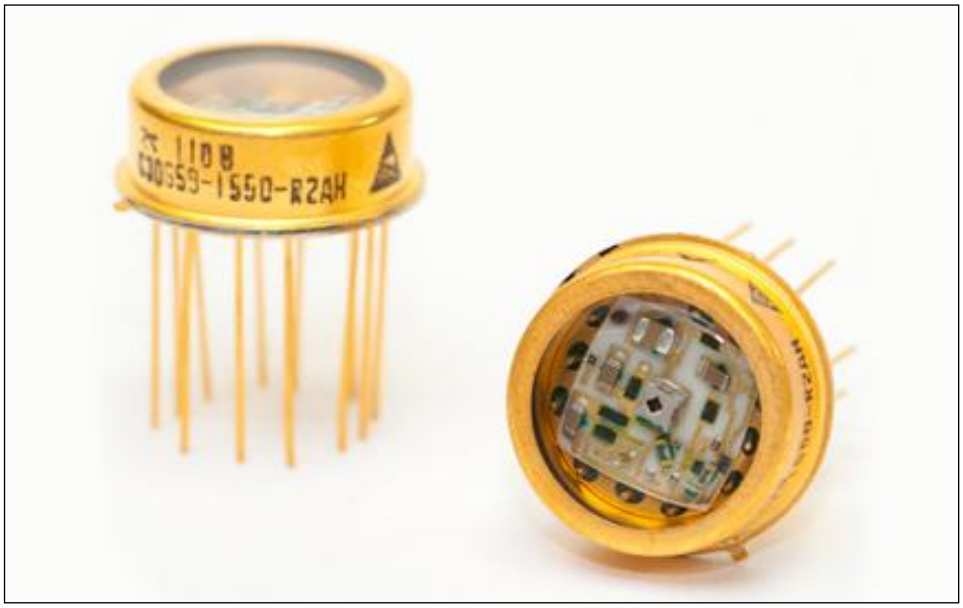
DATASHEET
Photon Detection

C30659 Series – 900/1060/1550/1550E

Si and InGaAs APD Preamplifier Modules



Excelitas' C30659-1550E InGasAs APD Preamplifier Modules exhibit enhanced damage threshold and greater resilience when exposed to higher optical power densities.

Excelitas' C30659 Series includes a Si or InGaAs Avalanche Photodiode (APD) with a hybrid preamplifier, in the same hermetically-sealed TO-8 package, to allow for ultra low noise operation.

The Si APDs used in these devices are the same as used in Excelitas' C30817EH, C30902EH, C30954EH and C30956EH products, while the InGaAs APDs are used in the C30645EH and C30662EH products. These detectors provide very good response between 830 and 1550 nm and very fast rise- and fall-times at all wavelengths. The preamplifier section of the module uses a very low noise GaAs FET front end designed to operate at higher transimpedance than Excelitas' regular C30950 Series.

The C30659 is pin-to-pin compatible with the C30950 Series with a negative output. An emitter follower is used as an output buffer stage. To obtain the wideband characteristics, the output of these devices should be capacitively- or AC-coupled to a 50 Ω termination. The module must not be DC-coupled to loads of less than 2,000 Ohms. For field use, it is recommended that a temperature-compensated HV supply be employed to maintain a constant responsivity over temperature.

Excelitas' InGaAs C30659-1550E Preamplifier Modules, with 1550 nm peak response, are designed to exhibit higher damage thresholds, thus providing greater resilience when exposed to high optical power densities.

Customization of the C30659 Series of APD Preamplifier Modules is available to meet your specific design challenges.

Key Features

- System bandwidths of 50 MHz and 200MHz
- Ultra low noise equivalent power (NEP)
- Spectral response range:
  - With Si APD: 400 to 1100 nm
  - With InGaAs APD: 1100 to 1700 nm
- Power consumption: 150 mW typical
- ±5 V amplifier operating voltages
- 50 Ω AC load capability
- Hermetically-sealed TO-8 package
- High reliability
- Fast overload recovery
- Pin-to-pin compatible with the C30950 Series
- Light entry angle, over 130°
- Model 1550E exhibits enhanced damage threshold
- RoHS-compliant

Applications

- Range Finding
- LIDAR
- Confocal Microscopy

EXCELITAS TECHNOLOGIES

C30659 Series – 900/1060/1550/1550E

Si and InGaAs APD Preamplifier Modules

Table 1. Performance Specifications – C30659-900 Models (900 nm peak response Si APD)

Test conditions: Case temperature = 22˚C, V_{amp} = ±5 V, HV = V_{op} (see Note 1), R_L = 50 Ω AC coupled)

Detector Type	C30659-900-R8AH (C30817EH APD)			C30659-900-R5BH (C30902EH APD)			
Parameter	**Min**	**Typical**	**Max**	**Min**	**Typical**	**Max**	**Units**
Active diameter		0.8			0.5		mm
Active area		0.5			0.2		mm²
Bandwidth range		50			200		MHz
Temperature coefficient of V_{op} for constant gain		2.2			0.7		V/˚C
V_{op} for specified responsivity	275	Note 1	435	180	Note 1	260	V
Temperature sensor sensitivity (Note 2)	-1.8	-2.1	-2.4	-1.8	-2.1	-2.4	mV/˚C
Responsivity at 830 nm at 900 nm R_f (Internal feedback resistor)		 2700 3000 82			 460 400 12		 kV/W kV/W kΩ
Noise equivalent power (NEP) (Note 3) Average from 100 kHz to f_{-3dB}, Δf = 1.0 Hz at 830 nm at 900 nm Output spectral noise voltage Averaged from 100 kHz to f_{-3dB}		 14 12 35	 17 15 45		 35 40 15	 55 65 25	 fW/√Hz fW/√Hz nV/√Hz
Output impedance	33	40	50	33	40	50	Ω
System bandwidth, f_{-3dB}	40	50		175	200		MHz
Rise time, t_r (λ = 830 and 900 nm) 10% to 90% points		7			2		ns
Fall time, t_f (λ = 830 and 900 nm) 90% to 10% points		7			2		ns
Recovery time after overload (Note 4)			150			150	ns
Output voltage swing (1 kΩ load) (Note 5)	2	3		2	3		V
Output voltage swing (50 Ω load) (Note 5)	0.7	0.9		0.7	0.9		V
DC output offset voltage	-1	0.25	1	-1	0.25	1	V
Positive supply current (V_+)		20	35		20	35	mA
Negative supply current (V_-)		10	20		10	20	mA

Notes:

1. A specific value of V_{op} is supplied with each device. The V_{op} value will be within the specified range.
2. I_f = 0.1 mA at 25˚C.
3. NEP is the calculated as the average output spectral noise voltage divided by the typical responsivity.
4. 0 dBm with 250 ns pulses.
5. Pulsed operation.

Table 2. Performance Specifications – C30659-1060 Models (1060 nm optimized response Silicon APD)

Test conditions: Case temperature = 22˚C, V_{amp} = ±5 V, HV = V_{op} (see Note 1), R_L = 50 Ω AC coupled)

Detector type	C30659-1060-3AH (C30956EH APD)			C30659-1060-R8BH (C30954EH APD)			
Parameter	**Min**	**Typical**	**Max**	**Min**	**Typical**	**Max**	**Units**
Active diameter		3.0			0.8		mm
Active area		7.1			0.5		mm²
Bandwidth range		50			200		MHz
Temperature coefficient of V_{op} for constant gain		2.2			0.7		V/˚C
V_{op} for specified responsivity	275	Note 1	425	275	Note 1	425	V
Temperature sensor sensitivity (Note 2)	-1.8	-2.1	-2.4	-1.8	-2.1	-2.4	mV/˚C
Responsivity at 900 nm at 1060 nm R_f (Internal feedback resistor)		 450 280 22			 370 200 12		 kV/W kV/W kΩ
Noise equivalent power (NEP) (Note 3) Average from 100 kHz to f_{-3dB}, Δf = 1.0 Hz at 900 nm at 1060 nm Output spectral noise voltage Averaged from 100 kHz to f_{-3dB}		 55 90 25	 90 125 35		 55 100 20	 80 150 30	 fW/√Hz fW/√Hz nV/√Hz
Output impedance	33	40	50	33	40	50	Ω
System bandwidth, f_{-3dB}	40	50		175	200		MHz
Rise time, t_r (λ = 900 and 1060 nm) 10% to 90% points		7			2		ns
Fall time, t_f (λ = 900 and 1060 nm) 90% to 10% points		7			2		ns
Recovery time after overload (Note 4)			150			150	ns
Output voltage swing (1 kΩ load) (Note 5)	2	3		2	3		V
Output voltage swing (50 Ω load) (Note 5)	0.7	0.9		0.7	0.9		V
DC output offset voltage	-1	0.25	1	-1	0.25	1	V
Positive supply current (V_+)		20	35		20	35	mA
Negative supply current (V_-)		10	20		10	20	mA

Notes:

1. A specific value of V_{op} is supplied with each device. The V_{op} value will be within the specified range.
2. I_f = 0.1 mA at 25˚C.
6. NEP is the calculated as the average output spectral noise voltage divided by the typical responsivity.
3. 0 dBm with 250 ns pulses.
4. Pulsed operation.

Table 3. Performance Specifications – C30659-1550, 1550E Models (1550 nm peak response InGaAs APD)

Test conditions: Case temperature = 22˚C, V_{amp} = ±5 V, HV = V_{op} (see Note 1), R_L = 50 Ω AC coupled)

Detector type	C30659-1550-R2AH C30659-1550E-R2AH (C30662EH APD)			C30659-1550-R08BH C30659-1550E-R08BH (C30645EH APD)			
Parameter	**Min**	**Typical**	**Max**	**Min**	**Typical**	**Max**	**Units**
Active diameter		0.2			0.08		mm
Active area		0.03			0.005		mm²
Bandwidth range		50			200		MHz
Temperature coefficient of V_{op} for constant gain		0.2			0.2		V/˚C
V_{op} for specified responsivity	40	Note 1	70	40	Note 1	70	V
Temperature sensor sensitivity (Note 2)	-1.8	-2.1	-2.4	-1.8	-2.1	-2.4	mV/˚C
Responsivity at 1300 nm at 1550 nm R_f (Internal feedback resistor)		 300 340 68			 80 90 18		 kV/W kV/W kΩ
Noise equivalent power (NEP) (Note 3) Average from 100 kHz to f_{-3dB}, Δf = 1.0 Hz at 1300 nm at 1550 nm Output spectral noise voltage Averaged from 100 kHz to f_{-3dB}		 150 130 45	 180 160 55		 250 220 20	 375 330 30	 fW/√Hz fW/√Hz nV/√Hz
Output impedance	33	40	50	33	40	50	Ω
System bandwidth, f_{-3dB}	40	50		175	200		MHz
Rise time, t_r (λ = 1300 and 1550 nm) 10% to 90% points		7			2		ns
Fall time, t_f (λ = 1300 and 1550 nm) 90% to 10% points		7			2		ns
Recovery time after overload (Note 4)			150			150	ns
Output voltage swing (1 kΩ load) (Note 5)	2	3		2	3		V
Output voltage swing (50 Ω load) (Note 5)	0.7	0.9		0.7	0.9		V
DC output offset voltage	-1	0.25	1	-1	0.25	1	V
Positive supply current (V_+)		20	35		20	35	mA
Negative supply current (V_-)		10	20		10	20	mA

Notes:

1. A specific value of V_{op} is supplied with each device. The V_{op} value will be within the specified range.
2. I_f = 0.1 mA at 25˚C.
7. NEP is the calculated as the average output spectral noise voltage divided by the typical responsivity.
3. 0 dBm with 250 ns pulses.
4. Pulsed operation.

C30659 Series – 900/1060/1550/1550E

Si and InGaAs APD Preamplifier Modules

Table 4. Absolute – Maximum Ratings, Limiting Values

Detector type	C30659-900 Models (Silicon APD)		C30659-1060 Models (Silicon APD)		C30659-1550 Models (InGaAs APD)		C30659-1550E Models (InGaAs APD)		
Parameter	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Units**
Photodiode bias voltage at T_A = +70˚C at T_A = -40˚C		 600 300		 600 300		 100 50		 100 50	 V V
Incident radiant flux, Φ_M, (Note 1) average (Note 2) peak (Note 3) peak (Note 4)		 0.1 50		 0.1 50	 4	 2 	 1000	 2 	 mW mW kW/cm²
Case temperature storage, T_{stg} operating, T_A	 -50 -40	 100 70	 -50 -40	 100 70	 -50 -40	 100 70	 -50 -40	 100 70	 ˚C ˚C
Preamplifier bias voltage	±4.5	±5.5	±4.5	±5.5	±4.5	±5.5	±4.5	±5.5	V

Notes:

1. As demonstrated in laboratory conditions.
2. Based on 0.5 W electrical power on the high voltage (HV) supply.
3. Test with 50 ns pulse width.
4. Tested at 1060 nm, 10 ns pulse width and 1 kHz pulse repetition rate.

Figure 1. Schematic Block Diagram – C30659 Series

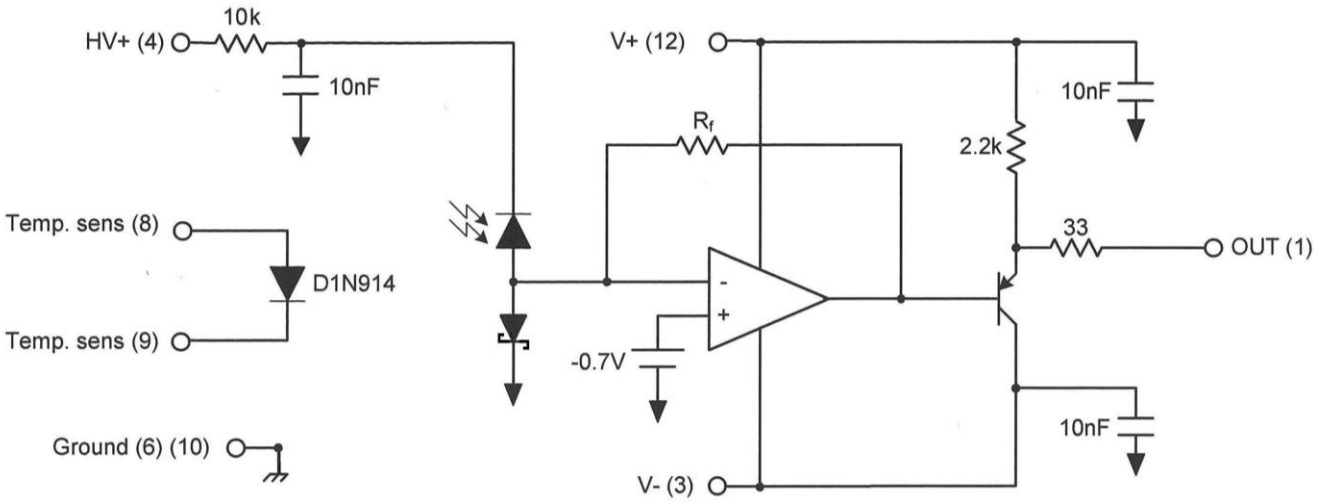


Figure 2. Typical Spectral Responsivity

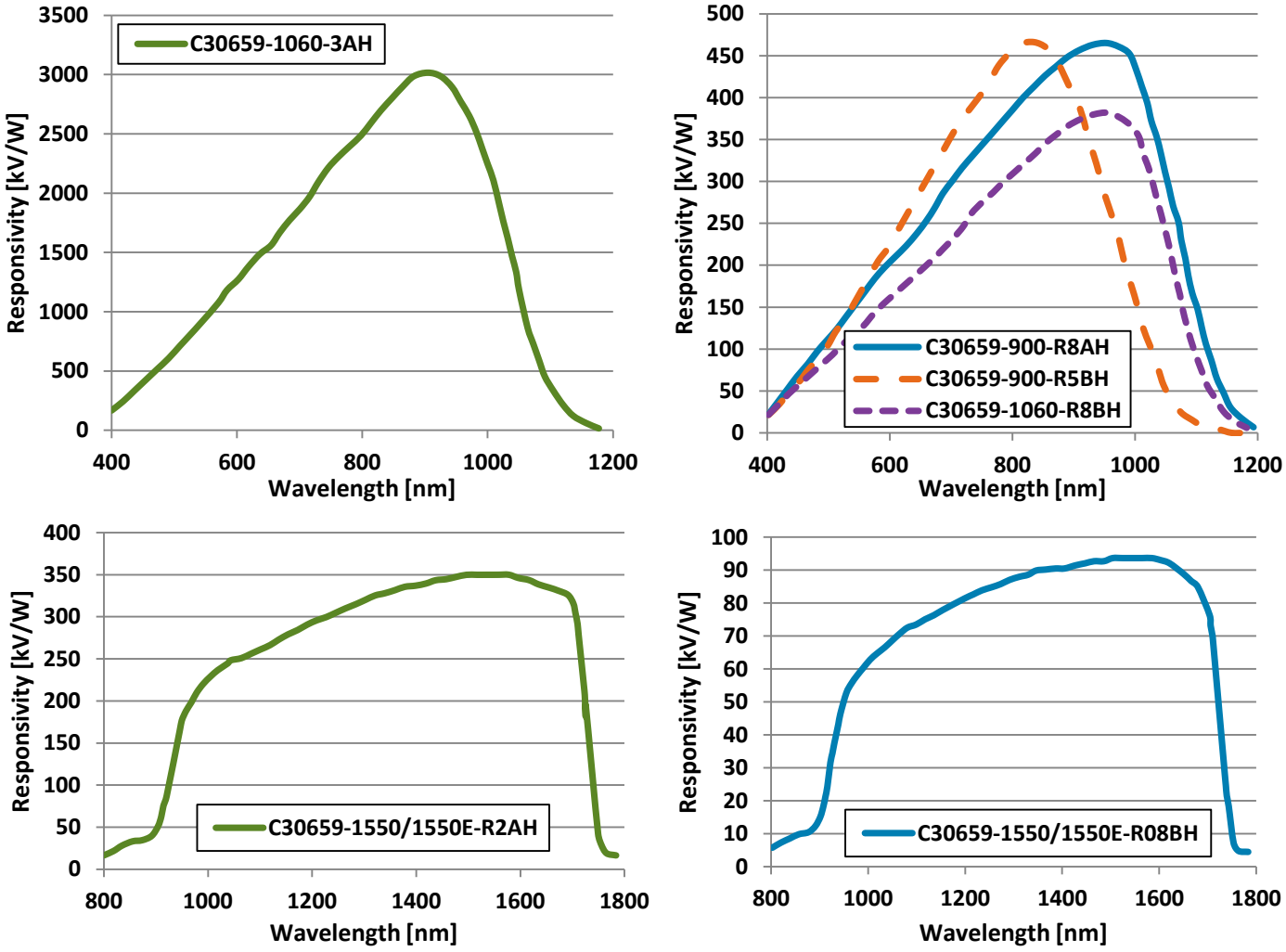
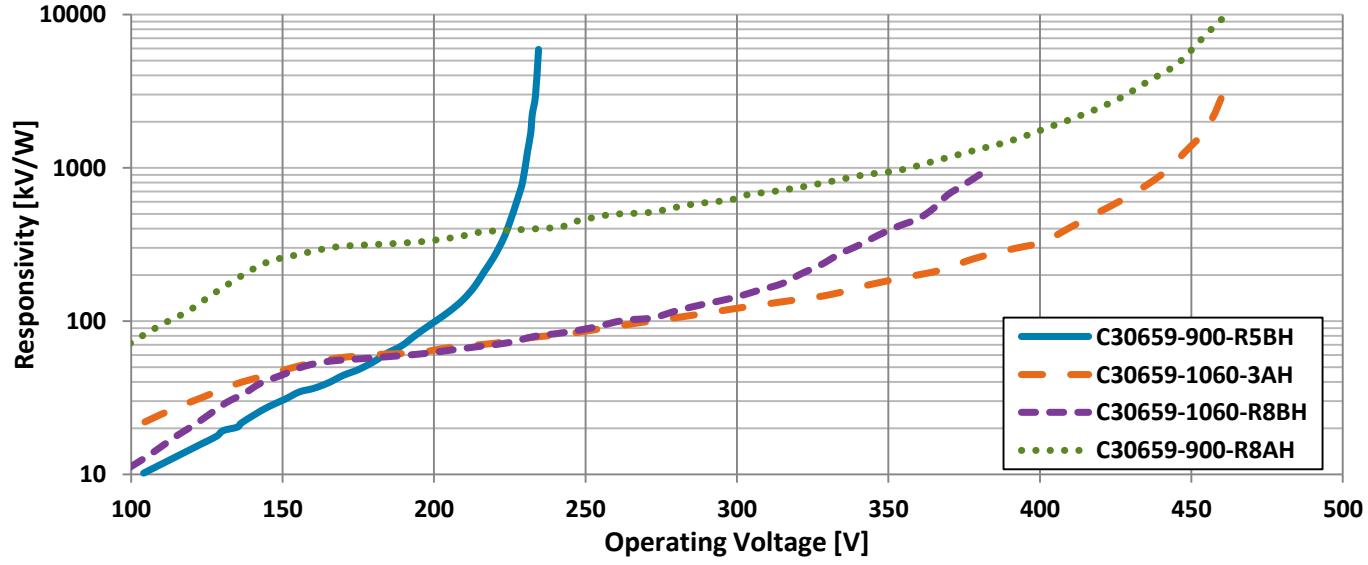


Figure 3. Typical Responsivity as a Function of Operating Voltage – C30659-(900/1060) Series



C30659 Series – 900/1060/1550/1550E

Si and InGaAs APD Preamplifier Modules

Figure 4. Typical Responsivity as a function of Operating Voltage – C30659-(1550/1550E) Series

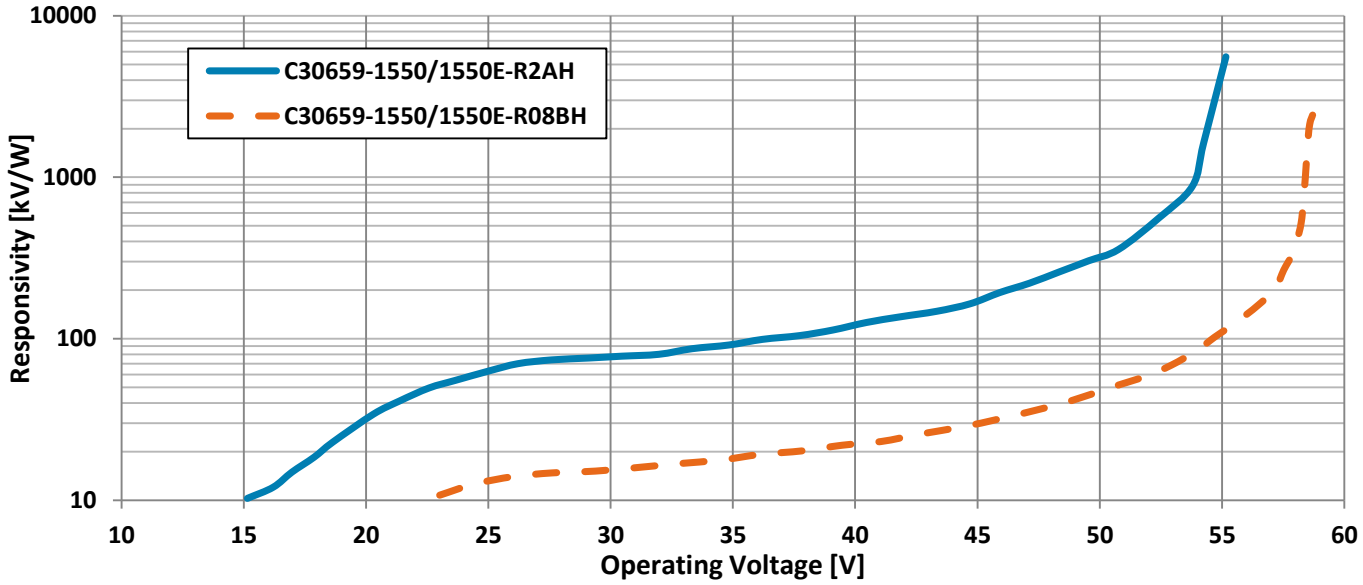
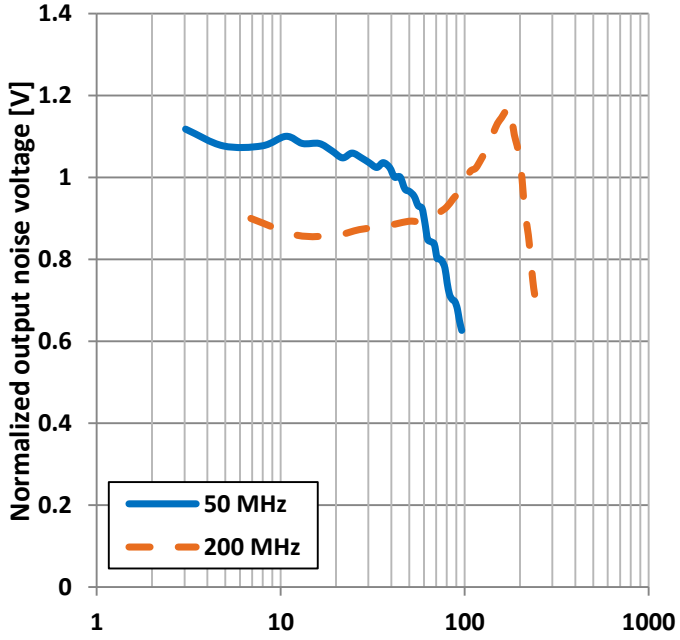
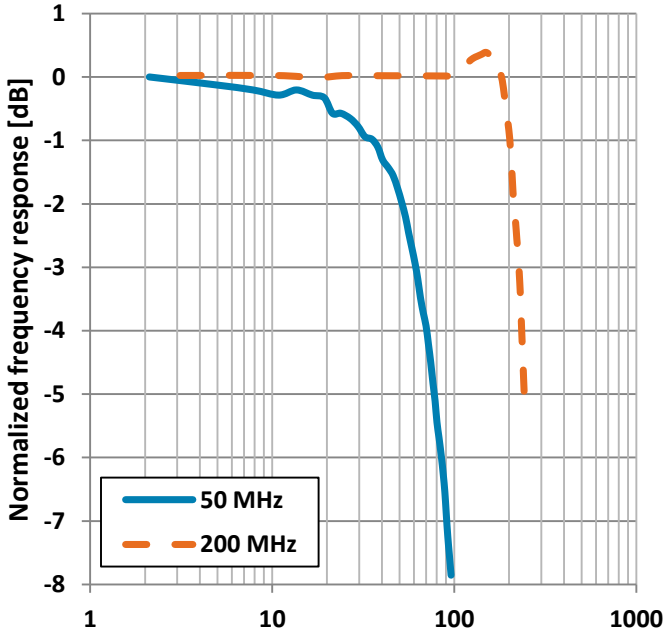


Figure 5. Typical Response and Noise Curves





Output voltage noise normalization is calculated using the following formula:

$$V_{n_{normalize}} = \frac{V_n}{V_{n_{average}}}, \text{ where } V_{n_{average}}\left[\frac{V}{\sqrt{Hz}}\right] = \sqrt{\frac{\int_{100kHz}^{f_{-3dB}} V_n^{\,2} \cdot df}{f_{-3dB}}}$$

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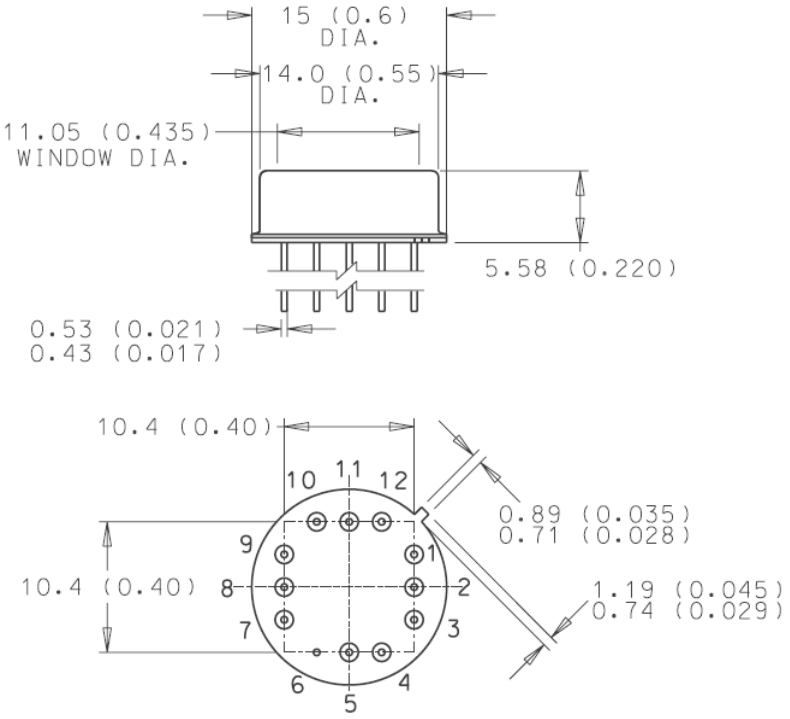
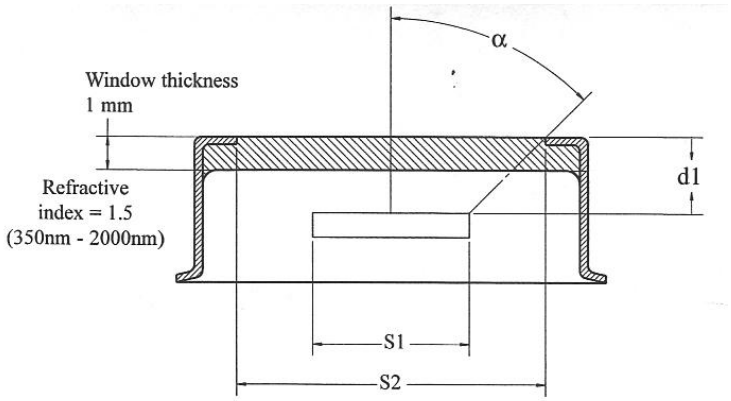
Figure 6. Mechanical Characteristics – C30659 Series – reference dimensions shown in mm (inches)



Pin #	Description
1	Output signal
2	No connection
3	$-V_{cc}$ negative amplifier bias
4	Positive high voltage (HV)
5	No connection
6	Case ground
7	No connection
8	Temperature sensing diode – anode
9	Temperature sensing diode – cathode
10	Ground, DC returns
11	No connection
12	$+V_{cc}$ positive amplifier bias

Figure 7. Optical Geometry – C30659 Series – reference dimensions shown



Model	APD used	S1 (mm)	S2 (mm)	d1 (mm)	α (deg)
C30659-900-R8AH	C30817EH	0.8	11	1.5	74
C30659-900-R5BH	C30902EH	0.8	11	1.5	74
C30659-1060-3AH	C30956EH	3.0	11	1.6	69
C30659-1060-R8BH	C30954EH	0.8	11	1.4	74
C30659-1550/1550E-R2AH	C30662EH	0.2	11	1.7	73
C30659-1550/1550E-R08BH	C30645EH	0.1	11	1.7	73

Ordering Guide

Model	APD Material	Nominal Bandwidth	Wavelength Response	APD Used	Active Diameter	Comments
C30659-900-R8AH	Silicon	50 MHz	900 nm (peak)	C30817EH	0.8 mm	
C30659-900-R5BH		200 MHz		C30902EH	0.5 mm	
C30659-1060-3AH		50 MHz	1060 nm (optimized)	C30956EH	3.0 mm	
C30659-1060-R8BH		200 MHz		C30954EH	0.8 mm	
C30659-1550-R2AH	InGaAs	50 MHz	1550 nm (peak)	C30662EH	0.2 mm	
C30659-1500-R08BH		200 MHz		C30645EH	0.08 mm	
C30659-1550E-R2AH		50 MHz		C30662EH	0.2 mm	Enhanced damage threshold
C30659-1550E-R08BH		200 MHz		C30645EH	0.08 mm	

RoHS Compliance

The C30659 Series of APD Preamplifier Modules are designed and built to be fully compliant with the European Union Directive 2002/95EEC – Restriction of the use of certain Hazardous Substances (RoHS) in Electrical and Electronic equipment.

RoHS 2002/95/EC

About Excelitas Technologies

Excelitas Technologies is a global technology leader focused on delivering innovative, customized solutions to meet the lighting, detection and other high-performance technology needs of OEM customers.

From aerospace and defense to analytical instrumentation, clinical diagnostics, medical, industrial, and safety and security applications, Excelitas Technologies is committed to enabling our customers' success in their specialty end-markets. Excelitas Technologies has approximately 3,000 employees in North America, Europe and Asia, serving customers across the world.

Excelitas Technologies
22001 Dumberry Road
Vaudreuil-Dorion, Quebec
Canada J7V 8P7
Telephone: (+1) 450.424.3300
Toll-free: (+1) 800.775.6786
Fax: (+1) 450.424.3345
detection.na@excelitas.com

Excelitas Technologies GmbH & Co. KG
Wenzel-Jaksch-Str. 31
D-65199 Wiesbaden
Germany
Telephone: (+49) 611 492 430
Fax: (+49) 611 492 165
detection.europe@excelitas.com

Excelitas Technologies Singapore, Pvt. Ltd.
47 Ayer Rajah Crescent #06-12
Singapore 139947
Telephone: (+65) 6775 2022 (Main Line)
Telephone: (+65) 6770 4366 (Customer Service)
Fax: (+65) 6778 1752
detection.asia@excelitas.com

EXCELITAS TECHNOLOGIES

For a complete listing of our global offices, visit www.excelitas.com/locations