Integrated 90deg Hybrid Balanced Receiver

1. INTRODUCTION

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.

Figure 1.1, Photo of an Integrated 90deg Optical Hybrid Balanced Receiver

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 on the left illustrates the functional block diagram of the integrated 90deg optical hybrid with balanced photoreceivers.

The integrated 90deg hybrid receiver 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 25dB (with a typical value of 35dB).

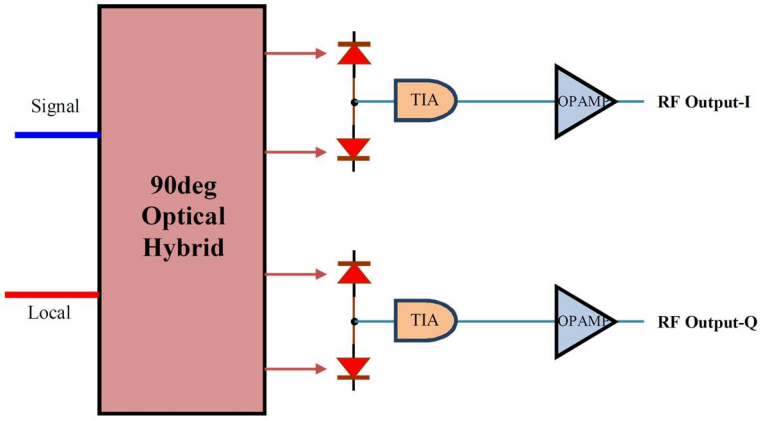


Figure 1.2, Functional illustration of the integrated 90deg hybrid with balanced photo-receiver.

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

2. ABSOLUTE MAXIMUM RATINGS

No	Parameter	Symbol	Unit	Conditions	Ratings		Notes
					Min	Max	
2.1	Input Optical Power	P_{in_Max}	*mW*		-	300	
2.2	Operating Temperature	T_c	^oC		-5	+70	
2.3	Operating Humidity	-	*%RH*	T_c = +65^{o}C, Non-condensing	5	85	
2.4	Storage Temperature	T_{stg}	^oC		-40	+85	
2.5	Storage Humidity	-	*%RH*	T_c = +85^{o}C, Non-condensing	5	85	

3. OPERATING CONDITIONS

No	Parameter	Symbol	Unit	Conditions	Ratings			Notes
					Min	Typ.	Max	
3.1	Input Optical Power	P_{in_Max}	*mW*		-		300	
3.2	Operating Temperature	T_c	^oC		-5		+65	
3.3	Operating Humidity, Relative, 40^{o}C non-condensing	-	*%RH*		5		85	
3.4	Storage Temperature	T_{stg}	^oC		-40		+85	
3.5	Storage Humidity	-	*%RH*		5		85	

4. OPTICAL PERFORMANCE REQUIREMENTS OF 90DEG OPTICAL HYBRID

4.1 Functional Block Diagram

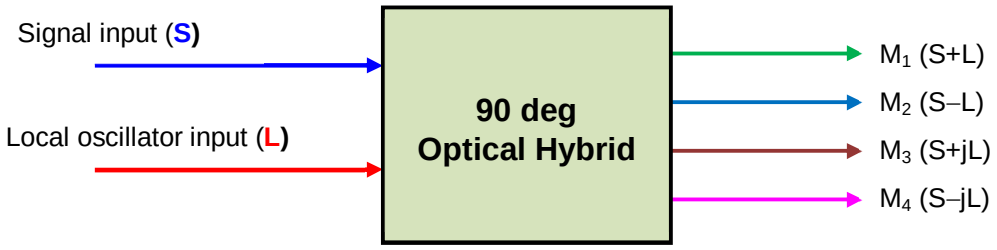


Figure 4.1, Functional block diagram of the 90deg hybrid

Table 4.1, Functional definitions of the 90deg hybrid

Port	Function	Phase Difference	Value	Note
1	Local		L	
2	Signal		S	
3	M_1	0	S + L	
4	M_2	π	S - L	
5	M_3	$\pi/2$	S + jL	
7	M_4	$-\pi/2$	S - jL	

4.2 Optical Performance Specifications

Table 4.1, Optical Performance Specification of the 90deg Hybrid

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*	90 ± 10
Insertion Loss[1] (without connector)	$S \rightarrow M_i$	*dB*	< 8.5
	$L \rightarrow M_i$	*dB*	< 8.5
Insertion Loss Difference[1]	$S \rightarrow M_1$ and $S \rightarrow M_2$	*dB*	< 0.7
	$S \rightarrow M_3$ and $S \rightarrow M_4$	*dB*	< 0.7
	$L \rightarrow M_1$ and $S \rightarrow M_2$	*dB*	< 0.7
	$L \rightarrow M_3$ and $S \rightarrow M_4$	*dB*	< 0.7
	Between all other ports	*dB*	< 1
Optical Return Loss		*dB*	> 27
Optical Path Difference (skew, between M_1 and M_2 and between M_3 and M_4)		*ps*	< 5
Optical Path Difference (skew, between any other two outputs)		*ps*	< 5
PM Fiber and Connector Alignment		-	Slow Axis aligned to the key
PER		*dB*	> 18
Max. Input Optical Power		*mW*	300

Notes:

1. *Over the stated spectral and operating temperature ranges and all polarization states.*

5. BALANCED PHOTORECEIVER

5.1 Optical-Electrical Characteristics for 100MHz Receiver

#	Parameter	Unit	Min	Typ.	Max	Note
5.1.1	Type of Detector		InGaAs			
5.1.2	Wavelength Range	*nm*	1510		1670	
5.1.3	Responsivity, Typical	*V/W*		8		
5.1.4	RF Output Bandwidth (3dB)	*MHz*	DC		100	
5.1.5	Common Mode Rejection Ratio (CMRR)	*dB*	20	30		
5.1.6	Transmission Gain	*V/A*		$50x10^3$		
5.1.7	Conversion Gain RF Output	*V/A*		$50x10^3$		
5.1.8	CW Saturation Power	μW		72		@1550nm
5.1.9	NEP (DC - 10MHz)	$pW/\sqrt{Hz}$		3.8		
5.1.10	Integrated Noise (DC - 100MHz)	nW_{RMS}		65		
5.1.11	Overall Output Voltage Noise	mV_{RMS}		2.2		
5.1.12	RF Output Impedance	Ω		50		
5.1.13	RF Output Voltage Swing	*V*			+-3.6	
5.1.14	DC Offset RF Output	*mV*			+/-3	
5.1.15	Max Optical Input Power	*mW*			20	
5.1.16	Power Supply, Voltage	*V*			+/-12	
5.1.17	Power Supply, Current	*mA*			200	
5.1.18	Electrical Output Interface		SMA			

5.2 PD Responsivity for 100MHz Receiver

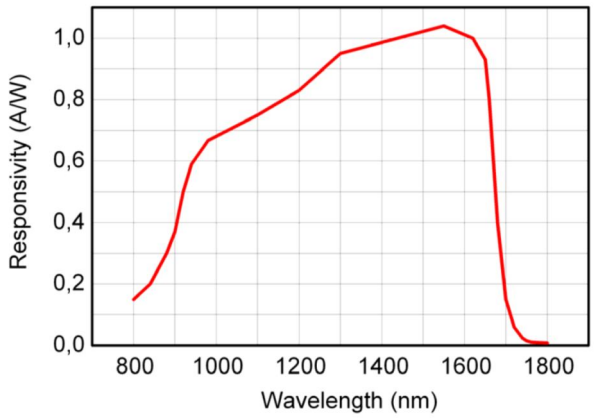


Figure 5.1, Responsivity

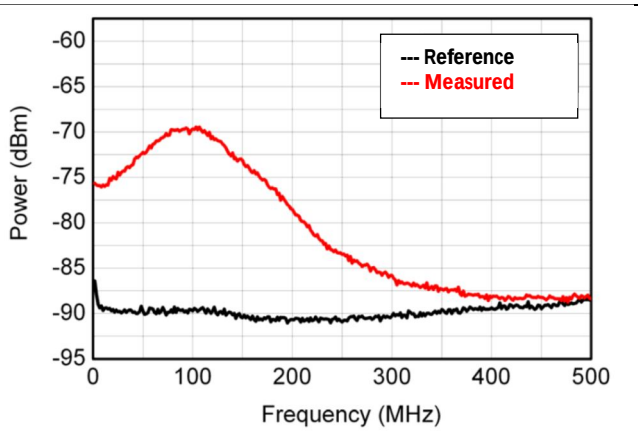


Figure 5.2, Spectral Noise

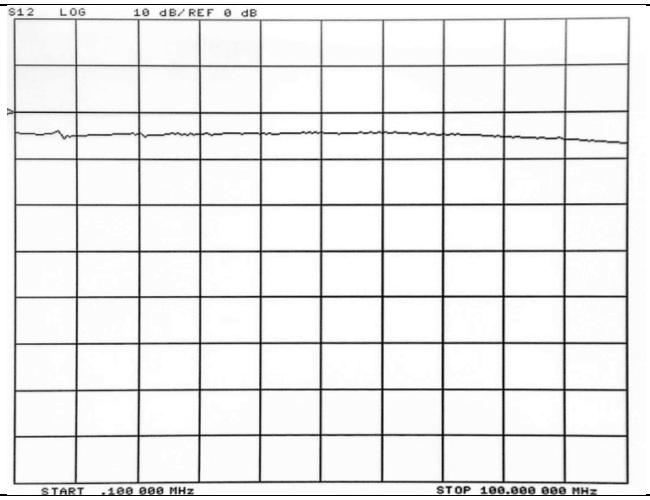


Figure 5.3, S21 of IM^{+}

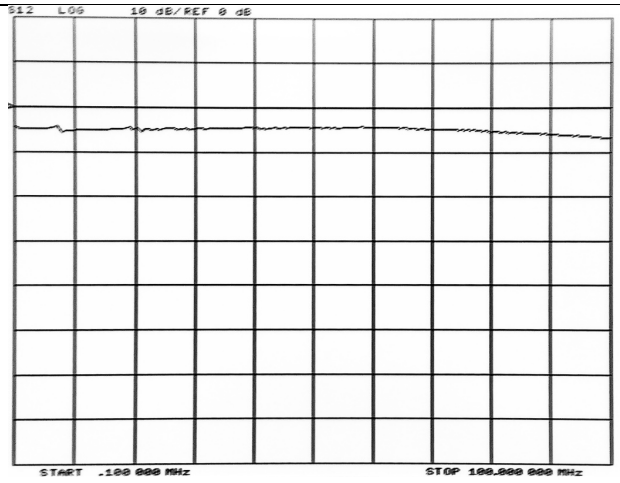


Figure 5.4, S21 of IM^{-}

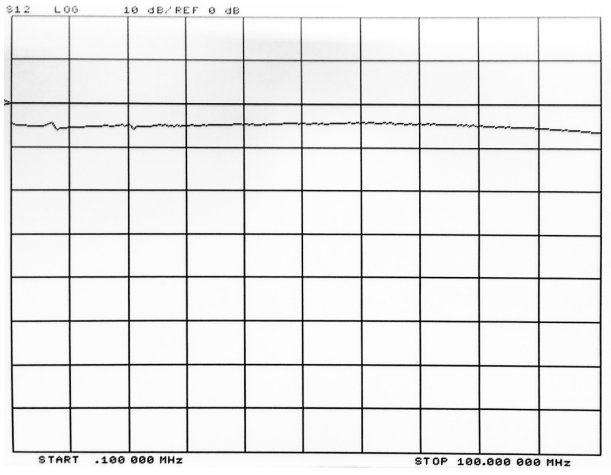


Figure 5.5, S21 of QM^{+}

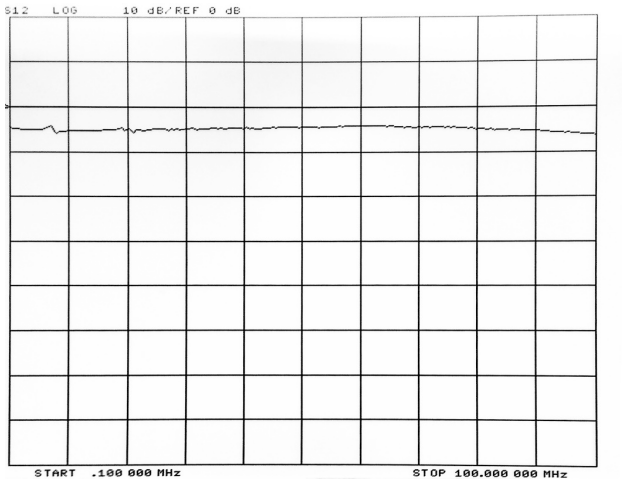


Figure 5.6, S21 of QM^{-}

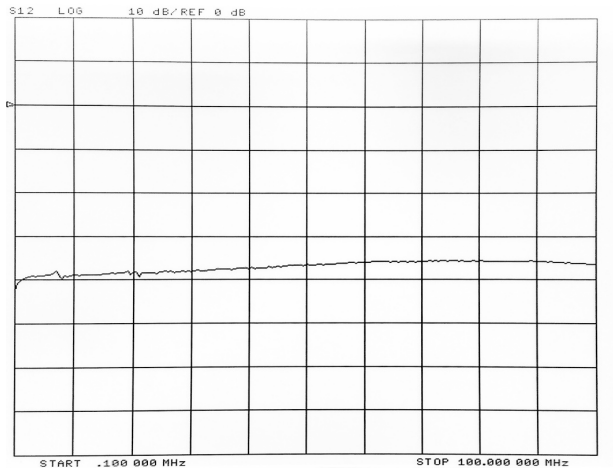


Figure 5.7, CMRR of Signal I_{RF}

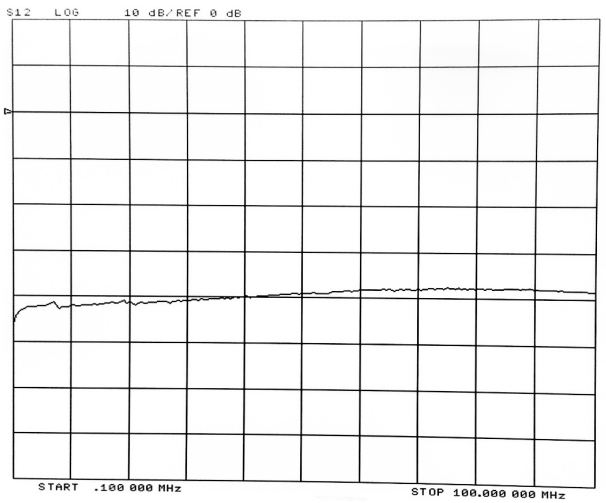


Figure 5.8, CMRR of Local I_{RF}

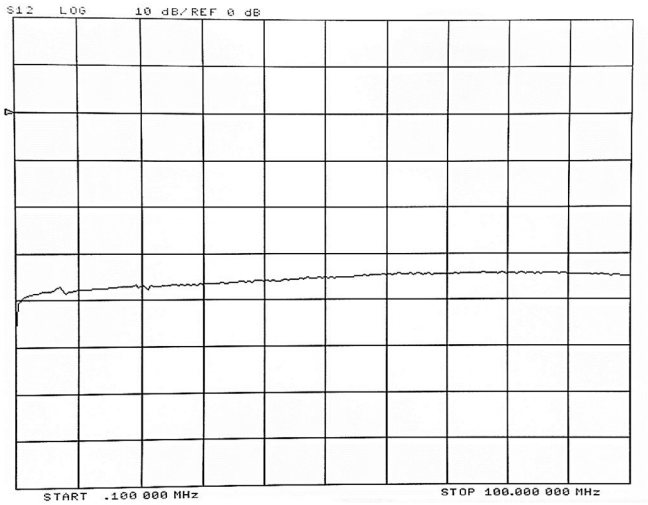


Figure 5.9, CMRR of Signal Q_{RF}

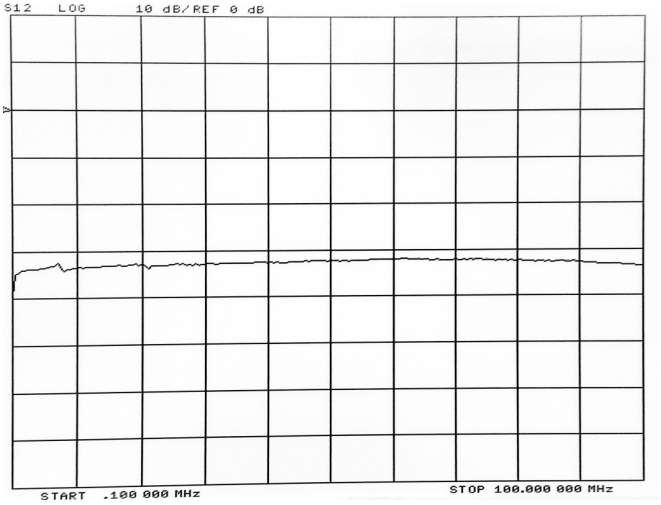


Figure 5.10, CMRR of Local Q_{RF}

6. PHYSICAL REQUIREMENTS

6.1 Mechanical Specification

Dimension: 150 x 82 x 36 mm

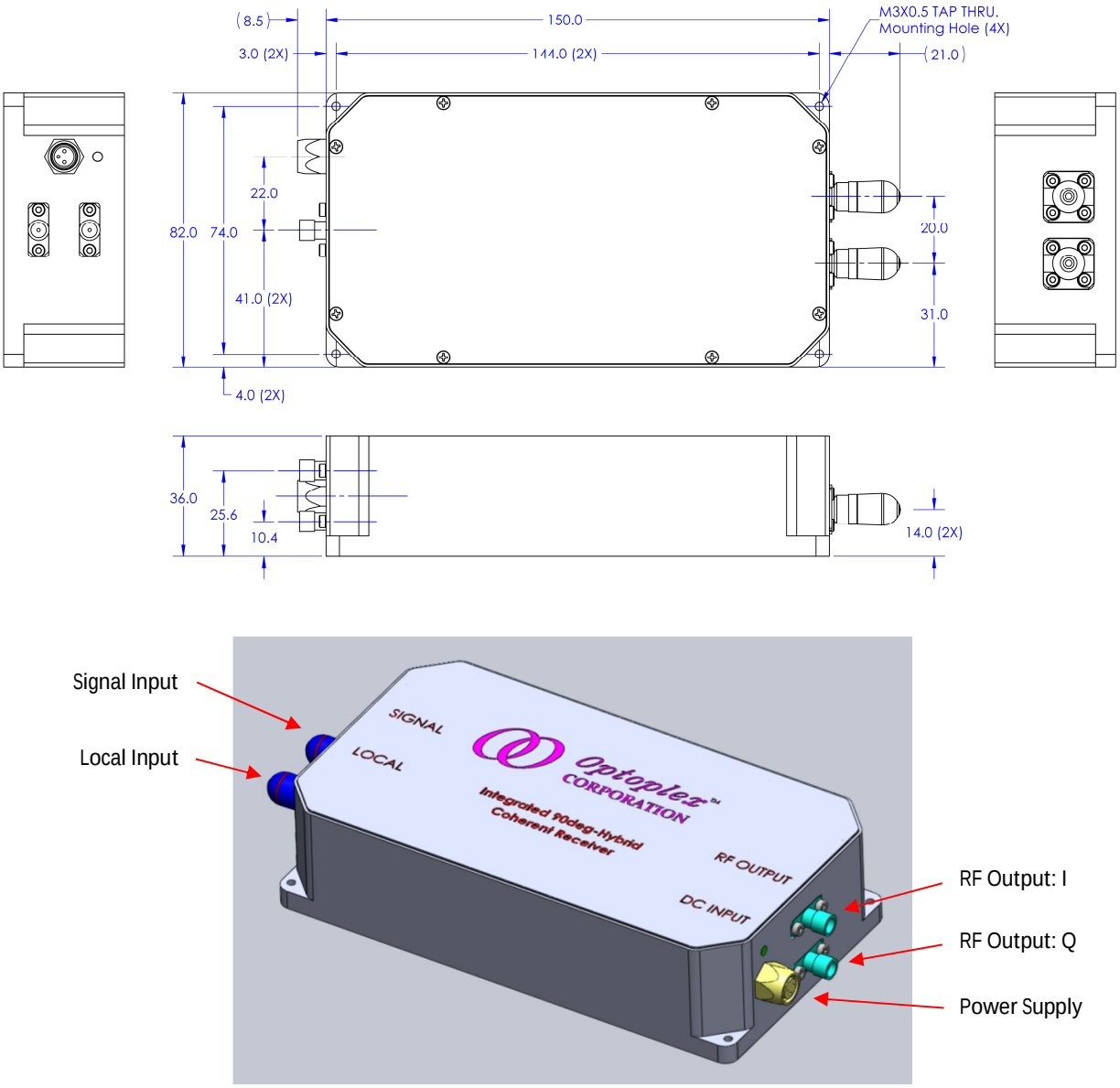


Figure 6.1, Mechanical drawing of the integrated 90deg hybrid with balanced receiver

6.2 Electrical Specification

Power Supply:

- ±12V DC, 800mA.

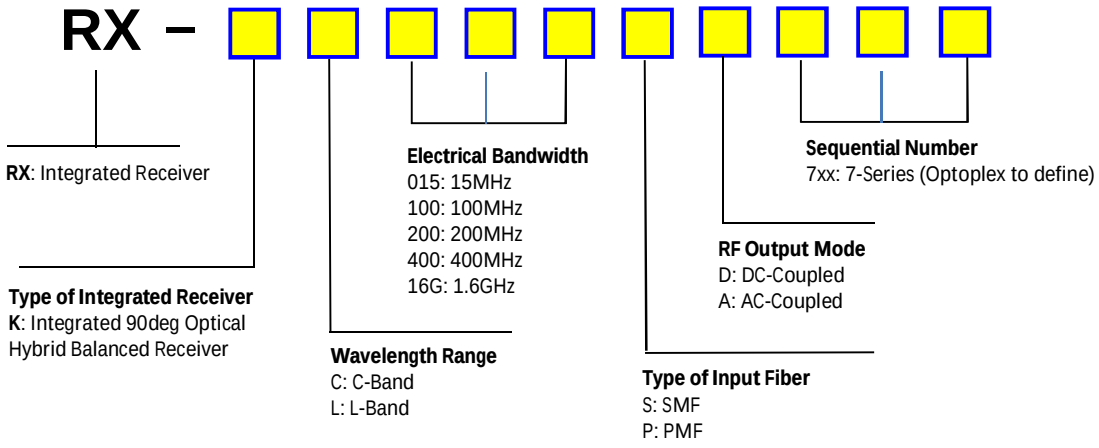
Electrical Output

- There are two sets of balanced photoreceivers inside the module. At the output, there are RF-Output-1 and RF-Output-2 with SMA connector

6.3 Optical Input Ports

- Signal-Input Port: PMF or SMF, FC/APC
- Local-Input Port: PMF or SMF, FC/APC

7. ORDERING INFORMATION



Examples

#	P/N	Description
1	RX-KC100PA701	Integrated 90deg optical hybrid balanced receiver, C-Band, 100MHz BW, PM fiber input, AC-Coupled
2	RX-KC100SA702	Integrated 90deg optical hybrid balanced receiver, C-Band, 100MHz BW, SMF fiber input, AC-Coupled
3	RX-KC16GSA709	Integrated 90deg optical hybrid balanced receiver, C-Band, 1.6GHz BW, SMF fiber input, AC-Coupled
4	RX-KC400SD726	Integrated 90deg optical hybrid balanced receiver, C-Band, 400MHz BW, SMF fiber input, DC-Coupled

Contact Information

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

Sales
sales@optoplex.com

Technical Support
support@optoplex.com