Deschutes BSI™ APD Photoreceivers

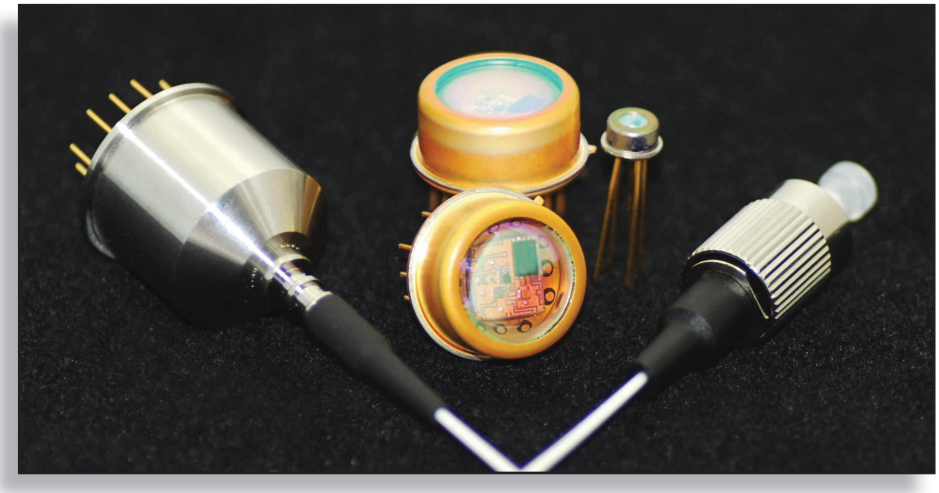
RxC-1000 Series

DESCHUTES BSI™ APD Photoreceivers

MHz-Class Receivers with High-Responsivity,
Back-Side-Illuminated NIR InGaAs/InAlAs APDs

Features

- Low-noise NIR InGaAs avalanche photodiode
- $k_{eff} \approx 0.20$, resulting in low excess noise
- 950–1700 nm response
- Low dark current, low excess noise combine for superior sensitivity not achieved with contemporary APDs
- Custom APDs available on request



Model RDC1-NJAF: 200µm APD, 300MHz
Model RDC1-JJAF: 75µm APD, 580MHz
Model RYC1-NJAF: 200µm APD, 200MHz
Model RVC1-NJAF: 200µm APD, 120MHz

Applications

- Free-space optical communications
- Laser range finding
- Optical time domain reflectometry
- Optical coherence tomography
- Fluorescence measurements, spectroscopy, chromatography and electrophoresis
- Telecommunications
- LADAR/LIDAR

Voxtel's RxC-1000 Series high-sensitivity photoreceivers integrate our Deschutes BSI™ backside-illuminated avalanche photodiodes (APDs) with low-noise, high-bandwidth transimpedance amplifiers (TIAs). The back-side-illuminated configuration of the Deschutes BSI™ detectors provides both higher responsivity and lower capacitance than competing frontside-illuminated APDs. The R-APD is custom-engineered for reduced excess noise, which allows this photoreceiver to achieve higher sensitivity, better signal-to-noise performance, and lower bit error rate (BER) than conventional telecom APDs. A single-stage thermoelectric cooler (TEC) is included to stabilize temperature.

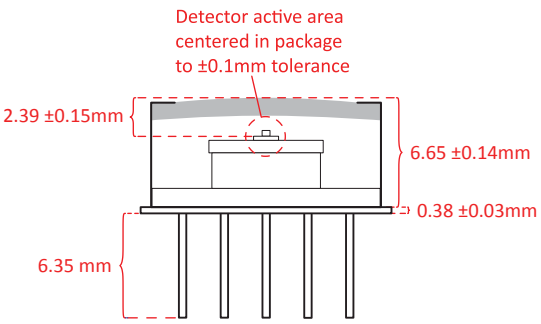
The RxC-1000 Series of photoreceivers comes standard with a large-area and low-noise 200µm APD, but are also available with a smaller 75µm APD, which provides increased bandwidth and sensitivity. Contact Voxtel for more information on this and other options.

Standard fiber pigtail options for the 75µm receivers include 62.5/125 (0.37NA) graded-index and 105/125 (0.37NA) step-index multi-mode fibers; other fiber options can be custom ordered. Optionally available with the photoreceivers are Support Electronics Modules, which provide power conditioning and TEC control.

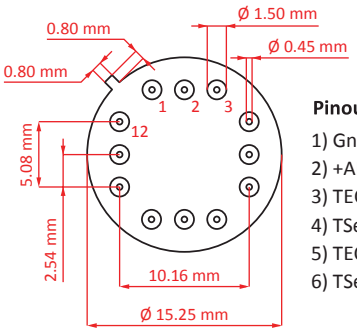
Voxtel, Inc., 15985 NW Schendel Avenue, #200, Beaverton, OR 97006, www.voxtel-inc.com, T 971.223.5646, F 503.296.2862
Voxtel Literature No. RxC1-xJAF, Version date: 06/2012

VOXTEL OPTO

Deschutes BSI™ Series Near-Infrared APDs



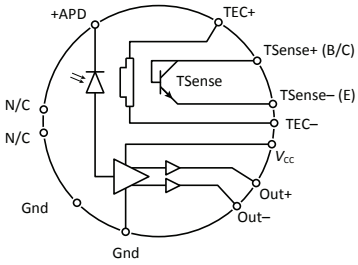
SIDE VIEW
with cap

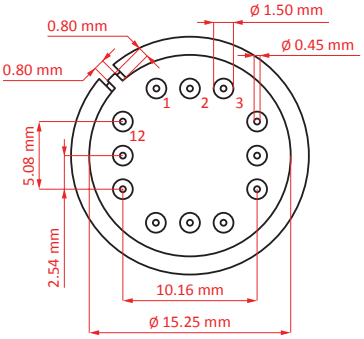


BOTTOM VIEW

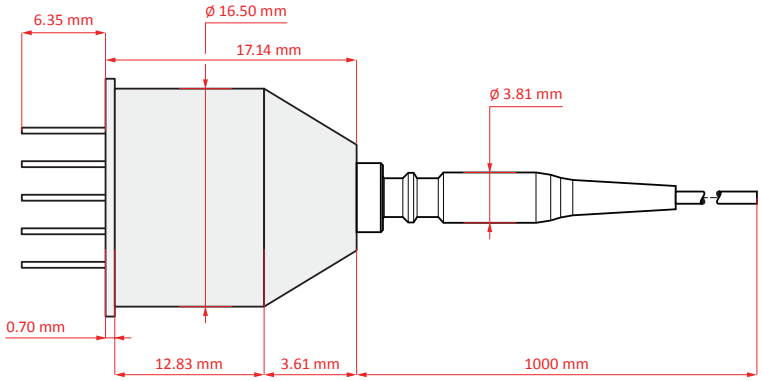
Pinout (from bottom)

1) Gnd	7) Out–
2) +APD	8) Gnd
3) TEC+	9) Out+
4) TSense–	10) V_{CC}
5) TEC–	11) N/C
6) TSense+	12) N/C

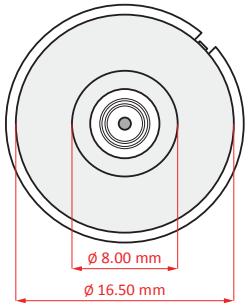




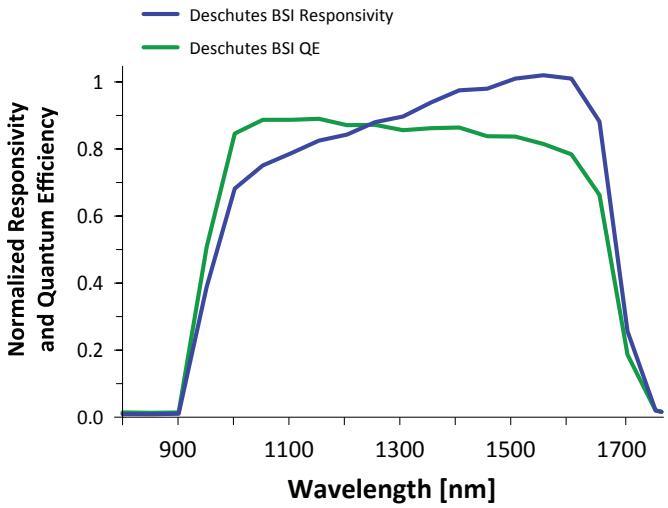
BOTTOM VIEW



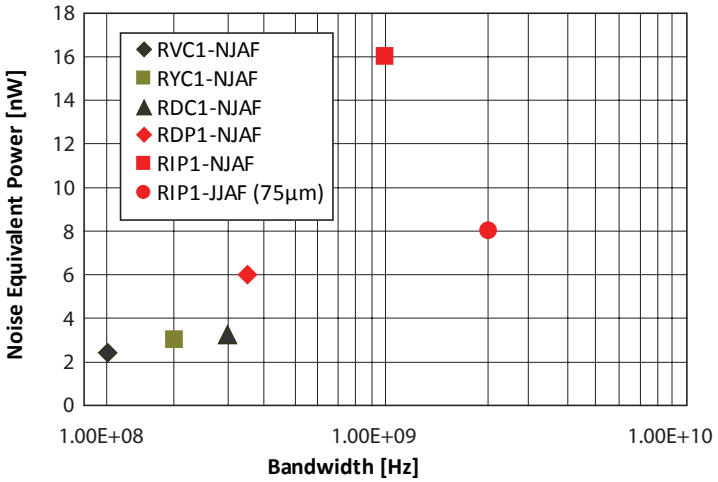
SIDE VIEW



TOP VIEW



Spectral responsivity and quantum efficiency of 200µm APD at 298K.



Standard receiver configurations with typical NEP valves and bandwidths

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MODEL RDC1-JJAF

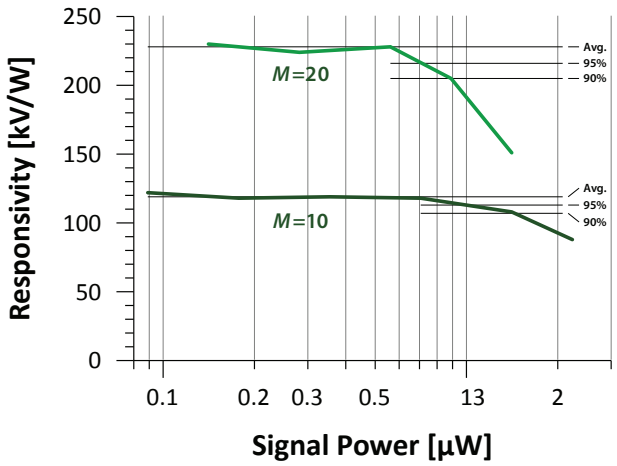
Deschutes BSI™ Series NIR Photoreceiver
580MHz with 75µm Backside-Illuminated APD

Specifications

Parameter	Min	Typical	Max	Units
Spectral Range, λ	950	1064–1600	1750	nm
Active Diameter		75		µm
Bandwidth		200		MHz
APD Operating Gain, *M*	1	15	20	
Receiver Responsivity at *M*=10[i]		100/140		kV/W at 1064/1550 nm
Noise Equivalent Power at *M*=20		3.1/2.4		nW at 1064/1550 nm
Low Frequency Cutoff		30		kHz
APD Breakdown Voltage, V_{BR}	45	50	55	V @ 295 K
TEC Δ*T*		40		K @ 295 K
TEC Supply			1.8/1.9	A/V
Temp Sensing Diode Voltage and ΔV/K[ii]	0.48	0.50 -2.18 mV/K	0.51	V
TIA Power		20		mA @ 3.3 V
Output Impedance[iii]		75	90	Ω
Overload/Saturation Power[iv]		100		µW
Maximum Instantaneous Input Power[v]			1	mW
Window Thickness	0.76	0.94	1.12	mm
Window Transparency		95/98%		1064/1550 nm

[i] 10MHz, -40dBm signal
[ii] Sourcing 10µA, *T*=298K
[iii] Single-ended; 100Ω differential
[iv] 1550nm signal with an APD multiplication gain of *M*=10
[v] APD multiplication gain of *M*=10 with a 10ns 1064nm signal at a 20Hz PRF

Linearity of Response: RDC1-JJAC 580-MHz



Linearity of response in the Deschutes BSI™ photoreceiver, model RDC1-JJAF. 20-MHz modulated signal.

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VOXTEL OPTO

MODEL RDC1-NJAF

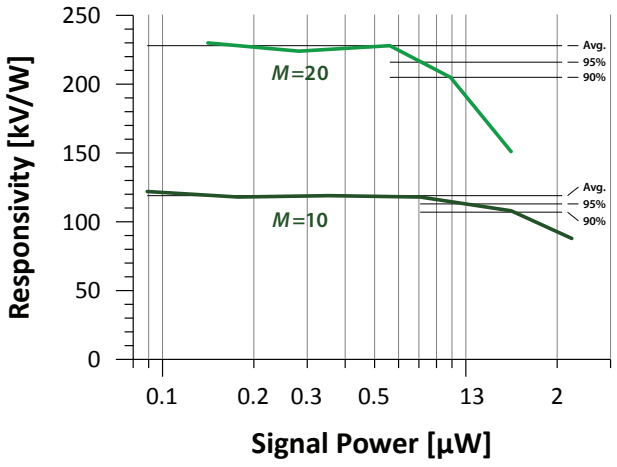
Deschutes BSI™ Series NIR Photoreceiver
300MHz with 200µm Backside-Illuminated APD

Specifications

Parameter	Min	Typical	Max	Units
Spectral Range, λ	950	1064–1600	1750	nm
Active Diameter		200		µm
Bandwidth		300		MHz
APD Operating Gain, *M*	1	15	20	
Receiver Responsivity at *M*=10[i]		100/140		kV/W at 1064/1550 nm
Noise Equivalent Power at *M*=20		4.1/3.2		nW at 1064/1550 nm
Low Frequency Cutoff		30		kHz
APD Breakdown Voltage, V_{BR}	45	50	55	V @ 295 K
TEC Δ*T*		40		K @ 295 K
TEC Supply			1.8/1.9	A/V
Temp Sensing Diode Voltage and ΔV/K[ii]	0.48	0.50 -2.18 mV/K	0.51	V
TIA Power		20		mA @ 3.3 V
Output Impedance[iii]		75	90	Ω
Overload/Saturation Power[iv]		100		µW
Maximum Instantaneous Input Power[v]			5	mW
Window Thickness	0.76	0.94	1.12	mm
Window Transparency		95/98%		1064/1550 nm

[i] 10MHz, -40dBm signal
[ii] Sourcing 10µA, *T*=298K
[iii] Single-ended; 100Ω differential
[iv] 1550nm signal with an APD multiplication gain of *M*=10
[v] APD multiplication gain of *M*=10 with a 10ns 1064nm signal at a 20Hz PRF

Linearity of Response: RDC1-NJAC 300-MHz



Linearity of response in the Deschutes BSI™ photoreceiver, model RDC1-NJAF. 20-MHz modulated signal.

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VOXTEL OPTO

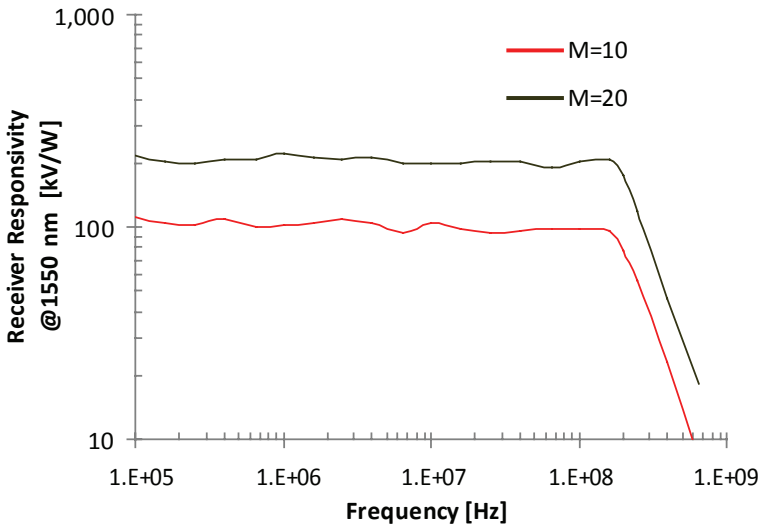
MODEL RYC1-NJAF

Deschutes BSI™ Series NIR Photoreceiver 200MHz with 200µm BSI APD

Specifications

Parameter	Min	Typical	Max	Units
Spectral Range, λ	950	1000–1600	1750	nm
Active Diameter		200		µm
Bandwidth	200			MHz
APD Operating Gain, *M*	1	10-15	20	
Receiver Responsivity at *M*=10[i]		80/100		kV/W at 1064/1550 nm
Noise Equivalent Power at *M*=20		4.0/3.1		nW at 1064/1550 nm
Low Frequency Cutoff[ii]		30		kHz
APD Breakdown Voltage, V_{BR}	45	50	55	V @ *T* = 295 K
TEC Δ*T*			40	K @ *T* = 295 K
TEC Supply			1.8/1.9	A/V
Temp Sensing Diode, Voltage and ΔV/K[iii]	0.48	0.50 -2.18 mV/K	0.51	V
TIA Power		25		mA @ 5V
Output Impedence[iv]	40	50	60	Ω
Overload/Saturation Power[v]	20	35		µW
Max Instantaneous Input Power[vi]			5	mW
Window Thickness	0.76	0.94	1.12	mm
Window Transparency		95/98%		1064/1550 nm

[i] 10MHz, -40dBm signal
[ii] -3dB, 1µA input
[iii] Sourcing 10µA, *T*=298K
[iv] Single-ended; 100Ω differential
[v] 1550nm signal with APDmultiplication gain of *M*=10
[vi] APD multiplication gain of *M*=10 with a 10ns 1064nm signal at 20Hz PRF



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VOXTEL OPTO

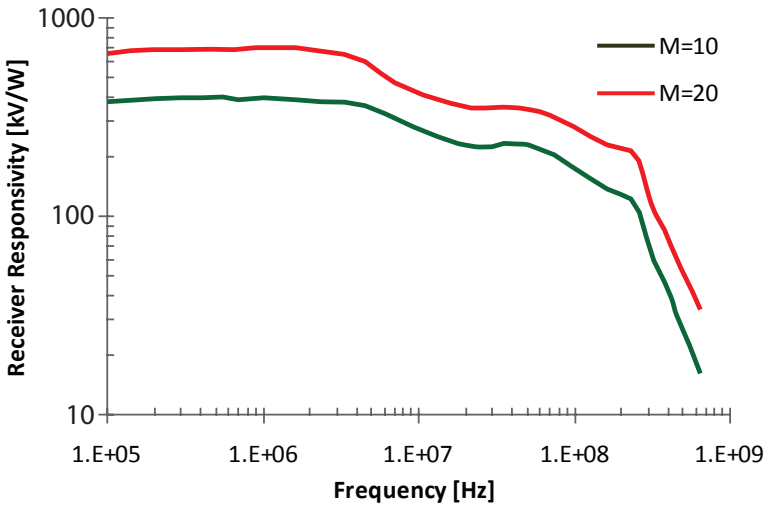
MODEL RVC1-NJAF

Deschutes BSI™ Series NIR Photoreceiver
120MHz with 200µm Backside Illuminated APD

Specifications

Parameter	Min	Typical	Max	Units
Spectral Range, λ	950	1000–1600	1750	nm
Active Diameter		200		µm
Bandwidth		120		MHz
APD Operating Gain, *M*	1	15	20	
Receiver Responsivity at *M*=10[i]		272/340		kV/W at 1064/1550 nm
Noise Equivalent Power at *M*=20		3.1/2.4		nW at 1064/1550 nm
Low Frequency Cutoff		7	25	kHz
APD Breakdown Voltage, V_{BR}	45	50	55	V @ 295 K
TEC Δ*T*		40		K @ 295 K
TEC Supply			1.8/1.9	A/V
Temp Sensing Diode Voltage and ΔV/K[ii]	0.48	0.50 -2.18 mV/K	0.51	V
TIA Power	22	28	36	mA @ 3.3 V
Output Impedence[iii]	50	67	80	Ω
Overload/Saturation Power[iv]	100	300		µW
Max Instantaneous Input Power[v]			5	mW
Window Thickness	0.76	0.94	1.12	mm
Window Transparency		95/98%		1064/1550 nm

[i] 10MHz, -40dBm signal
[ii] Sourcing 10µA, *T*=298K
[iii] Single-ended; 100Ω differential
[iv] 1550nm signal with an APD multiplication gain of *M*=10
[v] APD multiplication gain of *M*=10 with a 10ns 1064nm signal at a 20Hz PRF



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Ordering Information For RxC-1000 Series APD Products

R	-	C1	-	J	-	F
Device Type	**Amplifier**	**Detector**	**Diameter**	**Package Option**	**Lens Option**	**Revision**
R=Photoreceiver	D=580MHz TIA	C=BSI Deschutes APD	J=75µm	J=TO-8 with 1-Stage TEC	A=Flat Window	F=40°C ΔT 1-Stage TEC
	Y=250MHz TIA		N=200µm		L=Single-mode (SM) 7µm	
	V=160MHz TIA				P=Multi-mode (MM) 50/125µm	
					Q=MM 62.5/125µm	
					R=MM 105/125µm	

Not all combinations of product features are available. Please contact Voxtel for specific ordering information and parts availability.

*Receiver bandwidth depends on APD diameter and capacitance.

Caution During APD Operation

If an APD is operated above its breakdown voltage without some form of current protection, it can draw enough current to permanently damage the device. To guard against this, the user can add either a protective resistor to the bias circuit or a current-limiting circuit in the supporting electronics.

The breakdown voltage of an APD is dependent upon its temperature: the breakdown voltage decreases when the APD is cooled. Consequently, a reverse bias operating point that is safe at room temperature may put the APD into breakdown at low temperature. The approximate temperature dependence of the breakdown voltage is published in the spec sheet for the part, but caution should be exercised when an APD is cooled.

Low-noise readout circuits usually have high impedance, and an unusually strong current pulse from the APD could generate a momentary excessive voltage that is higher than the readout's supply voltage, possibly damaging the input to the amplifier. To prevent this, a protective circuit should be connected to divert excessive voltage at the inputs to a power supply voltage line.

As noted in the specification, another consideration is that the APD gain changes depending on temperature. When an APD is used over a wide temperature range, it is necessary to use some kind of temperature compensation to obtain operation at a stable gain. This can be implemented as either regulation of the applied reverse bias according to temperature, feedback temperature control using a thermoelectric cooler (TEC) or other refrigerator, or both.

Upon request, Voxtel will gladly assist customers in implementing the proper controls to ensure safe and reliable operation of APDs in their system.

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