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USER'S GUIDE

DC to 3.5-GHz Amplified Photoreceivers

Models 1591 & 1592



These photoreceivers are sensitive to electrostatic discharges and could be permanently damaged if subjected even to small discharges. Ground yourself adequately prior to handling these receivers or making connections. A ground strap provides the most effective grounding and minimizes the likelihood of electrostatic damage.

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Operation

Introduction

High-speed measurements down to a few microwatts are easy with the Models 1591 and 1592 photoreceiver modules. These modules convert optical signals to electronic signals, in effect, giving every high-speed/high-frequency instrument in your lab an optical input.

In these receivers, the optical signal is delivered to the photodiode through a multi-mode fiber.

Model 1592 consists of an InGaAs photodiode; Model Model 1591 features a GaAs photodiode. The small size of the module allows you to connect it directly to your test instrument or amplifier. This eliminates the need to follow the photoreceiver with coaxial cable, which can seriously distort picosecond pulses and attenuate microwave signals.

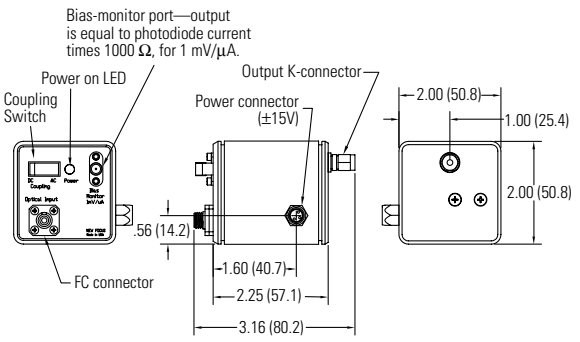


Figure 1: Models 1591 and 1592 photoreceiver modules

Handling Precautions

Whenever handling the photoreceiver, make sure to follow these precautions:

- Follow standard electrostatic-discharge precautions, including grounding yourself prior to handling the detector or making connections—even small electrostatic discharges could permanently damage the detector. A ground strap provides the most effective grounding and minimizes the likelihood of electrostatic damage.
- Do not over torque the microwave K-connector. Excessive torque can damage connectors.
- Make sure the optical connector is clean and undamaged before connecting it to the detector module.

Connecting the Power Supply and Bias

1. Prior to handling the detector, ground yourself with a grounding strap to prevent electrostatic damage to the receiver.
2. Connect the power cable to the power supply. Two power cables were included with the receiver; use the appropriate cable for your power supply.

   Connecting to a New Focus power supply: Use the cable with the two round microconnectors. Connect one end of the cable to one of the power supply's 300-mA outputs.

   Connecting to another power supply: Use the cable with the round microconnector on one end and three banana plugs on the other end. Be careful to connect the banana plugs to the power supply as follows; connect the red plug to a well-regulated, +15-V, 200-mA source; connect the black plug to a -15-V, 200-mA source; connect

the green plug to the common ground of the two sources.

3. Connect the bias-monitor port to a voltmeter and observe the voltage level. This voltage is the DC offset plus dark current. This dark voltage should be less than 5 mV. This monitor output is present in both the DC- and AC-coupled modes.

Note: *If you are coupling light into a fiber, use the voltmeter to monitor the photocurrent to help optimize the coupling.*

Microwave Connection and Set-up

1. Connect the photoreceiver module's microwave connector to a test instrument that has a 50-Ω input, such as an oscilloscope or spectrum analyzer, or to another 50-Ω load. If necessary, use a high-frequency cable (best performance is achieved without a cable).
2. To avoid connector damage and signal distortion, be sure that the cable and the instrument you intend to connect to the module have compatible connectors. See "Appendix II: Microwave Connectors" on page 17 for a list of compatible connectors.
3. These photoreceivers have a front panel switch to select either the DC- or AC-coupled electrical output. In the DC-coupled mode, the RF output is the sum of DC offset plus AC signal, and this mode is indicated by a red light. In the AC-coupled mode only the AC signal is present at the output and is indicated by a green light.

Connecting the Receiver to the Optical Input

1. Before connecting the photoreceiver, measure the power in the fiber to ensure it is within the safe operating range. For a pulsed input, determine the maximum (peak) power.

   You may want to use the New Focus Model 2011-FC 200-kHz Photoreceiver for this purpose; it has a higher maximum pulse power, and has the sensitivity to aid in fiber alignment.

2. Connect the fiber-optic cable to the fiber-optic input.

Troubleshooting

Testing the Photodiode

The photodiode can be damaged by electrostatic discharge or excessive optical power, which can lead to an increased dark (or *offset*) voltage. A damaged photodiode can result in a degraded responsivity and frequency/impulse response. See "Checking the DC-Offset Voltage," below.

Other problems, such as a damaged amplifier, are more difficult to diagnose. If the response from your receiver is lower than you expect, contact New Focus to arrange for a repair (see "Customer Service" on page 13).

Checking the DC-Offset Voltage

1. With no light on the photodetector, turn the detector on.
2. Use a voltmeter to measure the Bias Monitor output voltage. This voltage is the DC offset plus dark current.
3. If the output is >5 mV, then the detector is probably damaged and will need to be returned to New Focus.

   If the output is <5 mV, then perform the Basic Optical Test described below.

Basic Optical Test

To quickly test the photodiode in your receiver, run this simple DC optical test.

1. Turn the receiver on.
2. Using a voltmeter or oscilloscope, measure the output voltage from the Bias Monitor on the front panel of the bias supply.

   With no light on the detector, the Bias Monitor voltage should be <5 mV.
3. Illuminate the photodetector.
4. With the voltmeter or oscilloscope, you should observe a DC output voltage.

   If you know the optical power and wavelength, you can calculate the expected output voltage (V_{out}) using the expression: $V_{out} = P_{in} \bullet R \bullet G$, where P_{in} is the input optical power (watts), R is the photodetector's responsivity (A/W) as shown in Figure 2, and G is the amplifier's transimpedance gain (V/A). The gain of the bias monitor port is 1000 V/A.

If the output voltage is low, then contact New Focus to arrange for a repair (see "Customer Service" on page 13).

Characteristics

Characteristics

Model #	1591	1592
Wavelength Range	400–870 nm	950–1630 nm
Minimum 3-dB Bandwidth	DC to 4.5 GHz	DC to 3.5 GHz
Low Frequency Cut-off (AC-coupled mode)	10 KHz	10 KHz
Rise Time	95 ps	115 ps
Peak Conversion Gain	500 V/W	1100 V/W
Typical Maximum Responsivity	0.4 A/W	0.9 A/W
Output Impedance	50 Ω	50 Ω
Minimum NEP	40 pW/$\sqrt{\text{Hz}}$	19 pW/$\sqrt{\text{Hz}}$
DC-Bias Monitor Bandwidth	50 KHz	50 KHz
DC-Bias Monitor Transimpedance Gain	1 V/mA	1 V/mA
CW Saturation Power	2.2 mW (<5% @ 850nm)	1 mW (<5% @ 1550nm)
Power Requirements	±15V, < 200 mA (Model 0901 recommended)	±15V, < 200 mA (Model 0901 recommended)
Optical Input Connector	FC MM (62.5 µm)	FC MM (62.5 µm)
Electrical Output	Wiltron K	Wiltron K

Responsivity

A graph of the typical and predicted responsivity of the Models 1591 and 1592 is shown below.

Figure 2: Responsivity vs. wavelength for Model 1591

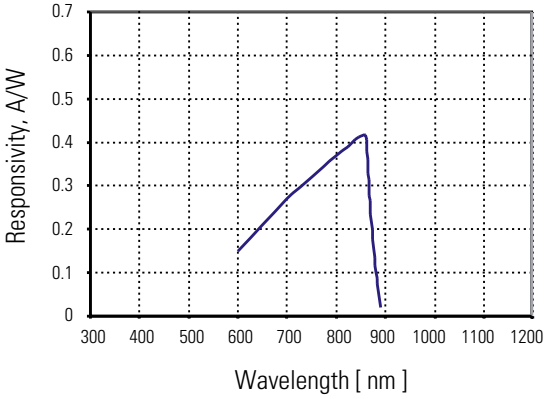
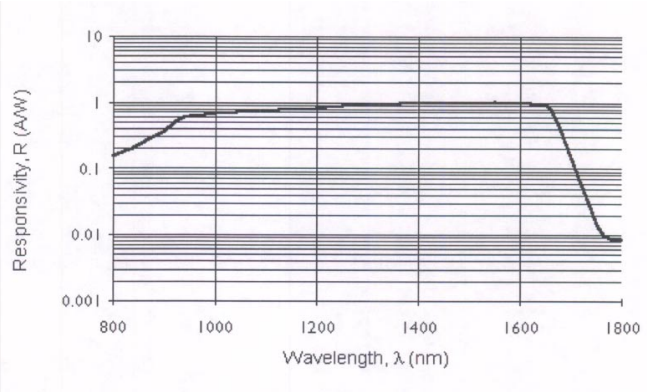


Figure 3: Responsivity vs. wavelength for Model 1592



Customer Service

Technical Support

Information and advice about the operation of any New Focus product is available from our technical support engineers.

Engineers are on duty from 8:00–5:00 PST, Monday through Friday (excluding holidays). For quickest response, ask for "Technical Support" and know the model number of your photoreceiver.

Phone: (408) 919-1500
Fax: (408) 980-8883

Support is also available by email:
techsupport@newfocus.com

We typically respond to email within one business day.

Service

In the event that your photoreceiver malfunctions or becomes damaged, please contact New Focus for a return authorization number and instructions on shipping the unit back for evaluation and repair.

Appendix I: Optical-Fiber Performance

Single-mode optical fiber can provide low-loss and low-distortion if attention is paid to a few important details. First, if more than one mode is allowed to propagate in a step-index fiber, the bandwidth will be degraded to approximately

$$f_{3\text{-dB}} = \frac{cn}{2L(NA)^2}$$

Where c is the speed of light in free space, n is the index of the core, L is the length of the fiber, and NA is the numerical aperture of the fiber. Modal distortion can be eliminated by using a fiber with a core small enough that only a single mode will propagate. In this case, the bandwidth of the fiber will be limited by material dispersion which is a property of the glass used in the fiber core. In this limit, the bandwidth is approximately*

$$f_{3\text{-dB}} = \frac{1}{2LM\Delta\lambda}$$

where L is the fiber length in kilometers, M is the material dispersion in ps/(nm x km), and $\Delta\lambda$ is the linewidth of the optical source in nm. This bandwidth limitation can be ignored for glass fibers less than 10 meters in length, but can be serious for longer fibers and spectrally broad sources.

* Palais, C. J., *Fiber Optic Communications,* Prentice-Hall, Inc., Englewood Cliffs, NJ, 1984.

Appendix II: Microwave Connectors

The performance you obtain from these two models of photoreceivers depends largely on the instruments you use to measure their outputs and how the connections are made to the instruments.

Connect the male connector of the photoreceiver directly to the female connector of the instrument.

If you need to use an adapter, make sure it is designed for your frequency range of interest. The following table lists a few connectors and the frequency ranges in which they may be used. For more information, request Application Note 1. If you use an intervening coaxial cable, select a cable with sufficiently low loss in the frequency range of interest.

Connector	Frequency Range	Compatibility
BNC	DC–2 GHz	——
SMA	DC–18 GHz	Wiltron K, 3.5 mm
3.5 mm	DC–34 GHz	SMA, Wiltron K
Wiltron K	DC–40 GHz	SMA, 3.5 mm
2.4 mm	DC–55 GHz	Wiltron V
Wiltron V	DC–65 GHz	2.4 mm
New Focus also offers the following adapters: Model 1225 Male-SMA to Female-BNC Model 1226 Female-SMA to Male-BNC Model 1227 40-GHz Flex Cable, Female-K to Male-K		

Appendix III: Inside the Photoreceiver

A gold-plated microwave housing inside the photoreceiver module contains the high-frequency circuitry. This housing is bolted to a printed-circuit board which regulates the bias for the photodiode and amplifies the DC photocurrent for the monitor port. The optical signal is brought from the front-panel connector to the microwave housing with a multimode (MM) 62.5-µm core fiber.

Although the material and modal dispersion per unit length of this fiber can be high at certain wavelengths, there is no degradation in frequency response since the fiber is only 0.1 meters long. These use a 50/125-µm fiber and a lens to image the core onto the detector active area.

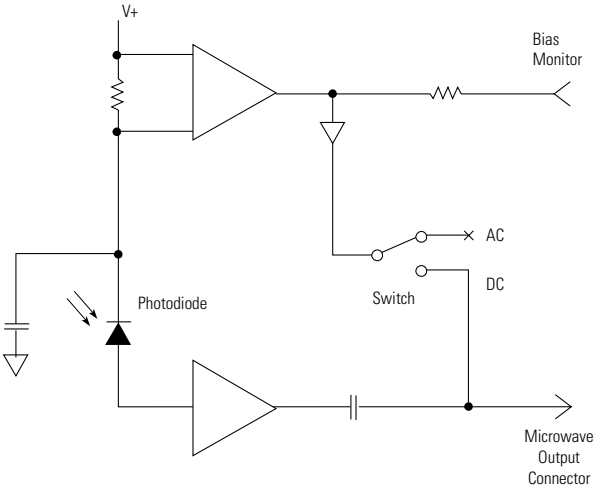


Figure 4: Simplified schematic of the Models 1591and 1592 photoreceiver modules

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