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USER'S GUIDE

High-Dynamic-Range Power Sensors

Models 2101 & 2103



NEW FOCUS®

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Operation

Introduction

Models 2101 and 2103 High-Dynamic-Range Power Sensors are sensitive optical receivers with logarithmic conversion circuitry to provide an analog output spanning a range of more than 70 dB of optical input power. Designed for use in swept-wavelength optical loss measurement, the fast rise and fall times allow measurements at speeds of 100 nm/s and beyond. For Model 2103, the provided calibration data enables accurate absolute power measurement over the wavelength range from 1520 nm to 1620 nm.

Outside of the calibrated band, both the Model 2101 and Model 2103 work well as relative power sensors. The logarithmic output provides a conversion gain of 50 mV/dB of optical power, so the full range of the sensor can be converted to a digital signal with better than 0.01-dB resolution using a single 14-bit, 5-V conversion. This simplifies data collection, eliminating the need for user-controlled gain switching and multiple-laser sweeps. As a result, data can be taken more quickly and without the added accuracy concerns that result from stitching errors between multiple sweeps.

The fast analog response is also useful for viewing high-range signals on an oscilloscope, making the Model 2101 and 2103 good tools for general lab use. Multiple units can be bolted together and their power

cables daisy-chained for testing of multi-channel devices and rack mounting.

Basic Operating Information

1. Multiple units may be bolted together using screws found in threaded storage holes in the bottom of the unit. Power connections can be daisy-chained from one unit to the next using the short cables provided.
2. The Model 2101 accepts free space light input; FC/PC and FC/APC fiber inputs are available with the Model 1281 fiber adapter accessory. The Model 2103 accepts both FC/PC and FC/APC input connectors.
3. A ±15-V, 75-mA power supply is required.

   In daisy-chained applications with *N* power sensors, the power supply should be rated for *N* times 75 mA.
4. The output is an analog voltage with a gain of 50 mV/dB of input light. For the Model 2101, a 3.5-V output typically corresponds to approximately 2 dBm of input optical power at 920 nm. A 3.5-V output corresponds to approximately 0 dBm of input power at 1550 nm for the Model 2103.
5. For the Model 2103, calibration information for precise measurements in the 1520-nm to 1620-nm range are provided on a sheet of paper found in the back of the manual.

Details of Operation

Optical Input

The Model 2101 accepts both free space and FC fiber input. A 5-mm diameter photodiode makes the free space light easy to align.

The Model 2103 accepts both FC/PC and FC/APC input connectors. The fiber illuminates a 1-mm photodiode at sufficiently close range so that all the light is detected from both fiber types. The fiber is perpendicular to the diode so that the non-angle-polished input fibers result in the specified polarization dependence of <0.02 dB.

The typical wavelength dependence of the response is shown in Figure 1 for Model 2101 and Figure 2 for Model 2103, respectively. The vertical axis is in optical dB, and the horizontal axis is in optical wavelength µm.

Figure 1: Wavelength response of Model 2101 vs. wavelength.

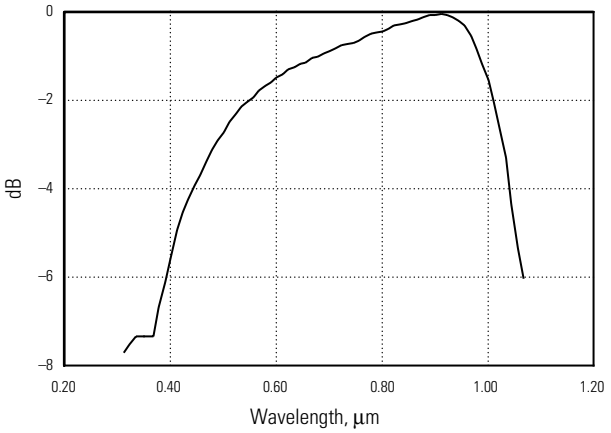
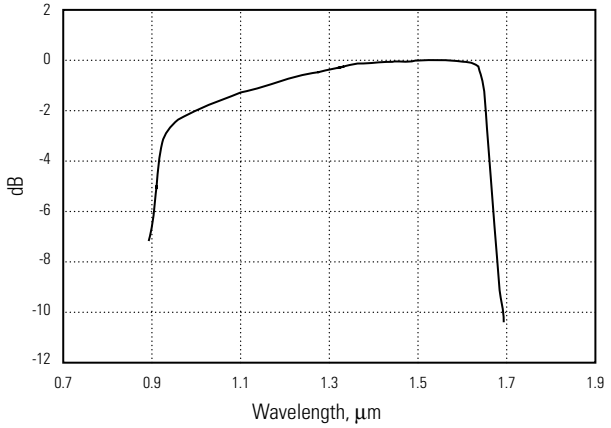


Figure 2: Wavelength response of Model 2103 vs. wavelength.



Calibration Data (Model 2103 Only)

To correct for wavelength response of the photodiode, calibration information is provided on a sheet of paper found in the back of the manual. These are the offsets (in volts) which must be subtracted from measured values in order for a 0-dBm input to produce 0 V at the output. Input optical power is then given by

$$P(\text{dBm}) = 20 \times (V_{meas} - V_{cal})$$

Warm-up Time

Active temperature stabilization of the photodiode and critical circuit components requires a warm-up time of about five minutes for full accuracy. Within this period, the status light (for Model 2103) changes from red to green and the output varies by several dB as the temperature stabilizes. Failure of the status light to turn green indicates the ambient temperature is outside the operating range, and Model 2103 may not give accurate readings. Model 2101 has no status light.

Output Signal

The output of the Models 2101 and 2103 is an analog voltage with a gain of 50 mV per dB of input light. For Model 2101, a 3.5-V output corresponds to approximately 2 dBm of input power at 920 nm; the accuracy degrades for signals outside the specified range of 0.4 V to 3.7 V (-60 dBm to +6 dBm). For the Model 2103, a 3.5-V output corresponds to approximately 0 dBm of input power at 1550 nm. While the output range is about -0.2 V to 3.75 V (-74 dBm to +5 dBm), accuracy degrades for signals outside the specified range of 0.4 V to 3.7 V (-62 dBm to +4 dBm). The unit must be connected to a high-impedance load; it cannot drive a 50-ohm load.

Measurement Speed

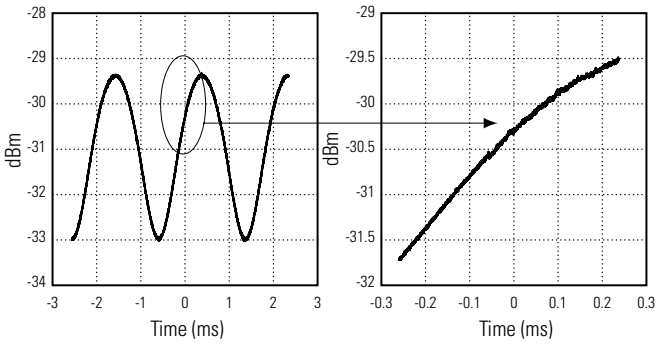
The Models 2101 and 2103 have three filter settings (1, 5, and 25 kHz) to reduce noise when speed of response is not critical. The fastest setting results in a 0-100% small signal rise time of 30 µs and an analog bandwidth in excess of 25 kHz. At this speed, the Models 2101 and 2103 can be used to measure narrow optical filters at wavelength sweep speeds of 100 nm/s.

To determine whether a slower filter setting can be used for swept-wavelength measurements, compare a measurement of the device under test at a faster sweep speed to one at a slower sweep speed (e.g., four times slower). If the faster measurement does not distort the result, the filter can be used.

Cross-over Detail

The Models 2101 and 2103 employ fast switching to achieve essentially seamless range-changing between two gain levels. This feature results in slight discontinuities (of both signal and noise) at the crossover point near the output level of -29 dBm for Model 2101 and 1.95 V (-31 dBm) for Model 2103. Figure 3 shows an example of the crossover. This will be insignificant for most applications but should be kept in mind.

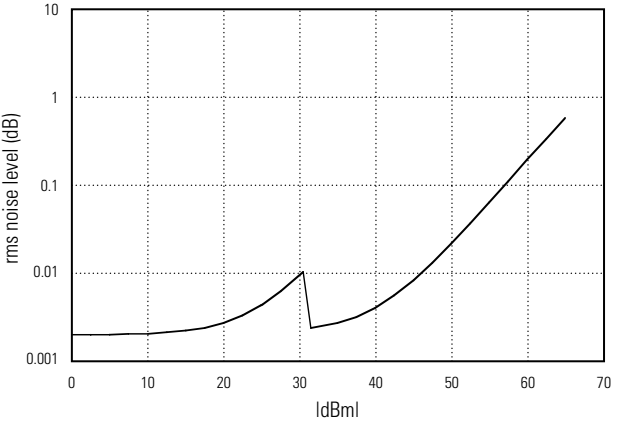
Figure 3: Close-up detail of crossover point for a sine-wave input



Noise Levels

The electrical noise voltage present at the output divided by the gain (50 mV/dB) of the power sensor represents the noise referred to the input. A plot of this is shown in Figure 4 for the 25-kHz filter setting. Note the discontinuity at the crossover.

Figure 4: Typical noise of the Model 2103 versus signal level



Multi-Channel Testing: Ganging Multiple Units

Multiple units can be bolted together to help maintain an orderly benchtop or to mount in a rack. Screws for this are located in storage holes in the bottom of the unit; these screws fit in the mating tabs (see Figure 5).

When bolted together, the short power cables provided with each unit are used to daisy chain the power connections so a single supply can power multiple units. The New Focus Model 0901 15-V Power Supply can power a total of nine units (four from each of the two 300-mA outputs, and one from the 100-mA output.)

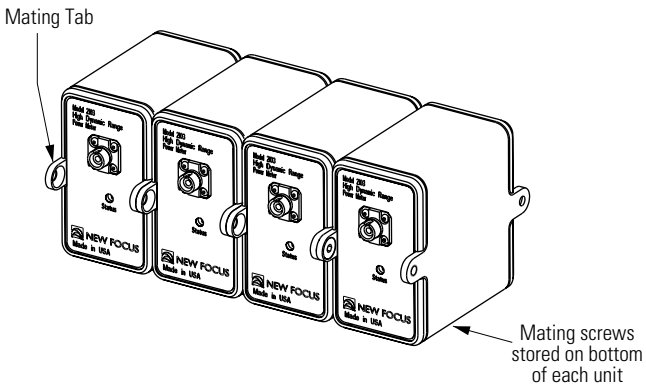
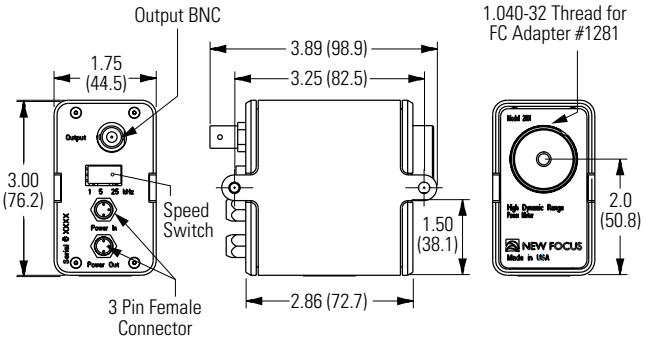


Figure 5: Ganging of Model 2103, front view. Daisy-chained power cables not shown.

Characteristics

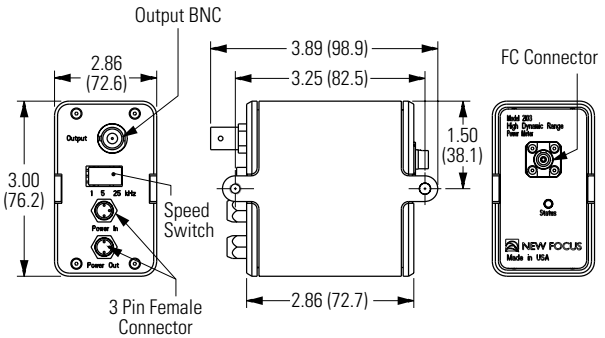
Physical Specifications

Figure 6: Front, side and back views of the Model 2101



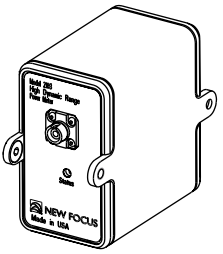
Unless otherwise noted, dimensions are in inches with metric dimensions in mm in parentheses.

Figure 7: Front, side and back views of the Model 2103



Unless otherwise noted, dimensions are in inches with metric dimensions in mm in parentheses.

Figure 8: Single unit configuration



Characteristics

Specification	Model 2101	Model 2103
Calibrated Wavelength Range	n/a	1520–1620 nm
Uncalibrated Wavelength Range	320~1060 nm	950–1650 nm
Photodiode Material	Si	InGaAs
Photodiode Diameter	5 mm	1 mm
Photodiode Window	Fusion bonded borosilicate glass, no AR coating	AR coating optimized at 1550 nm
Bandwidth Settings (3 dB)	1, 5, 25 kHz	1, 5, 25 kHz
Transition Time 0–100%, 25 kHz setting	30 µs	30 µs
Maximum Power*	6 dBm (920 nm typical)	4 dBm
rms Noise Floor*	-69 dBm (920 nm typical)	-71 dBm
Calibrated Accuracy (0 dBm, 22˚ C)	n/a	0.1 dB
Relative Accuracy* (-61 to +4 dBm)	0.05 dB +63 pW (920 nm typical)	0.05 dB + 40 pW
Optical Return Loss, Single-Mode APC	n/a	-50 dB
Polarization Dependence (FC/PC)	n/a	0.02 dB
Repeatability	n/a	0.01 dB
Crossover Level*	-29 dBm typical	-31 dBm typical
Crossover Transient	0.001 dB•ms	0.001 dB•ms

Specification	Model 2101	Model 2103
Crossover Discontinuity	0.03 dB	0.03 dB
Temperature Drift	0.005 dB/° C typical	0.005 dB/° C typical
Output Type	Analog	Analog
Output Impedance	<1 Ω typical	<1 Ω typical
Output Reference Level* (23° C)	2 dBm = 3.5 V (920 nm typical)	0 dBm = 3.5 ±0.005 V
Output Slope	0.5 V/decade	0.5 V/decade
Output Range	-0.2 to +3.75 V typ.	-0.2 to +3.75 V typ.
Input Connector	Free space plus fiber adapter option	FC/PC or FC/APC
Power Consumption	±15 V, 75 mA	±15 V, 75 mA
Operating Temperature Range	15–35° C	15–35° C

* Taken at 1550 nm.

Customer Service

Technical Support

Information and advice about the operation of any New Focus product is available from our applications engineers. For quickest response, ask for "Technical Support" and know the model and serial numbers for your product.

Hours: 8:00–5:00 PST, Monday through Friday (excluding holidays).

Toll Free: 1-866-NUFOCUS (1-866-683-6287)
(from the USA & Canada only)
Phone: (408) 919-1500

Support is also available by fax and email:

Fax: (408) 980-8883
Email: techsupport@newfocus.com

We typically respond to faxes and email within one business day.

Service

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

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