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# Balanced Photo-Receivers

Revision 2019

## 1. INTRODUCTION

### 1.1 General Introduction

This document describes a balanced photoreceiver for balanced detection.

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.

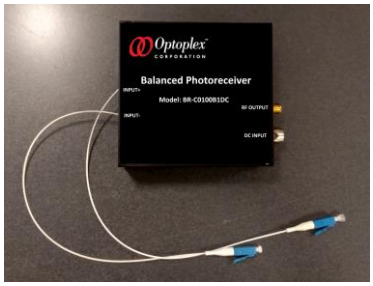


*Figure 1. Photo of a Balanced Receiver of 100MHz BW*

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

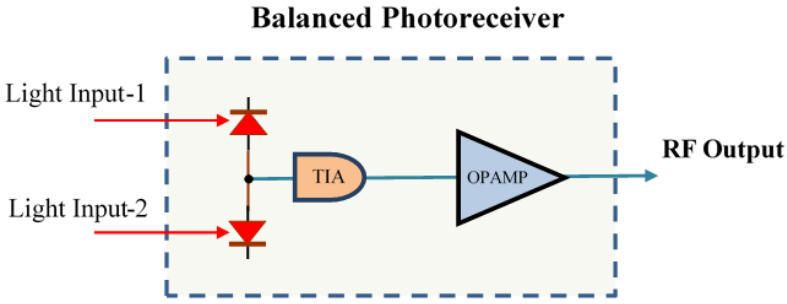


*Figure 2. Functional Block Diagram of the Balanced Photoreceiver*

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).

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### 1.2 Applications

The balanced photoreceivers are used with a 90deg optical hybrid or a polarization-diversified coherent mixer for coherent detection in Coherent Doppler Lidar, DAS (distributed acoustic sensing system), OCT (optical coherent tomorgraphy) in biomedical optics, Coherent OTDR (Optical Time-Domain Reflectometry), Coherent OSA (optical spectrum analyzer) etc.

Two typical examples of coherent detection are shown in Fibure 3 and 4.

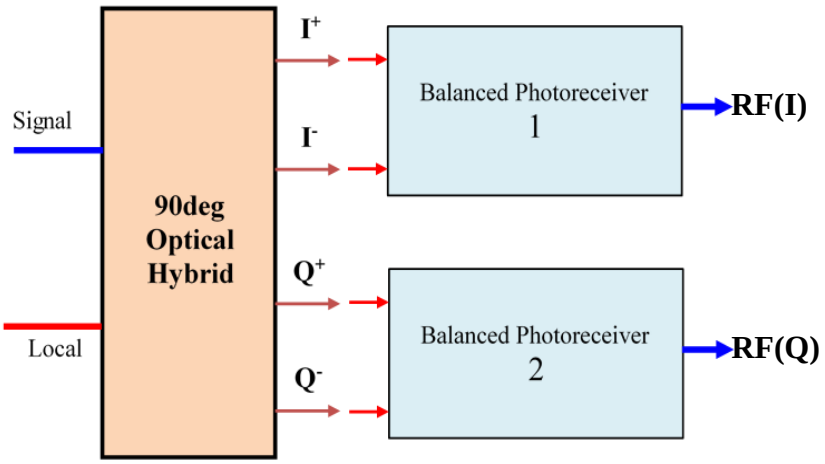


*Figure 3. Functional Block Diagram of a 90deg Optical Hybrid integrated with 2 Balanced Photoreceivers*

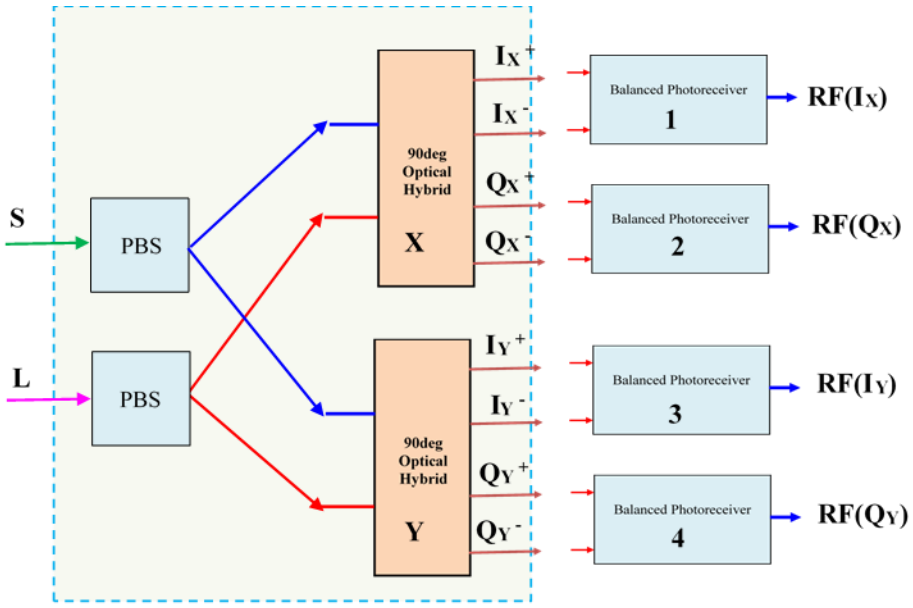


*Figure 4. Functional Block Diagram of a polarization-diversified 90deg Optical Hybrid (also called 2x8 Coherent Mixer) integrated with 4 Balanced Photoreceivers*

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Optoplex has the 90deg hybrid integrated with balanced receivers (as shown in Figure 3) and the 2x8 coherent mixer integrated with balanced receivers (as shown in Figure 4). Visit www.optoplex.com for detail product information.

## 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 | $T_c$ | *°C* | | -5 | +70 | |
| 2.3 | Operating Humidity | - | *%RH* | $T_c$ = +65°C, Non-condensing | 5 | 85 | |
| 2.4 | Storage Temperature | $T_{stg}$ | *°C* | | -40 | +85 | |
| 2.5 | Storage Humidity | - | *%RH* | $T_c$ = +85°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 | $T_c$ | *°C* | | -5 | | +65 | |
| 3.3 | Operating Humidity, Relative, 40°C non-condensing | - | *%RH* | | 5 | | 85 | |
| 3.4 | Storage Temperature | $T_{stg}$ | *°C* | | -40 | | +85 | |
| 3.5 | Storage Humidity | - | *%RH* | | 5 | | 85 | |

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## 4. BALANCED PHOTORECEIVER (100MHZ BW)

### 4.1 Optical-Electrical Characteristics

| # | Parameter | Unit | Min | Typ. | Max | Note |
|---|---|---|---|---|---|---|
| 4.1.1 | Type of Detector | | | InGaAs | | |
| 4.1.2 | Wavelength Range | *nm* | **1310** | | **1670** | |
| 4.1.3 | Responsivity, Typical | *V/W* | | 8 | | |
| 4.1.4 | RF Output Bandwidth (3dB) | *MHz* | DC | | 100 | |
| 4.1.5 | Common Mode Rejection Ratio (CMRR) | *dB* | 20 | 30 | | |
| 4.1.6 | Transmission Gain | *V/A* | | $25x10^3$ | | |
| 4.1.7 | Conversion Gain RF Output | *V/W* | | $25x10^3$ | | |
| 4.1.8 | CW Saturation Power | $\mu W$ | | 72 | | @1550nm |
| 4.1.9 | NEP (DC - 10MHz) | $\frac{pW}{\sqrt{Hz}}$ | | 3.8 | | |
| 4.1.10 | Integrated Noise (DC - 100MHz) | $nW_{RMS}$ | | 65 | | |
| 4.1.11 | Overall Output Voltage Noise | $mV_{RMS}$ | | 2.2 | | |
| 4.1.12 | RF Output Impedance | $\Omega$ | | 50 | | |
| 4.1.13 | RF Output Voltage Swing | *V* | | | +-3.6 | |
| 4.1.14 | DC Offset RF Output | *mV* | | | +/-3 | |
| 4.1.15 | Max Optical Input Power | *mW* | | | 20 | |
| 4.1.16 | Power Supply, Voltage | *V* | | | +/-12 | |
| 4.1.17 | Power Supply, Current | *mA* | | | 200 | |
| 4.1.18 | Output Coupling | | | AC-coupled output | | |
| 4.1.19 | Electrical Output Interface | | | SMA | | |

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**4.2 PD Responsivity**

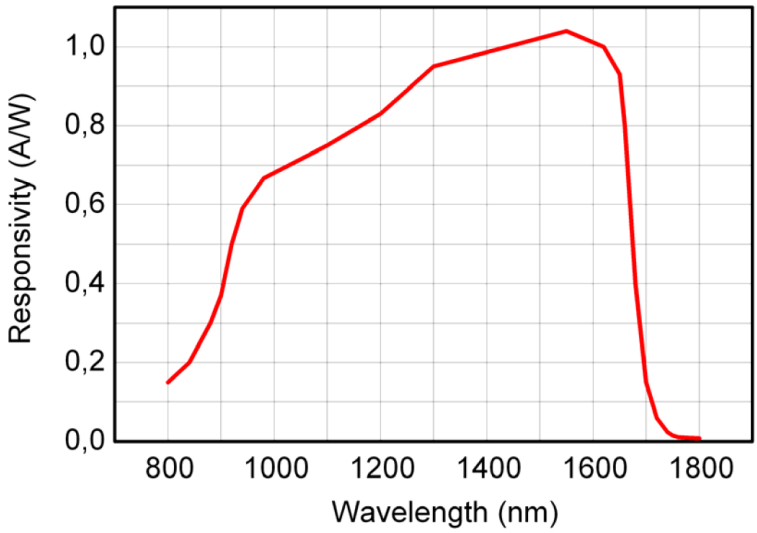


*Figure 4.1, Typical Responsivity (for illustration only)*

4.3 CMRR

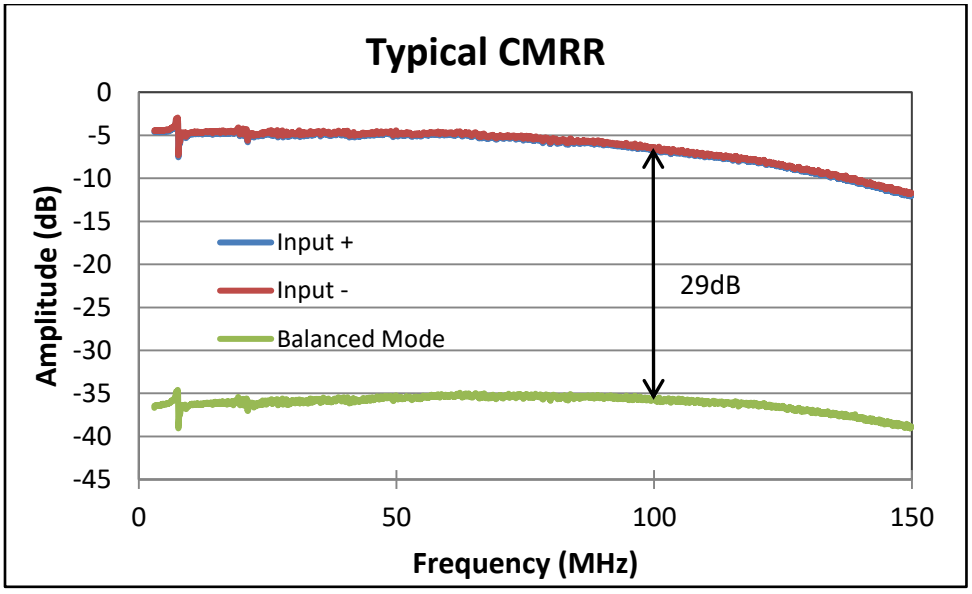


*Figure 4.2, Typical CMRR*

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## 5. PHYSICAL REQUIREMENTS

### 5.1 Mechanical Specification

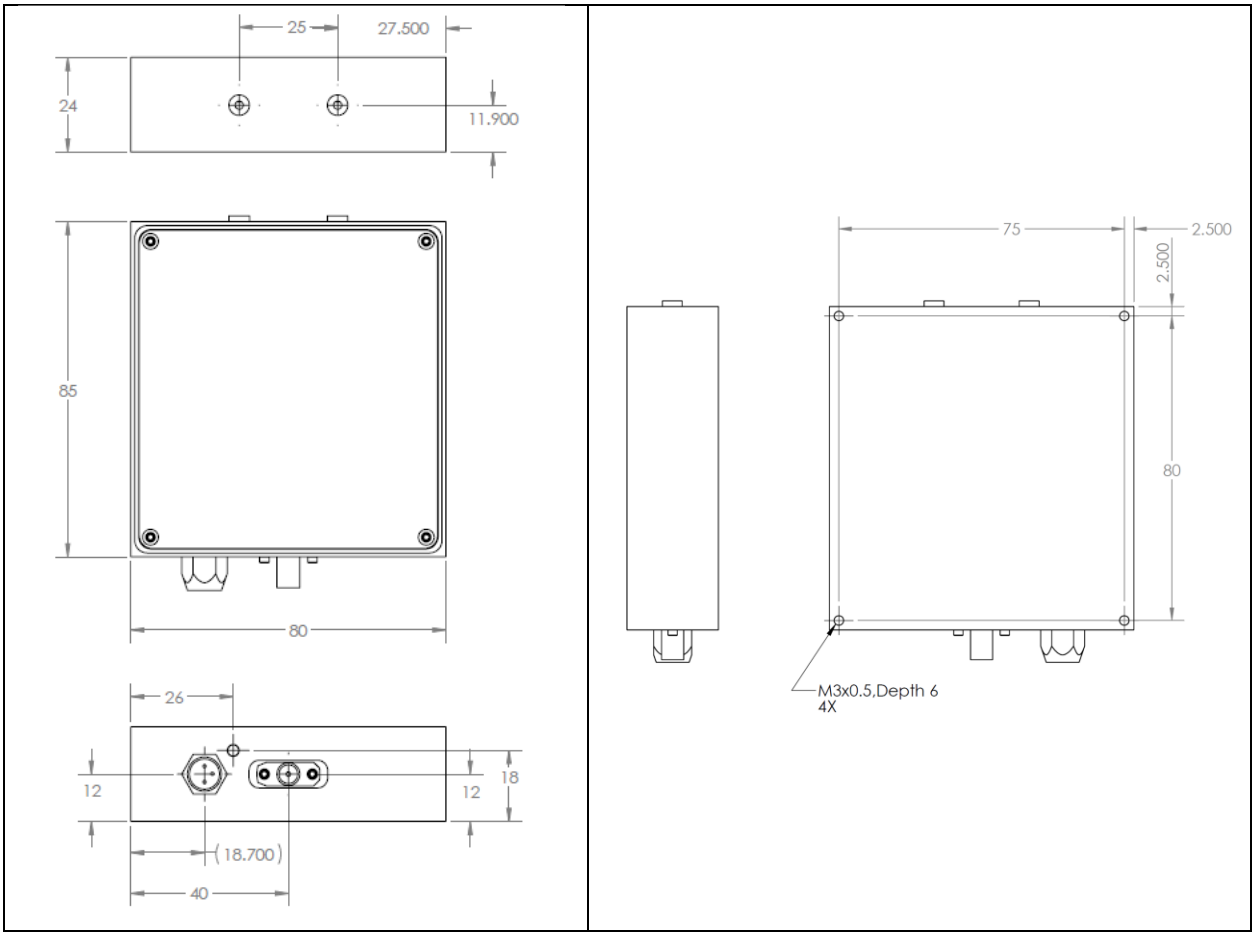


*Figure 5.1, Mechanical drawing of the balanced photoreceiver*

### 5.2 Electrical Specification

Power Supply: (Optional)

- ±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
- AC-coupled output, or DC-coupled output. Customer specific.

### 5.3 Optical Input Ports

- Fiber: SMF
- FC/APC, or LC/UPC, or customer specific.

## 6. ORDERING INFORMATION

| 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 |

### Accessory:

Power Supply: Sold Separately

- ±12V DC, 800mA.

## 7. CONTACT INFORMATION

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