PGA-600HSX 100 MHz Single Photon Receiver

- **High Speed Operation to 100 MHz**
- **Ultra High Sensitivity InGaAs/InP Detector**
- **High Detection Efficiency**
- **Low Dark Count Rate**
- **Adjustable Blanking Function**

1. PRODUCT DESCRIPTION

The Princeton Lightwave 100 MHz Single Photon Bench-top Receiver is a complete solution for single photon counting applications that require very high counting rate. The receiver integrates a Princeton Lightwave premium grade (ultra-high sensitivity) InGaAs/InP Single Photon Avalanche Diode (SPAD) with all the necessary bias and control electronics. The SPAD design has been optimized specifically for single photon counting to provide high detection efficiency and low dark count rate. The unit's electronics utilize patented biasing and detection techniques to achieve the highest performance. The front panel of the unit displays the number of photons detected in a selected interval as well as other operational and diagnostic information. All operating parameters and values can also be accessed through the USB interface enabling automation of single photon measurement systems. The receiver is configured in a standard 2U 19-inch rack mount chassis.

2. PERFORMANCE SPECIFICATIONS

Test Conditions (unless otherwise specified): T_{APD} = 223 K, 1 MHz trigger rate, 1 ns gate width, no blanking

Parameter Description	Test Conditions	Specifications			Unit
		Min	Typ	Max	
Gate Width			1		ns
Gate Trigger Rate		0.01		100	MHz
Detection Efficiency (DE)	1550 nm, at DCR max	15	20		%
Dark Count Probability (DCP)	at DE min			6×10^{-6}	ns^{-1}
Dark Count Rate (DCR)	at DE min			6	kHz
After-pulse Probability (AP)	trigger rate = 1 MHz at DE min			2×10^{-4}	/gate
After-pulse Probability (AP)	trigger rate = 100 MHz at DE min		5×10^{-2}		/gate
After-pulse Probability (AP)	trigger rate = 100 MHz at DE min with blanking =9			5×10^{-3}	/gate

Cited dark count probability and dark count rate are exclusive of after-pulsing effects.

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3. GENERAL SPECIFICATIONS

Parameter Description	Specifications			Unit
	Min	Typ	Max	
Ambient Operating Temperature	10		35	°C
Dimensions		19×17×3.5		$inch^3$
Power Supply Input Voltage	90		240	V_{AC}
Power Supply Input Frequency	47		63	Hz
Optical connector		FC/PC		
RF Connectors		SMA (F)		
Wavelength range	1100		1600	nm
CW Optical Input Power			1	mW

4. ADJUSTABLE OPERATING PARAMETERS

Parameter Description	Specifications			Unit
	Min	Typ	Max	
Gate Trigger Rate	0.01		100	MHz
Trigger Input Pulse Level	1.0	2.0	5.0	V
Trigger Delay	0		TBD	ns
Avalanche Discriminator Level	0	250	1250	mV
Blanking Interval	0		255	triggers
Count Interval	1		continuous	sec
APD Bias	25	60	90	V_{DC}

5. INTERFACE

All unit operating parameters may be set through the front panel LCD display or through the USB interface. For the receiver, settings include APD temperature, blanking value, trigger delay, and discriminator level. The measurement results displayed include the avalanche count, gate pulse count. The sampling time interval (gate width and trigger rate) may also be set through the interface. The trigger and photon detection pulse outputs are standard LVTTL output levels into a 50Ω load.

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6. THEORY OF OPERATION

The receiver provides a complete solution for detecting single photons, including the integration of a thermally controlled InGaAs SPAD with all the required electronics. The receiver has four major functional elements, as shown in the block diagram below. These are (i) the SPAD, (ii) analog signal processing circuitry, (iii) a discriminator circuitry, and (iv) triggering, biasing, and blanking circuitry.

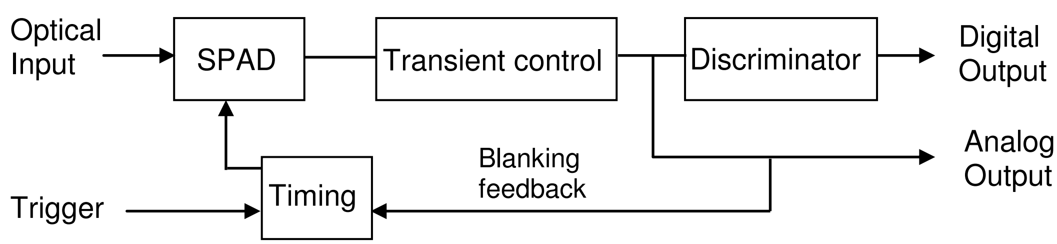
The SPAD is designed for single photon detection applications. It is operated at 223 K to optimize photon detection with reduced probability of dark counts. When the detector is triggered, the APD bias voltage is raised above its reverse breakdown voltage (V_{BR}) to operate in “Geiger mode”. After the specific gate duration, the bias is reduced below V_{BR} again to quench any avalanche that has occurred, and to prevent false events between gates.

The analog signal processing circuitry eliminates the transient noise created when a short bias pulse is applied to the SPAD and isolates the charge pulse that results from an avalanche event. This circuitry is based on single photon detection technology patented by IBM and licensed to Princeton Lightwave.

The discriminator circuitry generates a digital logic pulse when an avalanche event is detected. The discriminator level is adjustable to optimize APD avalanche detection and eliminate electronic noise detection.

The triggering circuitry initiates bias pulse generation when a trigger pulse reaches a set threshold level, and the delay between triggering and bias pulse generation can be adjusted so that the bias pulses accurately coincide with the expected photon arrival time. By using short bias pulses, the probability of dark counts is significantly reduced, improving the detector’s signal-to-noise performance.

An adjustable blanking function is provided to suppress bias pulse generation for a set number of trigger pulses after the discriminator indicates an avalanche event has occurred. This blanking feature is useful to suppress the afterpulsing effect of the SPAD, a phenomenon where the probability of a dark avalanche event occurring increases after a previous avalanche event. Afterpulse probability increases with faster trigger rates.



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