

**W2 Optronics, Inc.**

## **DQPSK Demodulator**

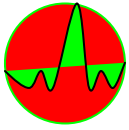
Specification

2011 Rev. W

### **PART NUMBER**

DQPSK-W-219

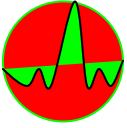
FSR=21.9GHz



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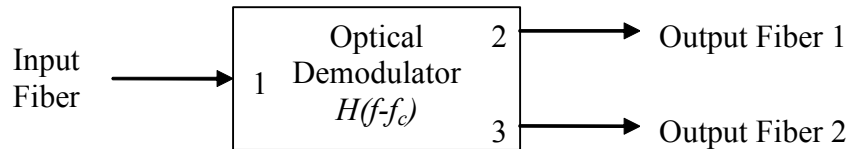
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## Product Description and Diagram

This document describes the optical, electrical, and mechanical specifications for an optical demodulator for DQPSK systems. Figure below shows the basic schematic of a single optical demodulator. This device is an all-pass filter with a free spectral range, FSR, and a variable optical phase shift,  $\phi_o$ . For an optical signal centered at a carrier frequency,  $f_c$ , the relationship between the input and output electric fields is characterized by the ideal transfer functions  $H_{1-2}(f-f_c)$  and  $H_{1-3}(f-f_c)$ ,



$$H_{1-2}(f - f_c) = \frac{1}{2} \left( 1 + e^{i2\pi(f-f_c)/FSR} e^{i\phi_o} \right)$$

$$H_{1-3}(f - f_c) = \frac{1}{2} \left( 1 - e^{i2\pi(f-f_c)/FSR} e^{i\phi_o} \right)$$

Optical Demodulator

corresponding to the constructive and destructive ports of the device, respectively.

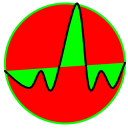
In optical communication systems employing phase-shift keying formats such as DQPSK, the demodulator functions as a digital phase decoder. When the two fiber output ports are photodetected and combined with a balanced receiver pair, the demodulator converts the phase transitions into an electrical digital signal of 1's and 0's. For DQPSK system, it is necessary to decode two signals propagating 90 degrees out of phase, each one at a baud rate, R. Thus, the DQPSK format requires two interferometers: one to decode the in-phase signal (I-signal) and another one to decode the quadrature signal (Q-signal). In this case, the demodulator FSR is related to the total transmission bitrate, B, as follows:

$$FSR = R = B/2$$

For a DQPSK signal centered at a carrier frequency,  $f_c$ , the demodulator achieves optimal decoding when

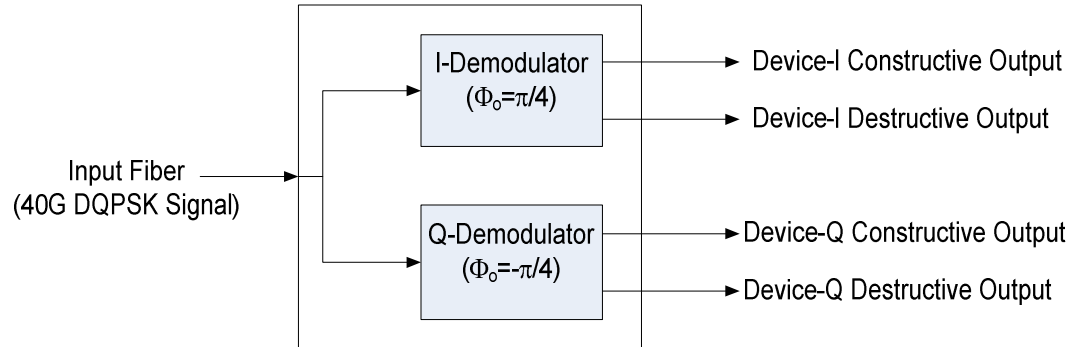
$$\phi_o = \pm\pi/4, \text{ DQPSK}$$

If the demodulator phase,  $\phi_o$ , for the I-device is set to  $\pi/4$ , then  $\phi_o$  must be set to  $-\pi/4$  on the Q-device.



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Figure below shows the optical schematic for the DQPSK demodulator.



Optical schematic for DQPSK Demodulator.

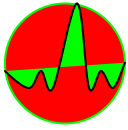
## Definitions

- *Insertion Loss.* It is the polarization-averaged transmission loss measured through any one arm of the demodulator.
- *Free Spectral Range.* It is the frequency shift between two consecutive peaks (or nulls) in the polarization-averaged transmission spectrum through one arm of the interferometer.
- *Extinction Ratio.* It is the difference in dB between consecutive peaks and nulls in the polarization-averaged transmission spectrum through one arm of the interferometer.
- *Polarization Dependent Frequency Shift.* It is the maximum frequency shift in the transmission spectrum induced by a change in the polarization of the input optical signal.
- *Polarization-dependent phase shift* =  $2 \cdot \pi \cdot \text{PDFS} \cdot T$
- *Skew.* Optical delay mismatch between demodulator output ports

## Environment Conditions

The module must be reliably endure the following conditions.

Item	Conditions	Unit	Specification		
			Min.	Typ.	Max.
1	Operating Temperature	C	-5	-	70
2	Storage Temperature	C	-40		85
3	Relative Humidity non condensing	%	5		95

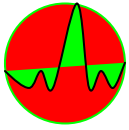


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## Electro-Optical Specifications

The module meets the specifications over all polarization states and the specified operating conditions.

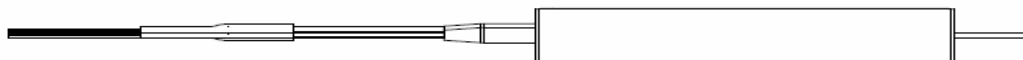
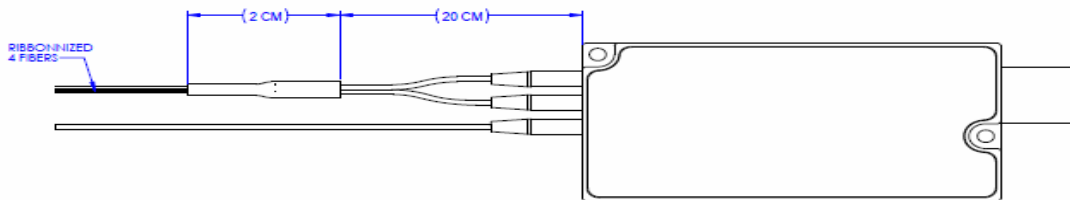
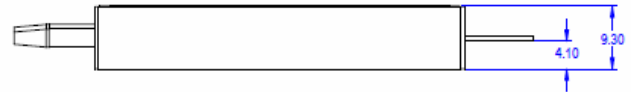
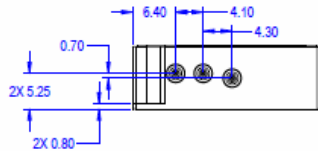
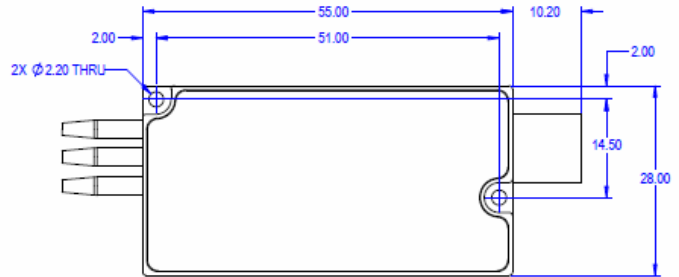
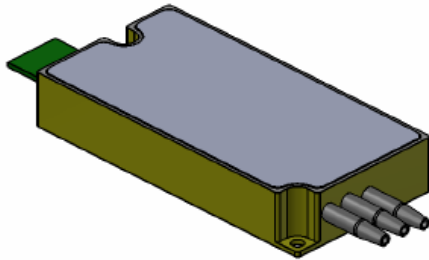
Item	Parameter	Symbol	Unit	Specification		
				Min.	Typ.	Max.
1	Wavelength Range	$\lambda$	nm	1527	-	1567
2	Free Spectral Range	FSR	GHz	21.9		
3	FSR Error	$\Delta$ FSR	%	-1		+1
4	Insertion Loss on Output ports	IL	dB		5.5	6
6	Insertion Loss Uniformity	$\Delta$ IL	dB			0.8
7	Extinction Ratio	ISO	dB	18		
8	Polarization Dependent Loss	PDL	dB			0.5
9	Return Loss	ORL	dB	40		
10	PMD	PMD	ps			0.1
11	Polarization Dependent Frequency Shift	PDFS	GHz			0.45
12	Temperature dependent Frequency shift	TDFS	GHz/C <sup>o</sup>		0.1	0.2
13	Phase Mismatch	PE	Degree	-5		+5
14	Optical Path Delay among all output ports	OPD	ps			1
15	Time Constant reaching 50% of target phase	T	msec			50
16	Tuning Range	TR	FSR	1		2
17	Tuning Resistance	R	$\Omega$	40		50
18	Total Power Consumption	PC	W			0.5
19	Phase Tuning Voltage	V1	V	-5		5
20	Dithering Tuning Voltage	V2	V	0		10
21	Maximum input Optical Power	P	mW			300
22	Connector Type			LC/UPC for sample No connector for production		
23	Fiber Pigtail Type			SMF-28 or equivalent with 900um tube for sample 4 fiber Ribbon for production		



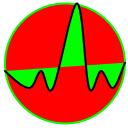
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## Mechanical Drawing

The dimension for DQPSK DLI is 9X55X28mm except fiber boot, package drawing is shown below.



PIN #	Description
1	+5V Power Supply
2	0~5 V DC to tune
3	GND
4	0~5V AC Dithering
5	-5V Power Supply



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## Channel Plan

Central wavelength / frequency with 100GHz grid in C band (ITU-T G.692)

Central $\lambda$ (nm)	Frequency (THz)	Central $\lambda$ (nm)	Frequency (THz)
1528.77	196.10*	1548.51	193.60
1529.55	196.00	1549.32	193.50
1530.33	195.90	1550.12	193.40
1531.12	195.80	1550.92	193.30
1531.90	195.70	1551.72	193.20
1532.68	195.60	1552.52	193.10
1533.47	195.50	1553.33	193.00
1534.25	195.40	1554.13	192.90
1535.04	195.30	1554.94	192.80
1535.82	195.20	1555.75	192.70
1536.61	195.10	1556.55	192.60
1537.40	195.00	1557.36	192.50
1538.19	194.90	1558.17	192.40
1538.98	194.80	1558.98	192.30
1539.77	194.70	1559.79	192.20
1540.56	194.60	1560.61	192.10
1541.35	194.50	1561.42	192.00
1542.14	194.40	1562.23	191.90
1542.94	194.30	1563.05	191.80
1543.73	194.20	1563.86	191.70
1544.53	194.10	1564.68	191.60
1545.32	194.00	1565.50	191.50
1546.12	193.90	1566.31	191.40
1546.92	193.80	1567.13	191.30
1547.72	193.70	1567.95	191.20*

Central wavelength / frequency with 100GHz grid in C+ band (ITU-T G.692)

Central $\lambda$ (nm)	Frequency (THz)	Central $\lambda$ (nm)	Frequency (THz)
1529.16	196.05	1548.91	193.55
1529.94	195.95	1549.72	193.45
1530.72	195.85	1550.52	193.35
1531.51	195.75	1551.32	193.25
1532.29	195.65	1552.12	193.15
1533.07	195.55	1552.93	193.05
1533.86	195.45	1553.73	192.95
1534.64	195.35	1554.54	192.85
1535.43	195.25	1555.34	192.75
1536.22	195.15	1556.15	192.65
1537.00	195.05	1556.96	192.55
1537.79	194.95	1557.77	192.45
1538.58	194.85	1558.58	192.35
1539.37	194.75	1559.39	192.25
1540.16	194.65	1560.20	192.15
1540.95	194.55	1561.01	192.05
1541.75	194.45	1561.83	191.95
1542.54	194.35	1562.64	191.85
1543.33	194.25	1563.45	191.75
1544.13	194.15	1564.27	191.65
1544.92	194.05	1565.09	191.55
1545.72	193.95	1565.90	191.45
1546.52	193.85	1566.72	191.35
1547.32	193.75	1567.54	191.25*
1548.11	193.65	1568.36	191.15*