Deschutes™ Photoreceivers

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

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

Voxtel's RxC-1000 Series high-sensitivity photoreceivers integrate our Deschutes backside-illuminated avalanche photodiodes (APDs) with low-noise, high-bandwidth transimpedance amplifiers (TIAs). The backside-illuminated configuration of the Deschutes detectors provides both higher responsivity and lower capacitance than competing frontside-illuminated APDs. The 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, low-noise 200-µm APD, and is also available with a smaller 75-µm APD, which provides increased bandwidth and sensitivity. Contact Voxtel for more information on this and other options.

Standard fiber pigtail options for the 75-µm 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.

Features

- InGaAs APDs for signal gain
- Low excess noise ($k_{eff} \approx 0.20$) gain
- Low noise transimpedance amplifier (TIA)
- Hermetic housing with thermoelectric cooling (TEC)
- Superior signal-to-noise (STN) performance

Applications

- Lasercom
- LADAR / LIDAR
- Fluorescence studies
- Biological imaging
- NIR confocal microscopy

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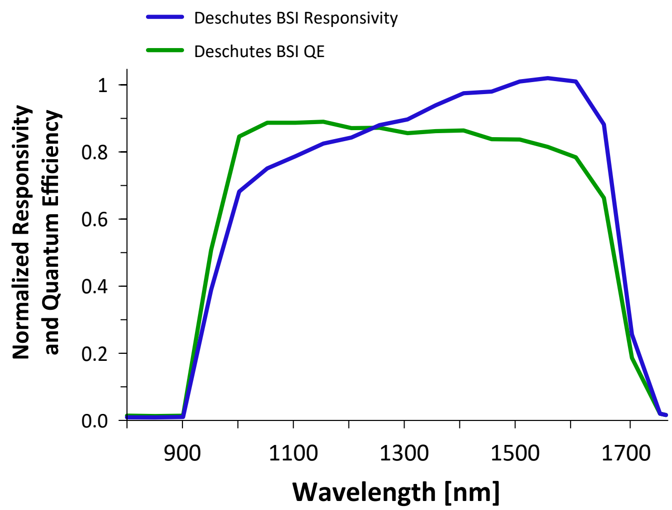
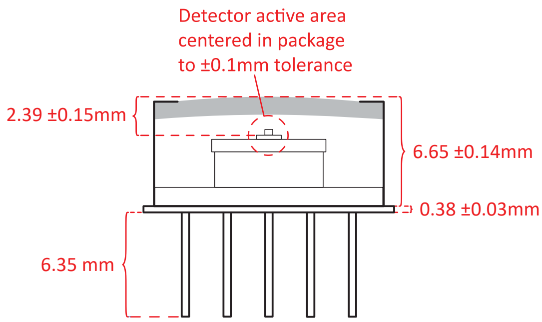
Deschutes Series Near-Infrared APDs

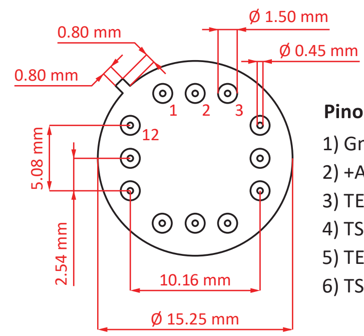
Model	Diameter	Bandwidth	NEP
RDC1-NJAF	200µm APD	300MHz	X
RDC1-JJAF	75µm APD	580MHz	X
RYC1-NJAF	200µm APD	200MHz	X
RYC1-NJAF	200µm APD	120MHz	X



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



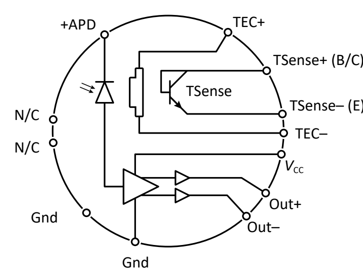
SIDE VIEW
with cap

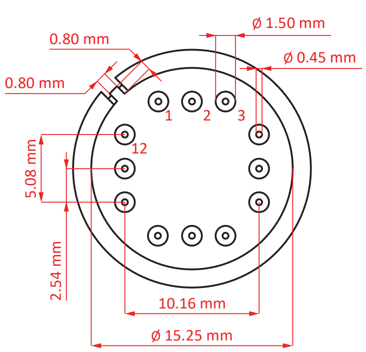


BOTTOM VIEW

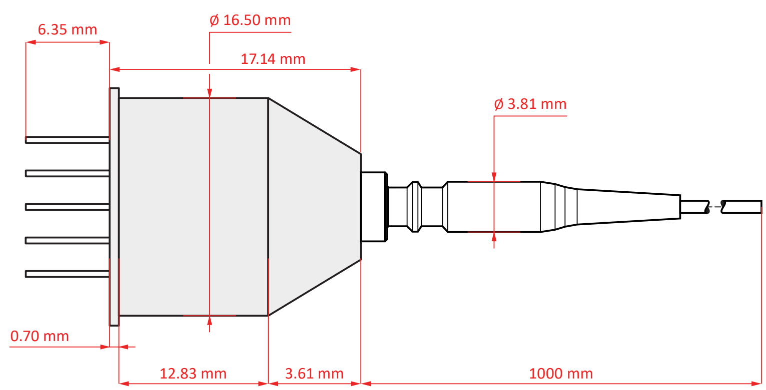
Pinout (from bottom)

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

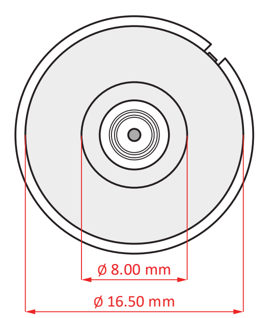




BOTTOM VIEW



SIDE VIEW



TOP VIEW

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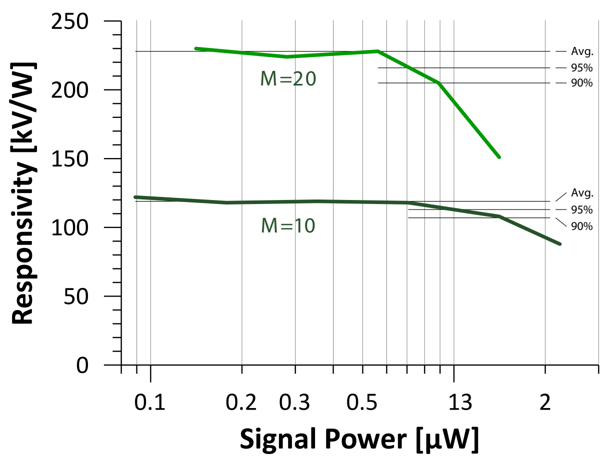
Model RDC1-JJAF
75-µm-diameter 580-MHz APD Photoreceiver

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

Linearity of Response: RDC1-JJAC 580-MHz



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

Model RDC1-NJAF
200-µm-diameter 300-MHz APD Photoreceiver

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 10 MHz, -40 dBm signal

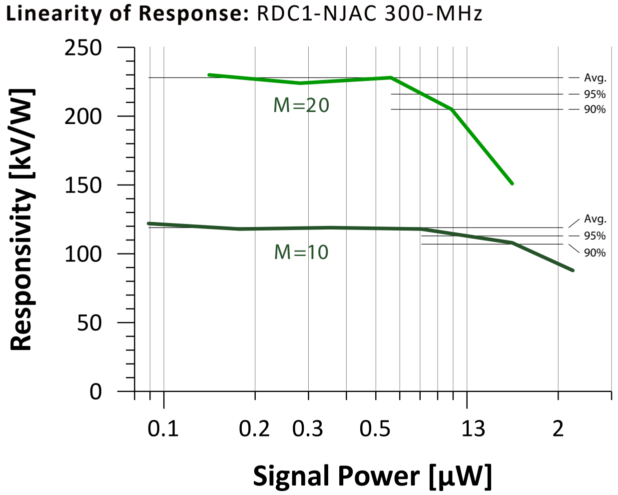
ii Sourcing 10 µA, T=298 K

iii Single-ended; 100 Ω differential

iv 1550 nm signal with an APD multiplication gain of M=10

v APD multiplication gain of M=10 with a 10 ns 1064 nm signal at a 20 Hz PRF

Linearity of Response: RDC1-NJAC 300-MHz



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

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Model RYC1-NJAF

200-µm-diameter 200-MHz APD Photoreceiver

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 ΔT			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 10 MHz, -40 dBm signal

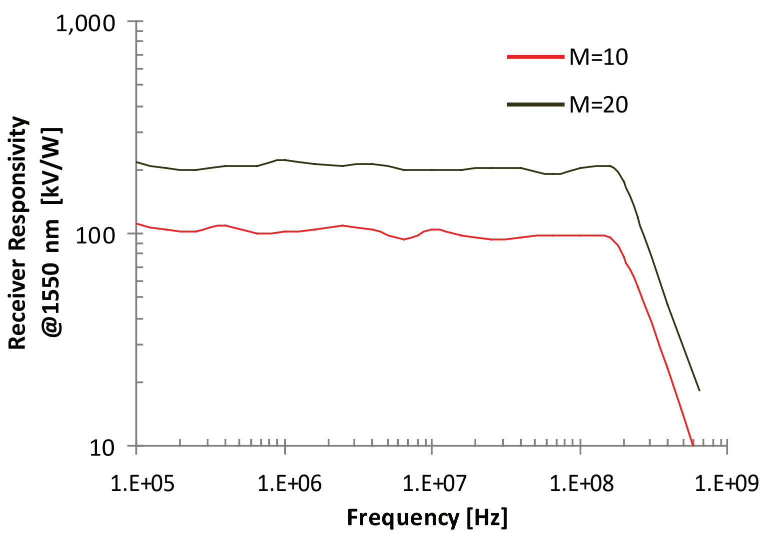
ii -3 dB, 1 µA input

iii Sourcing 10 µA, T=298 K

iv Single-ended; 100 Ω differential

v 1550 nm signal with APDmultiplication gain of M=10

vi APD multiplication gain of M=10 with a 10 ns 1064 nm signal at 20 Hz PRF



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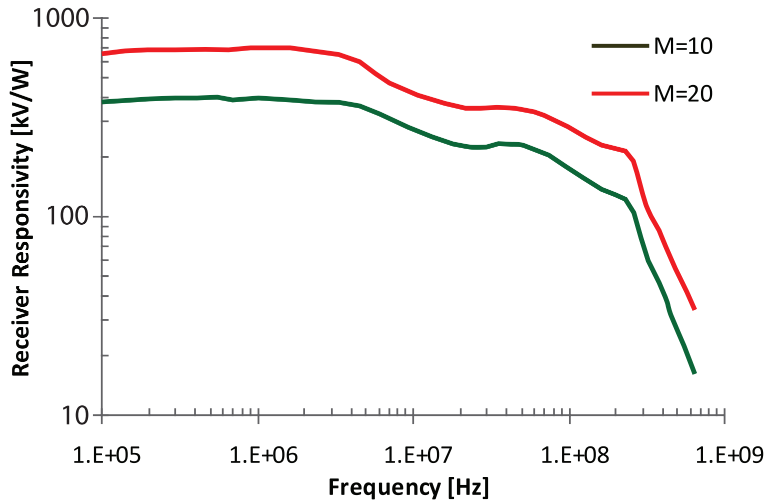
Model RVC1-NJAF
200-μm-diameter 120-MHz APD Photoreceiver

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



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Ordering Information For RxC-1000 Series APD Products

R	-	C1	1	-	J	-	*F*
Device Type	**TIA**	**Detector**	**Elements**	**Diameter**	**Package Option**	**Lens Option**	**Rev.**
R = Photo-receiver	D = 580 MHz Y = 250 MHz V = 160 MHz	C = Deschutes APD	1 = Single Element	J = 75 µm N = 200 µm	J = TO-8 w/ 1-Stage TEC K = TO-46	A = Flat Window L = Single-mode (SM) 7µm P = Multi-mode (MM) 50/125µm *Q* = MM 62.5/125µm R=MM 105/125µm	*F* = 40ºC Δ*T* 1-Stage TEC

Not all combinations of product features are available. Contact Voxtel for specific ordering information and parts availability.
**Receiver bandwidth depends on APD diameter and capacitance.*

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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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