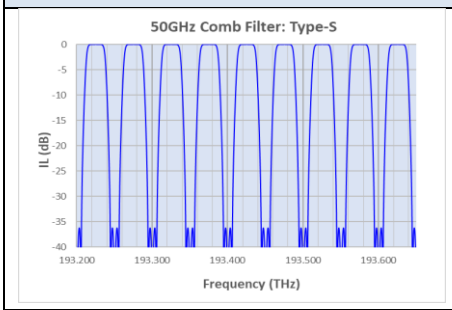
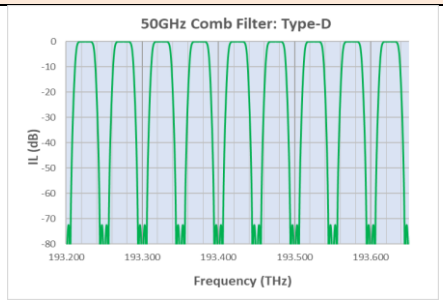
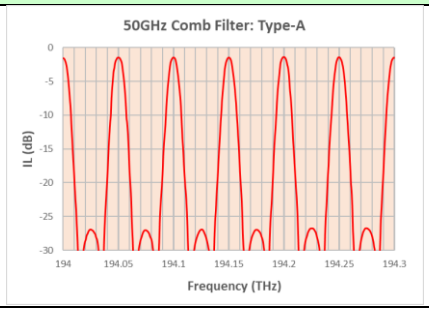
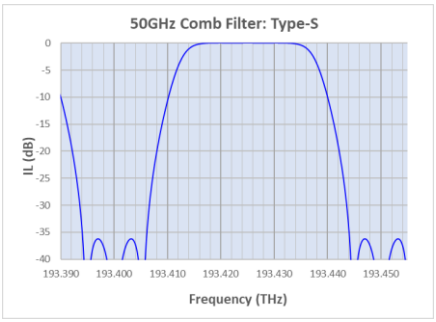
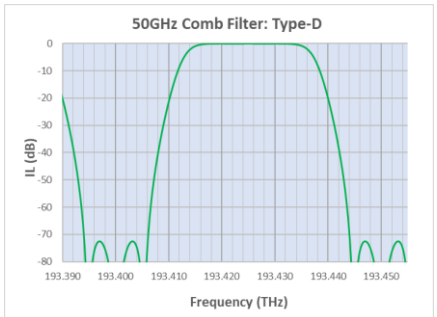
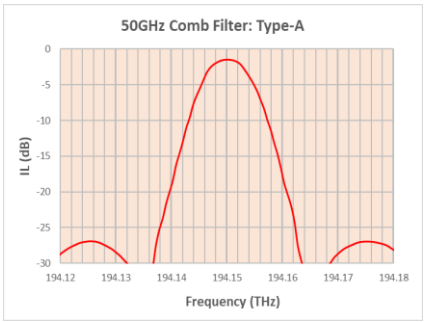


Types of Comb Filter Designs

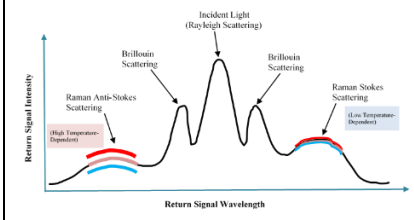
- Type-S: A standard design offers about 20 ~ 25dB isolation
- Type-D: A Dual-Stage design of the standard one (Type-S), offers almost 2X isolation. Due to dual-stage design, the package form is only in Module.
- Type-A: A special design (Optoplex's proprietary technology) that offers 2X narrower 3dB Bandwdith of the standard one.

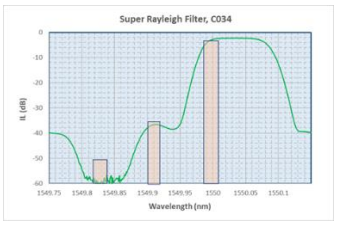
Custom Design

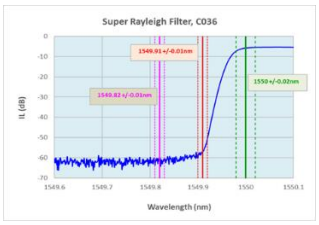
- Bandwidth: based on Type-A design, Optoplex's has the special expertise to custom design and make the comb filter to tailor the bandwidth to meet customer specific requirement.
- Slope: Optoplex has special expertise to design the comb filter with very steep slope and/or very high isolation. This is particularly useful in application such as optical sensing (Rayleigh, Raman or Stokes) where the signal is very weak (compared to the excitation laser) and very close to the excitation laser.

Type-S: Standard	Type-D: Dual Stage	Type-A: Special Design
		
		

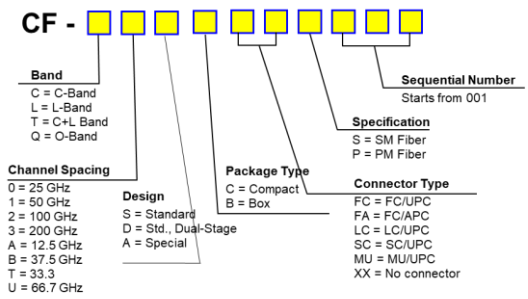
Optoplex can custom design special comb filter with very steep slope to separate two signals very close to each other, and/or with very high rejection ratio (60 ~ 80dB) such that very weak signal can be detected easily.

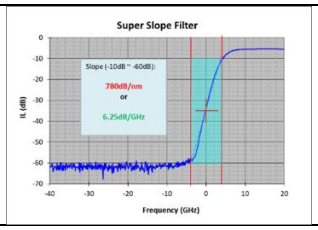


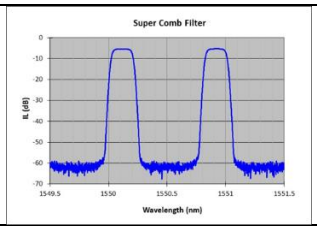




Product Ordering Information:







For special requirements on comb filter, please contact Optoplex at sales@optoplex.com.

Or call + 1 (510) 490-9930

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Wavelength Locker

Optoplex's Athermal Fabry-Perot Wavelength Locker is a thermally stable, etalon-based device that can be widely used in wavelength monitoring or ITU-grid channel locking in DWDM systems, laser stabilization for tunable laser, optical power and network monitoring. The wavelength locker has a wide capture range and excellent wavelength accuracy. A built-in thermistor can be used to calibrate out residue thermal effects when even higher wavelength accuracy is required or for a very narrow-FSR locker. The key optical component of the wavelength locker is an Etalon which is made in-house with Optoplex's proven technology in thin-film optical coating and optical contact.

Features

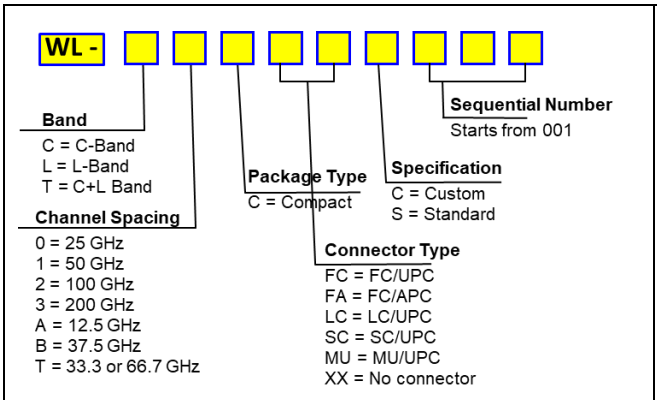
- Athermal design
- C+L-band coverage by a single device
- Extremely low temperature dependence
- High wavelength accuracy
- Periodical locking covers all channels
- Built-in thermistor for better locking accuracy
- Telcordia GR-468 & 1221 compliant

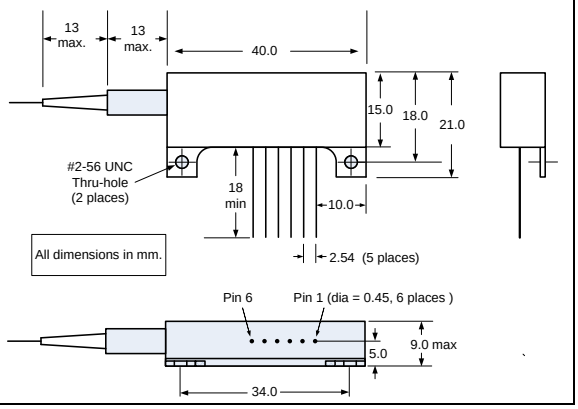
Applications

- Precision laser locking for DWDM and ultra DWDM transmitter
- Wavelength monitoring
- Laser stabilization for tunable laser module
- **DWDM channel frequency and optical power monitoring**

Parameter	Unit	12.5GHz	25GHz	50GHz	100GHz	200GHz
Wavelength Range	*nm*	C-Band: 1525-1565				
		L-Band: 1560-1620				
		C+L Band: 1520-1620				
		O- Band: 1260-1360				
		1064nm +/ 10nm				
Center Wavelength			ITU, or customer specific			
Wavelength Accuracy over T, Pol and FOL	*GHz*	±0.75	±1.25	±1.50	±1.50	±1.50
Polarization Dependent Accuracy	*GHz*	0.4	0.4	0.6	0.6	0.6
Wavelength Capture Range (from ITU)	*GHz*	5	9	18	30	30
Locking Slope at ITU Point	*dB/GHz*	~ 0.5 – 0.8	~ 0.5 – 0.8	~ 0.5 – 0.8	~ 0.5 – 0.8	~ 0.5 – 0.8
Input Power Range	*dBm*	<10	<10	<10	<10	<10
ORL Min	*dB*	45	45	45	45	45
PD Calibration Offset	*dB*	0.4	0.4	0.6	0.6	0.6
PD1 Responsivity (Reference)	*A/W*	0.1 to 0.4	0.1 to 0.4	0.16 to 0.32	0.16 to 0.32	0.16 to 0.32
PD2 Responsivity (Etalon)	*A/W*	0.1 to 0.4	0.1 to 0.4	0.16 to 0.32	0.16 to 0.32	0.16 to 0.32
PD Dark Current @5V (reverse bias)	*nA*	1	1	1	1	1
Temperature Sensor Supply Voltage	*V*	4 to 10	4 to 10	4 to 10	4 to 10	4 to 10
Temperature Sensor Monitor	*mV/C*	7 to 13	7 to 13	7 to 13	7 to 13	7 to 13

#	MPN	Product Description
1	WL-C0AXXS001	25GHz FSR, C-Band, SMF, No Connector
2	WL-C1CXXS003	50GHz FSR, C-Band, SMF, No Connector
3	WL-C1CFCS017	50GHz FSR, C-Band, SMF, FC/UPC
4	WL-C2CXXS004	100GHz FSR, C-Band, SMF, No Connector
5	WL-CACXXC006	12.5GHz FSR, C-Band, SMF, No Connector
6	WL-TACFCC028	12.5GHz FSR, C+L Band, SMF, FC/UPC
7	WL-A2CFAS030	100GHz FSR, 1064nm+/-10nm, HI-1060 SMF, FC/APC
8	WL-Q0CFAS031	25GHz FSR, O-Band, SMF, FC/APC
9	WL-Q1CFAS032	50GHz FSR, O-Band, SMF, FC/APC
10	WL-Q1CFAS033	100GHz FSR, O-Band, SMF, FC/APC
11	WL-Q2CFAS034	200GHz FSR, O-Band, SMF, FC/APC





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Tunable Optical Filters *(Thin Film DWDM Filter Based)*

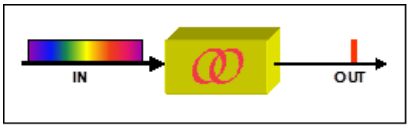
Optoplex's **Tunable Optical Filter**, including **Tunable Bandpass Filter** and **Tunable Edge Filter**, is an integrated module, consisting of micro-optics and electronics. When receiving a stream of optical signals of a plurality of wavelengths from the Input-Port (IN), the 2-port Tunable Optical Filter directs a selected channel to the Output-Port (OUT). The selected channel can be varied (tuned) within the operating wavelength (frequency) range by a remote command sent through the built-in control PCB and firmware.

Optoplex's Tunable Optical Filter is based on a patented micro-optic design and thin-film filter coating technology. The *thin-film filter* used in the optical tunable filter is similar to those already widely used in DWDM devices. The wavelength tuning is achieved by varying the incident angle of the incoming light beam on the *thin-film filter*. Each single device is optimized to cover either C- or L-band wavelengths. The standard optical tunable filter product family supports 50-, 100-, and 200-GHz channel spacing.

Parameter	Unit	50 GHz	100 GHz
Wavelength Tuning Range	*nm*	C-band: 1528 ~ 1562, L-band: 1567 ~ 1603	
Wavelength Tuning Resolution	*THz*	~ 10 pm or Calibrated to ITU grids	
Passband Width[1] @ 0.5 dB	*GHz*	-	> 30
Passband Width[1] @ 1.0 dB	*GHz*	> 16	-
Passband Width[1] @ 3.0 dB	*GHz*	25 GHz (typical)	50 GHz (typical)
Passband Width[1] @ 20 dB	*GHz*	< 85	-
Passband Width[1] @ 25 dB	*GHz*	-	< 150
Peak Insertion Loss[1] (without connector)	*dB*	< 4.5	< 3.0
Polarization Dependent Loss[1]	*dB*	<0.3 within CW±5GHz	< 0.4 within CW±10GHz
Polarization Mode Dispersion	*ps*	0.5	0.3
Chromatic Dispersion[1]	*ps/nm*	< ±100 within CW ±5GHz	< ±50 within CW ±12GHz
Wavelength Setting Error[2]	*GHz*	< ±4	
Wavelength Repeatability[2]	*GHz*	±1	
Wavelength Temperature Dependence	*pm/°C*	< ± 1 (typical)	
Return Loss	*dB*	> 40	
Maximum Input Optical Power	*mW*	300	
Tuning Speed (channel to channel)	*sec*	<10	
Tuning Power Consumption	*mW*	< 1800 (peak); < 300 (idle)	
Tuning Voltage	*V*	5 (DC)	
Electronic Interface	*mW*	RS232	
Operating Temperature	*°C*	0 to 65	
Storage Temperature	*°C*	-40 to 85	
Dimension (L×W×H)[3]	*mm*	84×61×16	

Notes:

1. Over the stated spectral and operating temperature ranges and all polarization states.
2. Related to mechanical accuracy at a given temperature.
3. Including collimator sleeve and control PCB.



Features

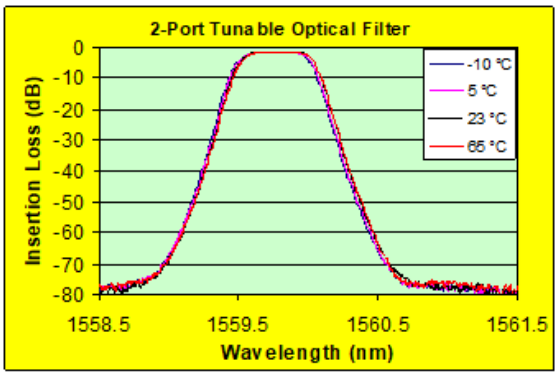
- 40G compliance
- Athermal design
- Wide tuning range, covering entire C-band or L-band
- Flat and wide passband
- Low & uniform insertion loss
- High channel isolation
- Option for tunable bandpass & tunable edge filter
- Latching & low power consumption
- Option for electrical connector from side or bottom
- Telcordia GR-468 qualified

Applications

- Dynamic wavelength selection in DWDM systems
- Signal demultiplexing for DWDMs
- Optical performance monitoring
- Tunable optical noise filtering
- Noise suppression for optical amplifiers

MPN	Product Description
TO-1C2CT801	50GHz, C-Band, SMF,
TO-1L2CT802	50GHz, L-Band, SMF,
TO-2C2CT803	100GHz, C-Band, SMF,
TO-2L2CT804	100GHz, L-Band, SMF,

For other operating wavelength ranges, such as S-, O-, E-band, and 1064nm, please contact Optoplex.



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Tunable Optical Filters *(MEMS-Based)*

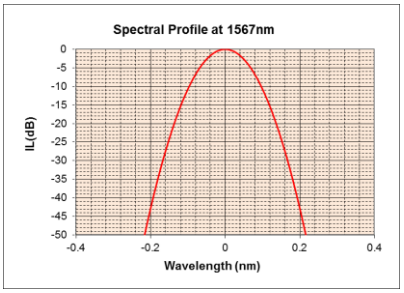
Optoplex's MEMS Tunable Optical Filter is based on a patented micro-optic design with MEMS tuning technology. It is an integrated module consisting of a MEMS chip, micro-optics and control electronics and interface. When receiving a stream of optical signals of a plurality of wavelengths from the Input-Port (IN), the 2-port tunable optical filter directs a selected channel to the Output-Port (OUT). Wavelength (frequency) tuning is achieved by changing driving voltage applied to the MEMS chip, via the control electronics and the built-in firmware.
The MEMS tunable filter offers high optical filtering performance: low insertion loss and high isolation. Moreover, the MEMS tunable filter provides high-speed tuning that is highly demanded in many applications. The standard optical tunable filter product family includes 30- and 60-GHz typical 3dB bandwidth.
Optoplex's MEMS tunable filter is ideal for applications from wavelength locking, optical channel monitoring and optical add/drop in optical communications; optical filtering and wavelength management in fiber sensing and spectroscopic instrumentation.

Compact Design

The MEMS tunable filter is designed and assembled in a compact module. For instance, the optical engine of the tunable filter is about 68x44x11mm. The full function tunable filter module (including control electronics) is about 100x68x11mm.

Gaussian Shape

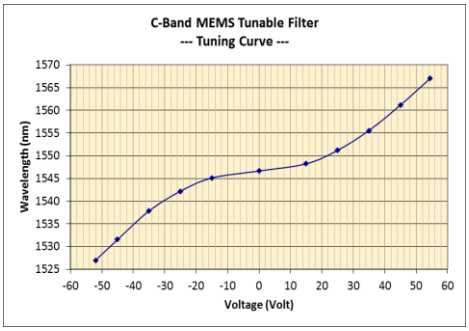
The tunable filter is based on optical grating and MEMS technology and the spectral shape is Gaussian-type. See Figure 2 above.



Easy to Use

The MEMS tunable is controlled with driving voltage. For optical engine, typical analog driving voltage is from -60 to +60 VDC. In the tunable filter full function module, a voltage converter is built-in, and the driving voltage is from -5 to +5 VDC.

In manufacturing, the wavelength vs driving voltage is well calibrated (including the effect of operating temperature). With the calibration data, the user can easily tune the tunable filter to desired wavelength in an optical engine with analog interface. Or in a full function module, the user just needs to simply issue a command to tune the device to required wavelength.



Features

- Athermal design
- Fast tuning speed
- Compact size
- Wide tuning range, covering entire C-, L-, C+L, or O-band
- Low TDL and WDL
- Low & uniform insertion loss
- High channel isolation
- Low power consumption
- Telcordia GR-1221 qualified

Applications

- Wavelength selection in DWDM systems
- Optical performance monitoring
- Optical spectrum analyzer
- Tunable optical noise filtering
- Noise suppression for optical amplifiers

Parameter	Unit	C- or L-Band	C+L or O-Band
Wavelength Tuning Range	*nm*	C-Band: 1527 ~ 1567; L-Band: 1570 ~ 1611	
		C+L Band: 1521 ~ 1611; O-Band: 1260 ~ 1360	
Wavelength Tuning Resolution	*pm*	~ 10 pm or Calibrated to ITU grids	
Passband Width @ 1.0 dB	*GHz*	> 16	> 25
Passband Width @ 3.0 dB	*GHz*	30 (typical)	60
Passband Width @ 20 dB	*GHz*	<85	< 185
Peak Insertion Loss (w/o connector)	*dB*	< 4.0	< 4.0
Polarization Dependent Loss	*dB*	< 0.3	< 0.3
Chromatic Dispersion	*ps/nm*	± 5	± 5
Wavelength Setting Error	*GHz*	< ±4	< ±5
Wavelength Repeatability	*GHz*	1	1
Return Loss	*dB*	> 40	
Maximum Input Optical Power	*mW*	10	
Tuning Speed (channel to channel)	*ms*	< 20	
Tuning Voltage	*V*	< 70	< 70
Operating Temperature	*°C*	-5 to 65	
Storage Temperature	*°C*	- 40 to 85	
Dimension (L × W × H) (Optical Engine)	*mm*	68×44×11	
Dimension (L × W × H) (Full Functional Module)	*mm*	100 x 68 x 11	

Wavelength Band	Wavelength Range (nm)	3dB BW	Optical TF Engine, P/N	Full Function TF Module, P/N
C-Band	1527 ~ 1565	30GHz	TO-1C2NM300	TO -1C2FM500
L-Band	1570 ~ 1610	30GHz	TO -1L2NM310	TO -1L2FM510
C+L Band	1520 ~ 1610	60GHz	TO -2T2NM420	TO -2T2FM620
O-Band	1260 ~ 1360	60GHz	TO -2Q2NM430	TO -2Q2FM630

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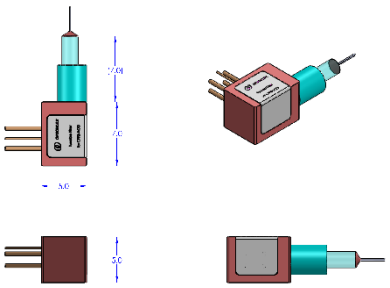
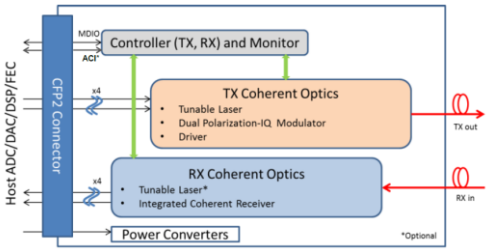
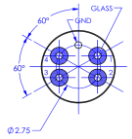
Mini Tunable Optical Filters

The Optoplex mini tunable filter described is specifically designed for 100G tunable transceiver analog coherent optics (CFP2-ACO) application. The main purpose of this tunable filter is to suppress the noise to improve the sensitivity and OSNR performance.
A VOA is integrated in the tunable filter to provide a max attenuation larger than 30dB. The integrated TF-VOA features a compact size, **5x5x7mm**, and the use of tight-bend ZBL fibers, is specifically suited for the communication SFP transceiver package. A 2-dimensional MEMS is used here as the active tuning element so that the tuning time for both TF and VOA is as short as 50 msec.

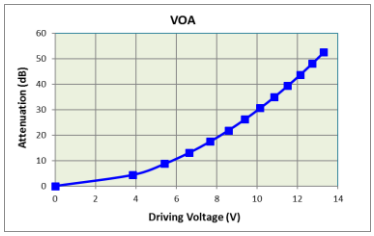


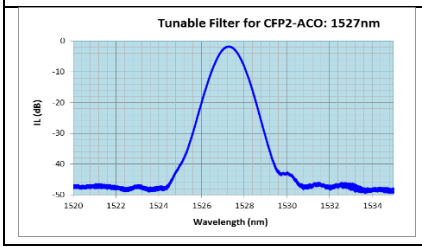


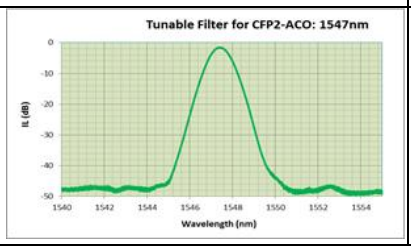
#	Parameter	Unit	Spec
1	FWHM	*GHz*	125 ~ 175
2	20dB BW	*GHz*	325 ~ 455
3	Max IL	*dB*	< 3.5
4	Tuning Speed	*ms*	< 50
5	VOA Attenuation Range	*dB*	> 30
6	VOA Response Time	*ms*	< 50
7	TF Driving Voltage	*V*	< 30
8	VOA Driving Voltage	*V*	< 15

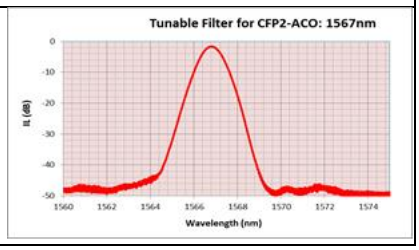


Pin#	Function
1	tune to shorter wavelength on voltage
2	attenuation (voltage on or voltage off)
3	Tune to longer wavelength on voltage
4	attenuation (voltage on or voltage off)

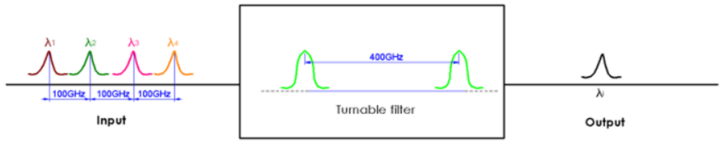




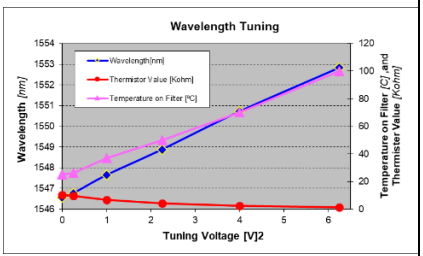


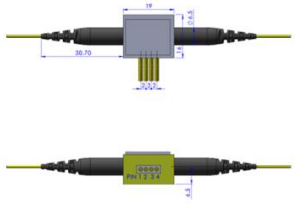


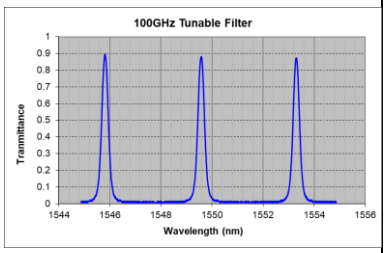
Tunable Etalon Filter



#	*Parameter*	*Min*	*Type*	*Max*	*Unit*
1	Operating wavelength range	1525		1565	*nm*
2	Insertion loss			2.5	*dB*
3	Tuning range	400			*GHz*
	Filter Passband Width (@1dB)	20			*GHz*
4	Filter Passband Width (@1dB)		35		
	Filter Passband Width (@1dB)			150	
5	Optical return loss	27			*dB*
6	PDL			0.8	*dB*
7	Tuning speed (ch i to i+1)			1	*s*
8	Thermistor resistance		10		*k Ω*
9	Tuning Voltage			5	*V*
10	Voltage Dependent Loss			2	*dB*







Pin#	Name	Description
1	Tuner +	Voltage supply, positive
2	Tuner -	Voltage supply, negative
3	Thermistor	No polarity
4	Thermistor	No polarity

Ordering Information:

Wavelength Range	MPN
C-Band	TO-2C2RT701
L-Band	TO-2L2RT704

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Optical Channel Monitor (OCM) /Optical Performance Monitor (OPM)

Optoplex's **Optical Performance Monitor** (OPM), also known as **Optical Channel Monitor** (OCM), uses proprietary thin-film filter technology combined with a micro-actuator and intelligent firmware. OPM/OCM measures critical information on optical transmission signals in DWDM networks for monitoring signal dynamics, determining system functionality, identifying performance change, and providing feedback for network control elements to maintain and optimize network performance. In particular, Optoplex's OPM/OCM can automatically scan the C-band, L-band and C+L-band wavelength range and precisely measure channel wavelength, power, and optical signal-to-noise ratio (OSNR).

Parameter	Unit	50 GHz	100 GHz
Wavelength Range	*nm*	C-, L- C+L, or O-Band	
Channel Number (for C- or L-band)	-	80 or 96	40 or 44
Adjacent Channel Power Difference	*dB*	< 13	< 15
Non-Adjacent Channel Power Difference	*dB*	< 20	< 25
Minimum Spacing Between Channels	*GHz*	40	75
Maximum Input Power	*dBm*	23	
Channel Input Power Range	*dBm*	– 40 ~ – 10	
Absolute Channel Power Accuracy	*dB*	0.5	
Relative Channel Power Accuracy	*dB*	0.3	
Power Measurement Repeatability	*dB*	0.1	
PDL	*dB*	< 0.3	
Absolute Wavelength Accuracy	*pm*	50	
Relative Wavelength Accuracy	*pm*	30	
Channel Wavelength Resolution	*pm*	20	
OSNR	*dB*	> 25	> 28
OSNR Accuracy	*dB*	1.5	
Noise Floor	*dBm*	–60	
Response Time	*ms*	< 200 (Power & Wavelength) < 500 (Power, Wavelength & OSNR)	
Power Consumption	*W*	< 2	
Operating Temperature Range	*°C*	–5 ~ 65	
Storage Temperature Range	*°C*	–40 ~ 85	

Features

- High dynamic range
- Low temperature sensitivity
- High power and wavelength accuracy
- Built-in wavelength reference
- Wide wavelength coverage
- Compact size
- 10, 40, and 100Gbps capable

Applications

- Optical performance monitoring of DWDM systems
- Optical add/drop monitoring
- Optical power or OSNR monitoring for gain equalization
- System alarms or error warnings
- Portable OSA/Spectrometer

Modulations	Data Rate (Gb/s)	Modulations	Data Rate (Gb/s)
OOK	2.5; 10	DP-DPSK	40
RZ-OOK	10	DP-DQPSK	100
ODB	2.5, 10	DP-BPSK	40
PSBT	2.5, 10	PM-BPSK	40
DPSK	10, 40	PM-QPSK	40, 100
RZ-DQPSK	40	DC PM-QPSK	100

Notes:

1) For OPM's capability to monitor various signals of different modulations and data rates, please consult with Optoplex for details.
2) Standard OPM with a dimension of 100x70x17.5mm and interface of UART or DPRAM available. Other custom footprint and interface available upon request.
3) 25GHz OPM for power monitoring available.
4) Custom made Dual-Mode OPM (it works for different channel spacing, 100/50, or 50/25GHz) available upon request.

OPM Part umbers

Wavelength Band	Wavelength Range	Channel Spacing	MPN
C-Band	1528 ~ 1567	50	OM-1C2AM801
C-Band	1528 ~ 1567	50	OM-1C3AM802
L-band	1570 ~ 1610	50	OM-1L2AM803
L-band	1570 ~ 1610	50	OM-1L3AM804
C-Band	1528 ~ 1567	100	OM-2C2AM811
C-Band	1528 ~ 1567	100	OM-2C3AM812
L-band	1570 ~ 1610	100	OM-2L2AM813
L-band	1570 ~ 1610	100	OM-2L3AM814
O-Band-1	1260 ~ 1300nm	100	OM-2Q2AM815
O-Band-2	1310 ~ 1360nm	100	OM-2Q2AM816
E-Band-1	1360 ~ 1400nm	100	OM-2E2AM817
E-Band-2	1450 ~ 1490nm	100	OM-2E2AM818
S-Band	1490 ~ 1530nm	100	OM-2S2AM819

Optical Spectrum Analyzer (OSA) OEM Modules

Wavelength Band	Wavelength Range	Channel Spacing	MPN
C-Band	1528 ~ 1567	50	OM-1C2AM821
L-Band	1570 ~ 1610	50	OM-1L2AM822
C-Band	1528 ~ 1567	100	OM-2C2AM823
L-Band	1570 ~ 1610	100	OM-2L2AM824

1) Based on Thin Film DWDM Filter with Angle-Tuning.
2) The different from OPM is that OSA output spectral raw data, rather than channel power and channel wavelength.

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Optical Spectrum Analyzer Module *(Based on MEMS-Grating)*

Optoplex's near-infrared optical spectrum analyzer module (NIR OSA) is a high performance optical spectral engine for Process Analytical Technology (PAT) and Fiber Optic Test Equipment (FOTE) applications. Based on proprietary MEMS and micro-optic technologies, Optoplex's OSA module offers higher spectral resolution than those available in the market, which is demanding in today's increasing spectroscopy applications. Moreover, the MEMS tunable filter provides high-speed tuning that is highly demanded in many applications. Full range scanning is less than 1 sec for our standard C, L, C+L and O-band OSA and less than 2 sec for our full-band OSA.

Other features include: compact, light-weight, low power consumption and wide wavelength coverage. With a dimension of 100x70x10 mm, Optoplex's compact OSA modules are suitable for a variety of handheld, portable, bench-top and inline OSA/spectrometer applications.

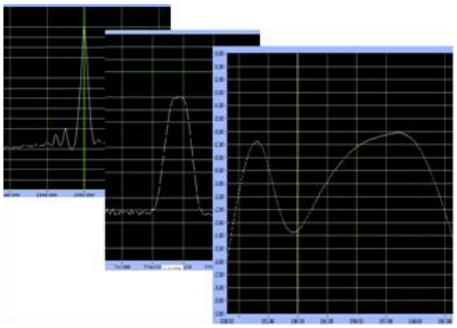
		C-Band	C+L Band	O-Band	Full-Band
Part Number		**OM-1C2MM353**	**OM-2T2MM301**	**OM-2O2MM302**	**OM-2AFOE304**
Spectral Measurement					
Wavelength Range	*nm*	1527 – 1567	1521 - 1611	1260 – 1360	1250 - 1650
Resolution Bandwidth (FWHM)	*nm*	0.2	0.4	0.4	4
Wavelength Accuracy	*nm*	0.05	0.05	0.05	0.5
Wavelength Repeatability [1,2)]	*pm*	± 10	± 10	± 10	± 100
Wavelength Readout Resolution	*pm*	1	1	1	10
Wavelength Linearity [1)]	*nm*	± 0.01	± 0.01	± 0.01	± 0.01
Power Measurement					
Dynamic Range [1)]	*dB*	+10 ~ -50	+10 ~ -50	+15 ~ -50	+10 ~ -50
Power Accuracy [1)]	*dB*	± 0.5	± 0.5	± 0.5	± 1.0
Power Repeatability [1,2)]	*dB*	± 0.1	± 0.1	± 0.1	± 0.1
Power Readout Resolution	*dB*	± 0.01	± 0.01	± 0.01	± 0.01
Power Linearity [1)]	*dB*	± 0.1	± 0.1	± 0.1	± 0.1
Optical Rejection Ratio (ORR) [1)]					
@25GHz (0.2nm)				6	
@50GHz (0.4nm)		25		24	
@75GHz (0.6nm)				45	
@100GHz (0.8nm)			25		
@200GHz (1.6nm)		40			25
@400GHz (3.2nm)			40		
General Specifications					
Scanning Time	*s*	2~3	2~3	2~3	2~3
Power Consumption	*W*	< 2.5			
Electronics Interface	-	UART			
Fiber Length	*m*	1.0 ± 0.1			
Optical Connector	-	FC/APC			
Dimension	*mm*	112 x 68 x 11			
Operating Temperature Range	*°C*	0 ~ +65			
Storage Temperature Range	*°C*	-40 ~ +85			

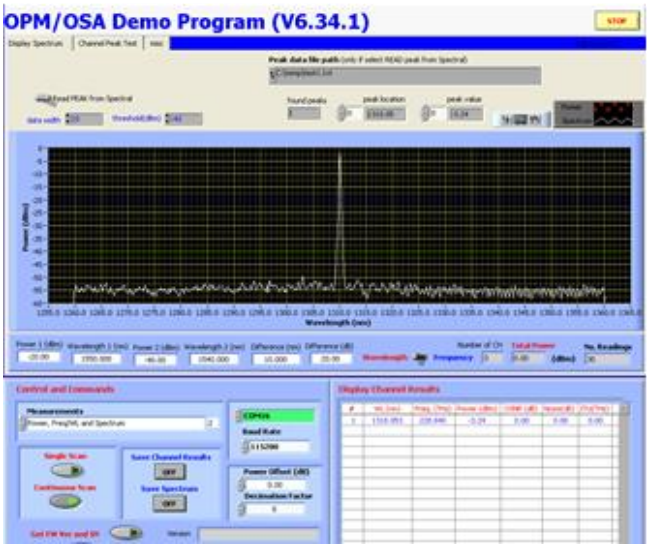
Features

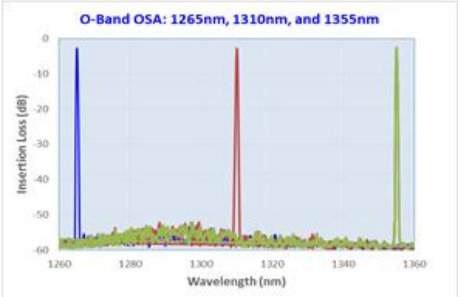
- Super spectral measurement performance
  - Extraordinary spectral resolution, and
  - High wavelength accuracy
- High power sensitivity
- High power accuracy
- Compact size, light weight
- Fast scan speed
- Software upgradeable
- Cost-effective

Applications

- Optical spectral analyzing
- Analytical spectroscopic instrumentation
- Optical testing in optical communications
- Optical channel/performance monitoring (OPM)
- Portable OSA in T&M and field test
- Biomedical optics, i.e., OCT imaging
- Fiber sensing
- Portable OSA in defense /military applications







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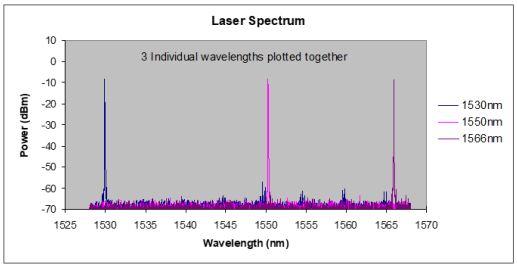
Tunable Laser (iTLA)

The Optoplex TL-MC040TA101 tunable laser is a high performance continuous wave (CW) tunable laser source for various test and measurement applications the C-band wavelength range covering from 1528nm (196.25 THz) to 1568nm (191.25 THz).
This tunable laser source is based on the OIF micro-iTLA standard. The laser and control electronics are pre-mounted on a dedicated circuit board for easy production installation. The tunable laser is featuring shuttered tuning, optical power control, off-grid tuning, adjustable grid spacing and narrow linewidth. A Labview software program and an RS232/USB cable are provided together with the tunable laser module. Users can plus and play with a computer (PC) to control the tunable laser very conveniently.
The TL-MC040TA101 tunable laser designed on a fully monolithic InP chip without moving parts, it is a low voltage electronically tuned device enabling channel switching with straightforward control electronics. The integrated semiconductor optical amplifier (SOA) provisions the optical power control and also acts as a shutter to allow dark tuning when reverse biased.
Laser tuning is implemented with thermal control. It can be tuned on grid or off-grid with a minimum tuning step of 0.1GHz. When operated in ON-Grid tuning, the tuning is shuttered. While in fine-tuning (+/-9GHz) mode, it is un-shuttered operation.
The TL-MC040TA101 tunable laser has a wavelength accuracy about 3.5pm max and a power stability of 0.02dB max (both measured in a period of 60 minutes).
With accurate wavelength and stable power output, the laser is ideal for many test and measurement applications, optical component and material characterization, and optical monitoring applications such as optical monitoring in optical thin film coating.

iTLA Tunable Laser Module

Parameter	Unit	Specification			Note
		Min	Typ.	Max	
Wavelength Range	*nm*	1528		1567	C-Band
Output Power	*dBm*	8		17	
Power Stability[1]	*dB*			±0.5	
Power Repeatability[2]	*dB*			±0.5	
Tuning Speed	*sec*	3		10	
SMSR (side mode suppression ratio)	*dB*	40			±2.5nm range, with 0.06nm RBW
Line width	*kHz*			400	
RIN (10MHz-1GHZ)	*dB/Hz*			-140	
RIN (1-10GHz)				-145	
OSNR	*dB*	55			0.1nm BW
PER	*dB*	20			
Back Reflection Tolerance	*dB*			27	
Shuttered Output Power	*dBm*			-35	
Power Supply Voltage	*V*	4.5		5	
Power Consumption	*W*			6	
Cold Start Settle Time	*s*			10	
Warm Start Settle Time	*s*			0.1	
Transient Settle Time	*µs*		150	250	
Dimensions (L x W x H)	*mm*	100 X 120 X 22			
Connector Type	-	FC/APC Standard			



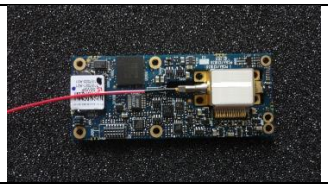
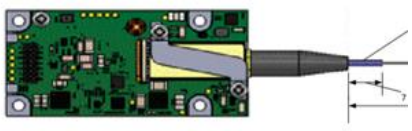
Features:

- Full C-Band tunable laser source
- Narrow line-width, <= 400kHz
- High output power +15.5dBm nominal
- Variable output power range, 8.0dB
- Electronic shutter for dark tuning
- Gridless operation
- Wavelength stabilized for 0.1GHz
- Un-shuttered frequency fine tuning capability ±9GHz
- Large SMSR, >40dB
- Low RIN
- Low phase noise
- Low power dissipation, 4.5W
- Case operating temperature range -5ºC to +75ºC
- Simple RS232 interface
- RS232/USB conversion cable available (optional)
- RoHS compliant 6/6
- Telcordia GR 468 Qualified
- Low-cost alternative solution in manufacturing line test and measurement
- Custom-software available for material and component characterization purpose upon request

Applications:

- Coherent optical communication systems
- Low-Cost alternative laser source in manufacturing line test and measurement
- Optical characterization of materials and components
- Optical monitoring system (OMS) in optical thin film coating

Ordering Information

MPN	TL-MC040TA101	TL-NC040TA105	TL-uC040TA110
Photo			
Description	**iTLA Tunable Laser Module (Full-Function with digital control interface), C-Band, 15dBm**	**iTLA, C-Band, 50GHz, 13dBm, Dithering**	**u-iTLA, MSA, C-Band, 13dBm**

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10G Tunable ROSA

With increasing demand for data and video from home, business and wireless, higher and higher bandwidth for the Optical Access Network is required.

FSAN (Full Service Access Network) initiated a working group to work on NG-PON2 in 2010 in collaboration with ITU-T. TWDM (TDM/WDM: Time Division Multiplexing/Wavelength Division Multiplexing) was selected as the preferred technology for NG-PON2.The first recommendation of NG-PON2 general requirements was published by ITU-T (G.989.1) in late 2012, and the physical layer requirements (ITU G.989.2) was approved in December 2014.

Optoplex started to work closely with major GPON equipment suppliers (the leading companies in FSAN) to develop colorless ONU for NG-PON2 since the very beginning when FSAN initiated the working group. With proprietary technology, Optoplex developed a periodic tuning filter – cost effective and small form factor for easy integration with APD/TIA, suitable for NG-PON2 application, and then a 10Gbps Tunable ROSA (10G APD/TIA integrated with a tunable filter). This 10G tunable ROSA has been successfully verified by many major companies in past three years and then deployed in field by a couple of T-1 service providers recently. The tunable ROSA used in NG-PON2 is illustrated in Figure 1.

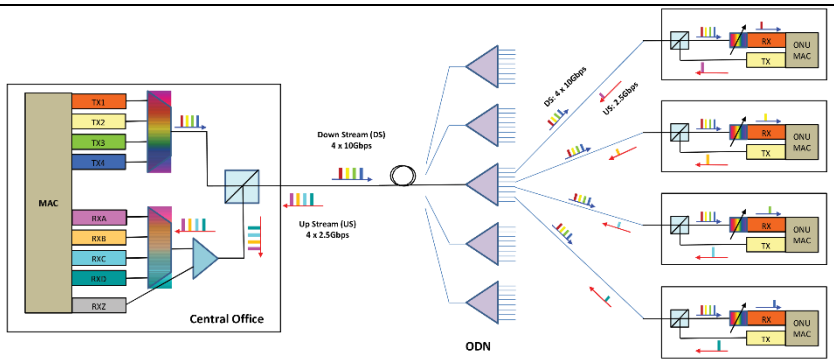

Figure 1, 10Gb/s Tunable ROSA for colorless ONU in NG-PON2

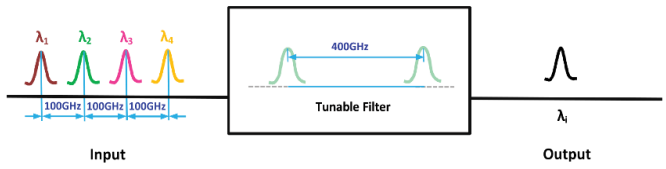

Figure 2, Functional block diagram of Tunable filter inside λ_x (x=1 to 4):

Features

- 100GHz tunable filter with tuning range of 4 channels
- InGaAs APD for 10Gbps
- High gain 12KΩ transimpedance pre-amplifier
- Differential data output
- High Sensitivity: < -28dBm
- Low power consumption: < 0.4W

Applications

- Digital fiber optic receiver for access networks for telecom
- High speed optical data networks
- Fiber in the loop (FTTx)
- SFP+/XFP/300pin MSA optical transceiver

Item	Parameter	Comments	Min	Typ.	Max	Unit
1	Operating Wavelength Range [1]		1570		1610	*nm*
2	Tunable Filter Insertion Loss				2.5	*dB*
3	Wavelength Tuning Range [2]	-5°C to 75°C	450			*GHz*
4	Filter Pass Band Width	@1dB	20			*GHz*
		@20dB			150	
5	Optical Return Loss		27			*dB*
6	PDL				0.8	*dB*
7	Tuning Speed	From channel *i* to *i±1*			1	*s*
8	Thermistor Resistance			10		*kΩ*
9	TF Tuning Voltage				3.8	*V*
10	Voltage Dependent Loss			0.5	1	*dB*

Notes

1) 1570 ~ 1610nm is the required operating wavelength for the 4 TWDM channels of NGPON2. Optoplex tunable filter can work in a much wider wavelength range from 1500 ~ 1650nm

2) The maximum working temperature of wavelength tuner is 120°C.

Item	Parameter	Comments	Min	Typ.	Max	Unit
1	Operating Wavelength Range		1570		1610	*nm*
2	Responsivity	M=1, CW		0.75		*A/W*
3	Responsivity with Filter	M=1, CW		0.42		*A/W*
4	Minimum Sensitivity	10.3Gbps, RL=50Ω, BER=1×10^{-3}, NRZ, ER=6.42 dB, PRBS=2^{31}-1 , M_{opt}, λ=1550nm		-30.5		*dBm*
5	Optical Return Loss		27			*dB*

Item	Parameter	Comments	Min	Typ.	Max	Unit
1	TIA Supply Voltage	V_{CC}	3	3.3	3.6	*V*
2	TIA Supply Current	P_{in}=0μW	40	55	70	*mA*
3	Operating Voltage	V_{OP}, M=M_{OPT}		0.9×V_{br}		*V*
4	Trans-impedance	F=200MHz, RL=50Ω, P_{in}=1μW, M=10, differential		2		*kΩ*
5	3dB Bandwidth	@-3dB, M=10,RL=50Ω, P_{in}=-20dBm		6		*GHz*
6	Temperature Coefficient of V_{br}	I_d=10μA, T_C=25~75°C		0.03		V/°C
7	Breakdown Voltage	Dark current I_d=10μA	25	34	40	*V*

Ordering Information

Product:	Tunable 10G ROSA
Product Description:	10G Tunable ROSA, APD/TIA, L-band, 100GHz Channel Spacing, 400GHz Tuning Range
Part Number:	**RX-2L2RT704**

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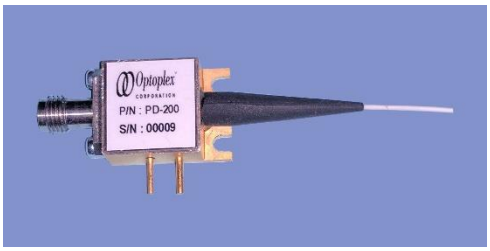
High-Speed High-Power Photodetector



These high speed photodiode, PD-200, is hermetically sealed, high reliability, low harmonic distortion photodiode modules designed for high optical power applications with minimum bandwidths of 20 GHz. The device is well suited for receiver applications with optical pre-amplification, and is available either with or without an internal 50Ω termination. The photodiode module is available in either a V-connector package or a miniature surface mount package with CPW (coplanar waveguide) RF output.

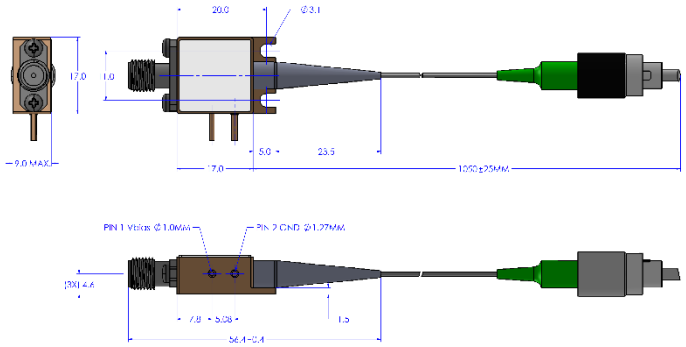
Parameter	Min	Typical	Max	Units
Responsivity (1480 nm~1620nm)	0.5	0.65	-	*A / W*
Logic Sense / Coupling	Positive Non-Inverting / DC 50 Ω			
3 dB Bandwidth	18	22	-	*GHz*
Rise Time/ Fall Time/ FWHM	-	14, 16, 22	-	*ps*
Dark Current @ 25C, 5V	-	10	100	*nA*
Electrical Return Loss	-	-10	-	*dB*
Optical Return Loss	27	30	-	*dB*
Bias Voltage	2.8	3.3	3.8	*V*
PDL @ 1550 nm	-	0.3	0.5	*dB*

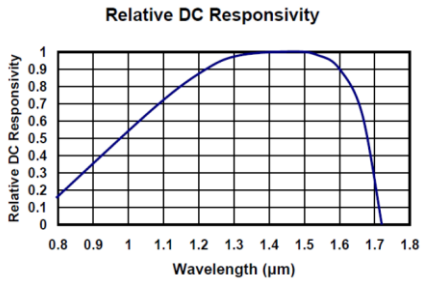
Features:

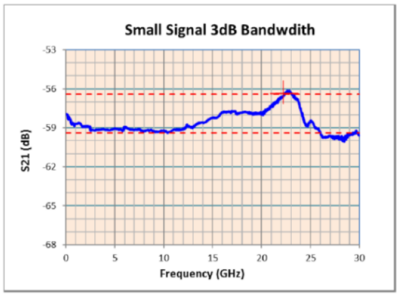
- High Current Handling (up to 20 mA)
- Lowest PDL (typical 0.05 dB)
- Useable spectral wavelength range of 800-1650 nm
- Low Group Delay
- Low Harmonic Distortion
- V-connector (SMA) or surface mount package options
- Bellcore GR-468 Qualified
- One device for multiple wavelengths reduces operational & inventory costs

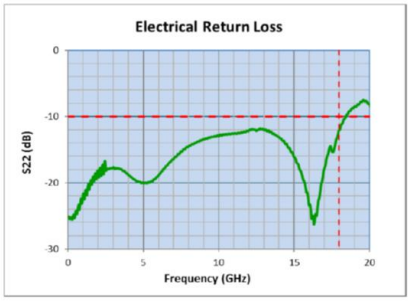
Applications:

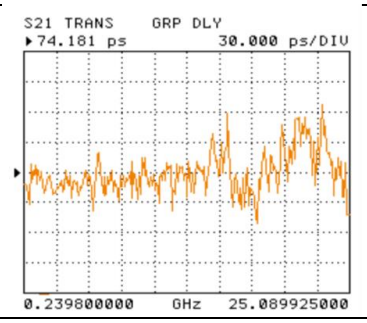
- Optically Amplified Systems
- RZ, NRZ, Super FEC Formats to 20 Gb/s
- High Dynamic Range, Analog RF Links over Fiber
- Rapid Doppler-Shift LIDAR Measurements
- Coherent Lightwave Systems
- Ideal Front-End O/E Converter for Test Instruments

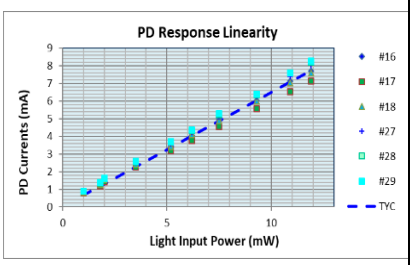


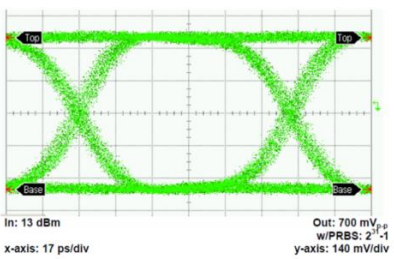












Product Ordering Information

Product: High-Speed, High Power Photodetector, C-Band, 20GHz BW, SMF Input Fiber, SMA Output

Model Number: PD-200

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