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User's Guide

Model 1647
Avalanche Photodiode Receiver

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ESD Sensitivity

The 1647 APD Receiver is sensitive to electrostatic discharge and could be permanently damaged if subjected even to small discharges. Ground yourself adequately prior to handling this receiver or making connections. A ground strap provides the most effective grounding and minimizes the likelihood of electrostatic discharge.



Avalanche Photodiode Damage Threshold

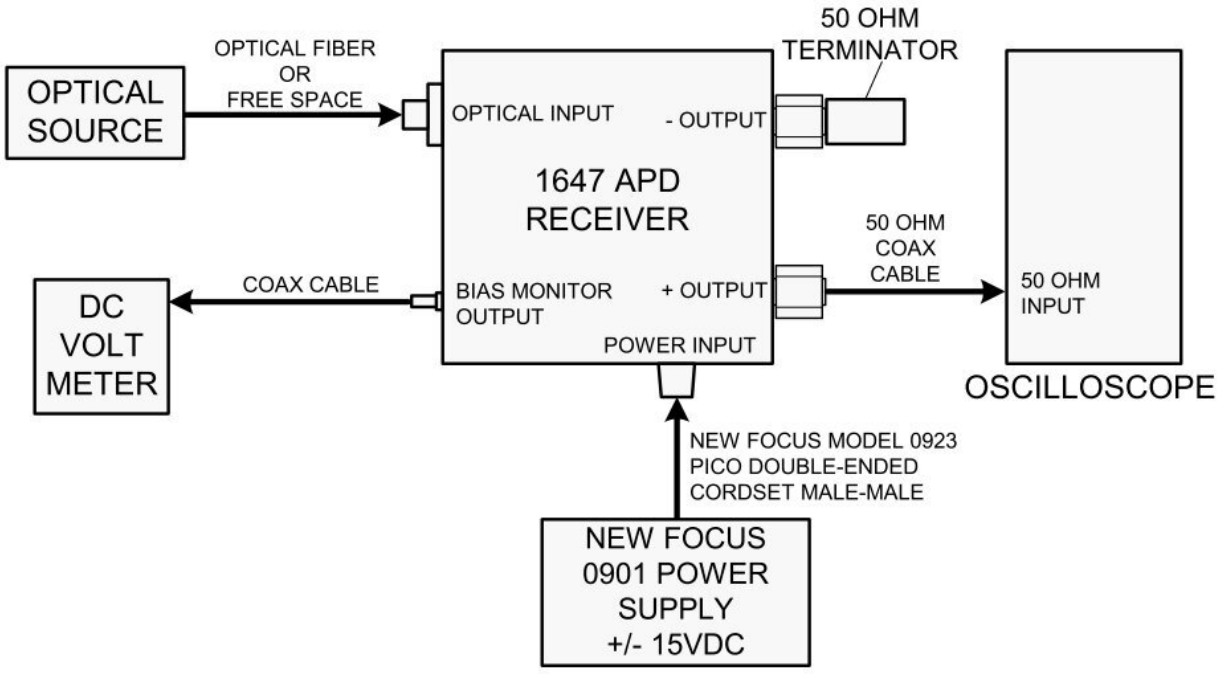
Overexposure to optical power can result in permanent damage that can result in pulse distortion, loss of bandwidth, loss of gain, or even catastrophic failure of the APD. The 1647 APD Receiver is more sensitive to input overpower at high bias voltage settings; the 1647 is more tolerant to input overpower at low bias voltage settings. The 1647 APD Receiver can withstand approximately 200 microwatts of optical input power at bias setting = 7. The maximum power levels for other bias settings are shown in the "Typical Parameters" table on page 6.

Before connecting the photoreceiver, measure the power in the fiber to ensure it is within the safe operating range.

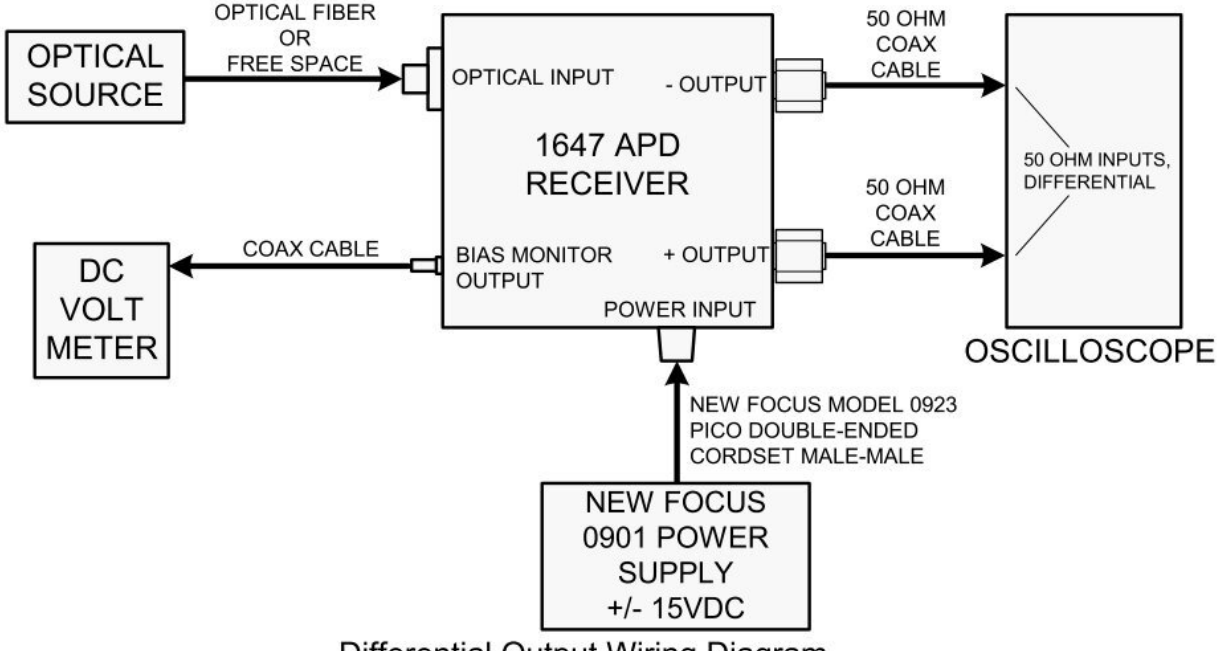
When beginning an experiment, start with the 1647 bias control knob set to position "1". Slowly turn up the bias voltage to the desired gain while watching the "Saturation/Overload" Indicator on the front of the unit. If the saturation indicator turns from GREEN to AMBER, you may want to stop increasing the bias voltage. See "Front Panel" section of this guide for more information.

After checking the power in the fiber, connect the fiber-optic cable to the fiber-optic input of the 1647.

External Wiring Diagrams

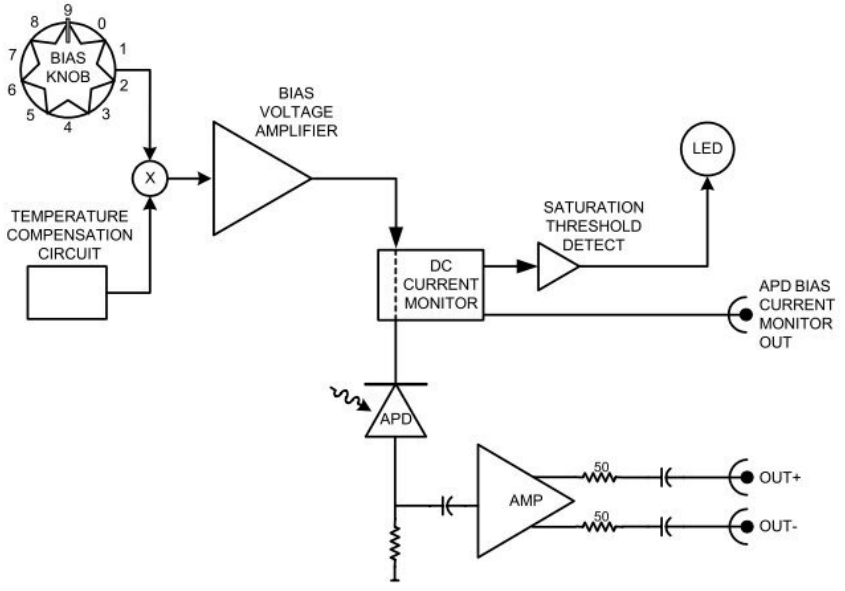


Single-Ended Output Wiring Diagram



Differential Output Wiring Diagram

1647 Simplified Block Diagram



AC-Coupled Input

The 1647's avalanche photodiode is AC-coupled to the amplifier; CW signals are blocked. This allows for modulation measurements on a CW signal. There is no "DC saturation" but there could be a slight decrease in effective DC bias voltage across the APD at very high CW power levels. This means that the overall gain of the 1647 will be decreased slightly because of the decreased effective DC bias voltage across the APD.

Power Supply

The 1647 APD Receiver will operate with a low noise power supply such as the New Focus Model 0901. The power enters the 1647 via three power pins: +Power, -Power, and Common.

When using the New Focus Model 0901 Power Supply, use only the 0.3A outputs and the Model 0923 Pico (m8) Double-Ended Male-Male Cordset. Do not use the 3-Banana Connector, 0.1A outputs because the Model 0901 banana jack outputs will automatically current limit and turn off.

Warm-Up Time

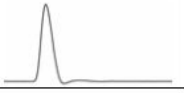
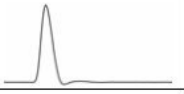
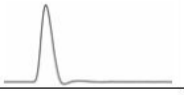
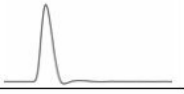
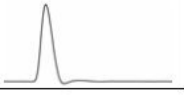
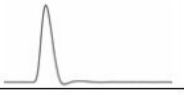
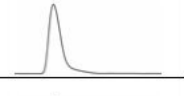
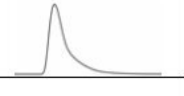
Wait one hour for the 1647 to warm up before making measurements. The aluminum chassis will become warm. After one hour, the circuitry will thermally stabilize for consistent measurements.

Front Panel

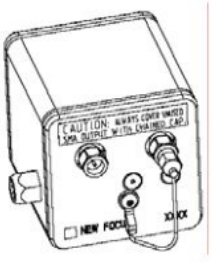
1) **Clear Fault Button:** Tests amber LED.
2) **PWR Indicator:** The power indicator will be GREEN when the positive/negative input power is equal to or greater than +/-12VDC.
3) **Saturation/Overload Indicator:** The saturation indicator will be GREEN during linear operation. The color will change to AMBER near the optical power level at which the internal transimpedance amplifier begins to limit it's output. It is safe to operate the 1647 when the transimpedance amplifier is in this limited condition, however the electrical output will no longer be a linear representation of the optical input. *If the input damage threshold is exceeded, the APD could be permanently damaged. (See the "Typical Parameters" table on page 6.)*
4) **Bias Monitor Connector:** The bias monitor output connector is a female SMA type. It's output is proportional to the APD bias current and is typically between 0 and 8.0VDC. The absolute maximum output is 9.5VDC.
5) **Optical Input Connector:** The optical input is via a FC/PC connector. The light is coupled to the APD internally via a flat-polished, 10 centimeter, 62.5um core diameter multimode fiber.

6) **Bias Knob:** The APD bias voltage control knob has ten positions for controlling the bias voltage of the avalanche photodiode.

Typical Parameters at 1550 nm

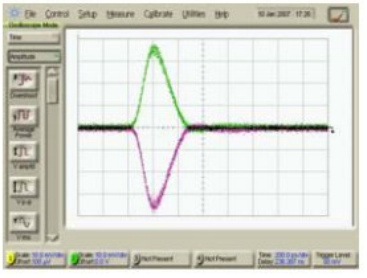
Bias Control Switch Position	APD Bias, Volts	Gain, V/W	NEP, pW/rt-Hz	Average Saturation Power, uW	BW, GHz	Rise/Fall Time, pS	Normalized Pulse Response	Optical Over-power Limit, uW
1	25.5	-	-	80	-	-	APD almost OFF	1500
2	36	3,000	5.3	28	1.4	200		800
3	49	6,000	2.7	15	1.4	210		460
4	51	7,000	2.4	13	1.3	215		400
5	53	9,000	2.0	10	1.3	220		310
6	54.5	11,000	1.8	8	1.2	230		250
7	56	14,000	1.6	6	1.1	250		200
8	58.5	30,000	1.3	3	0.6	470		80
9	59.5	50,000	1.1	2	0.2	-		45
10	60	-	-	-	-	-	APD saturated and very noisy	20

Rear Panel



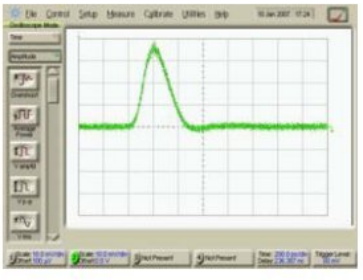
1) **Left SMA connector:** The male SMA connector on the left is the positive-going (+) output channel. DC signals are blocked by an internal capacitor. Output impedance is 50 ohms.
2) **Right SMA connector:** The male SMA connector on the right is the negative-going (-) output channel. DC signals are blocked by an internal capacitor. Output impedance is 50 ohms.

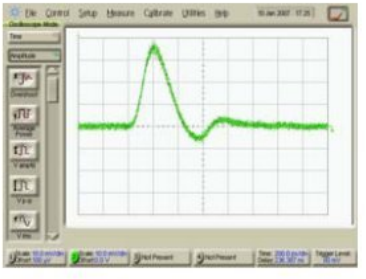
The left and right SMA connectors, used together, allow for differential output connections.



Differential outputs of 1647.

When either of the left or the right SMA connectors is not being used, it must be terminated in 50 ohms to avoid excessive ringing on the active output. For your convenience, a 50 ohm terminating cap is attached to the rear cover of the 1647 for this purpose.



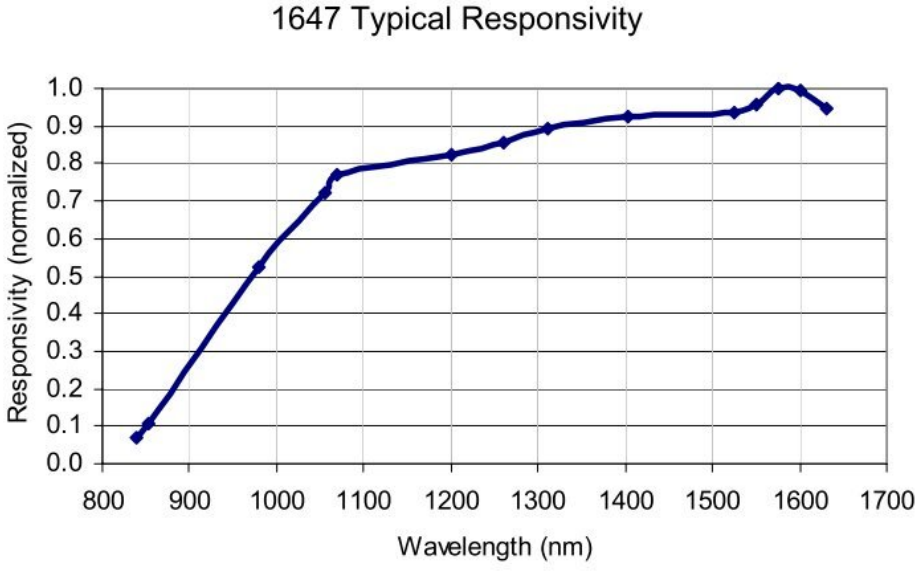


1647 pulse response at positive output with negative output terminated (left) and unterminated (right).

Temperature Compensation

There is a temperature compensation circuit within the 1647 Avalanche Receiver. It senses the temperature at the avalanche photodiode and adjusts the bias voltage to maintain constant gain over a 15°C to 35°C ambient temperature range.

Responsivity



Performance Specifications

The characteristics of the APD vary according to the bias voltage setting. The typical specifications below are given at bias voltage setting "7".

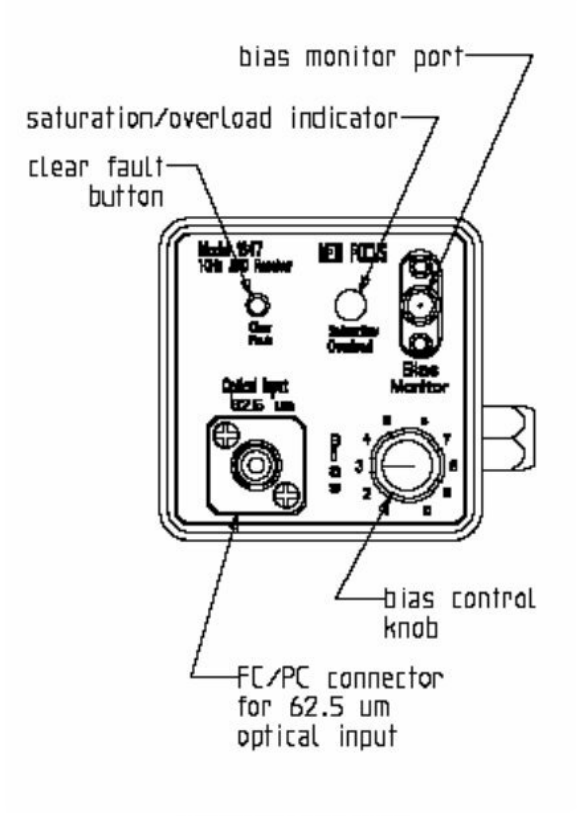
Wavelength Range	800-1650nm
3-dB Bandwidth	15kHz – 1.1Ghz
Rise Time	250 pS
Peak Conversion Gain, single output	14,000 V/W
Peak Conversion Gain, differential outputs	28,000 V/W
Output Impedance, each output	50 Ω
NEP, single output	1.6 pW/√Hz
APD Excess Noise Factor	5
Optical Saturation Power, AC	6 uW
Optical Saturation Power, DC (CW)	200 uW
Optical Damage Threshold	200 uW average
Bias Monitor Output Bandwidth	16kHz

Power & Environmental Specifications

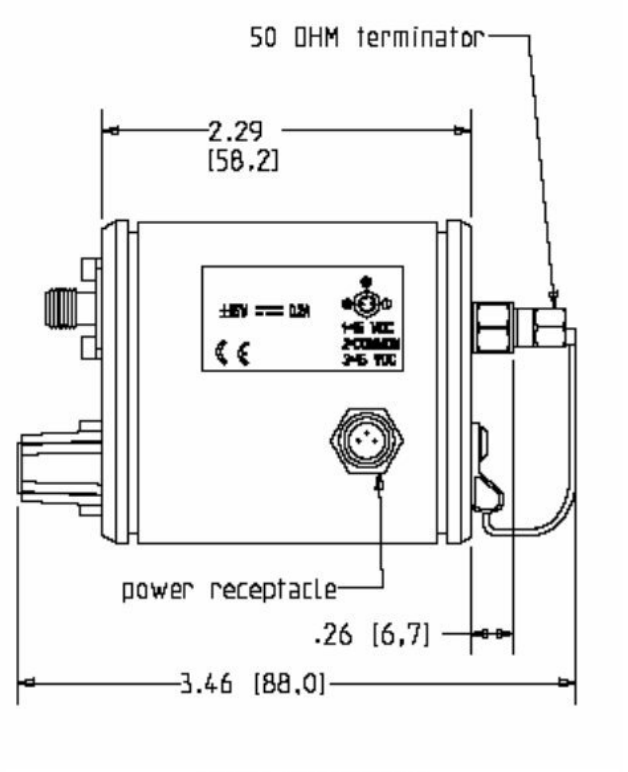
Power Input, positive Power Input, negative	+12 to +15VDC, 0.2A -12 to -15VDC, 0.005A
Temperature, storage Temperature, operating	-20°C to 60°C -10°C to 35°C
Peak Conversion Gain Drift	10% (15°C to 35°C)
Humidity	0% to 90% RH, non condensing
Altitude	2000 m
Pollution Degree	Pollution Degree 2
Weight	200 grams
Cooling Method	Natural air circulation

Mechanical

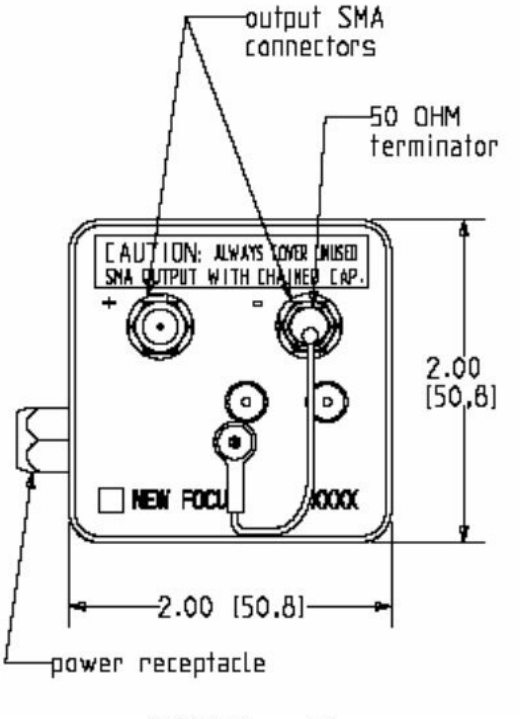
Optical Input	FC, 62.5 um
Electrical Outputs	SMA, male



1647 Front View



1647 Side View



1647 Rear View

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