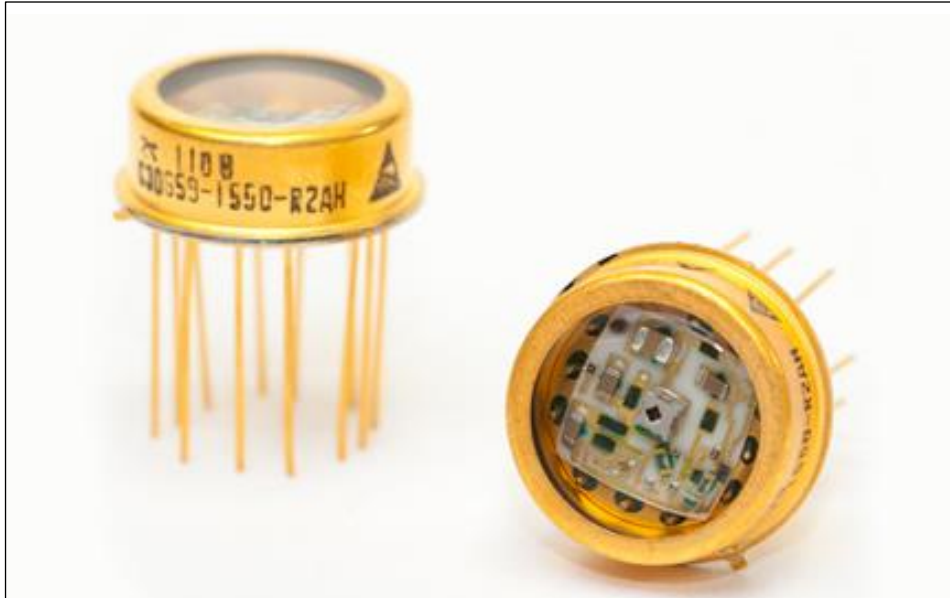


## **C30659 Series – 900/1060/1550/1550E** **Si and InGaAs APD Preamplifier Modules**



### **Key Features**

- System bandwidths of 50 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
- Typical power consumption: 150 mW
- $\pm 5$  V amplifier operating voltages
- 50  $\Omega$  AC load capability (AC-Coupled)
- Hermetically-sealed TO-8 package
- High reliability
- Fast overload recovery
- Pin-to-pin compatible with the C30950
- Light entry angle, over 130°
- Model 1550E exhibits enhanced damage threshold
- RoHS-compliant

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

Excelitas Technologies' 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 series features an inverting amplifier design with an emitter follower used as an output buffer stage. It remains pin-to-pin compatible with the C30950 Series. To obtain the wideband characteristics, the output of these devices should be capacitively- or AC-coupled to a 50  $\Omega$  termination. The module must not be DC-coupled to loads of less than 2 k $\Omega$ . 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; modifications include bandwidth and gain optimization, use of different APDs, FC-connectorized packaging.

### **Applications**

- LIDAR
- Range finding
- Laser designation
- Confocal microscopy
- High-speed, extreme low-light detection
- Distributed temperature sensing (DTS)
- Analytical instrumentation
- High-speed, free-space optical communication

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,  $V_{amp} = \pm 5$  V,  $HV = V_{op}$  (see Note 1),  $R_L = 50 \Omega$  AC coupled

Detector Type	C30659-900-R8AH (C30817EH APD)			C30659-900-R5BH (C30902EH APD)			Units
	Min	Typical	Max	Min	Typical	Max	
Active diameter		0.8			0.5		mm
Active area		0.5			0.2		mm <sup>2</sup>
Nominal field of view $\alpha$ (see Figure 8)		147			148		Degrees
Nominal field of view $\alpha'$ (see Figure 8)		151			151		Degrees
System bandwidth, $f_{-3dB}$	40	50		175	200		MHz
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 k $\Omega$
Noise equivalent power (NEP) (Note 3) Average from 100 kHz to $f_{-3dB}$ , $\Delta f = 1.0$ Hz at 830 nm at 900 nm		14 12	17 15		35 40	55 65	fW/ $\sqrt{Hz}$ fW/ $\sqrt{Hz}$
Output spectral noise voltage Averaged from 100 kHz to $f_{-3dB}$		35	45		15	25	nV/ $\sqrt{Hz}$
Output impedance	33	40	50	33	40	50	$\Omega$
Rise time, $t_r$ ( $\lambda = 830$ and $900$ nm) 10% to 90% points		7			2		ns
Fall time, $t_f$ ( $\lambda = 830$ and $900$ nm) 90% to 10% points		7			2		ns
Recovery time after overload (Note 4)			150			150	ns
Output voltage swing (1 k $\Omega$ load) (Note 5)	2	3		2	3		V <sub>pp</sub>
Output voltage swing (50 $\Omega$ load) (Note 5)	0.7	0.9		0.7	0.9		V <sub>pp</sub>
DC output offset voltage	-1	0.25	1	-1	0.25	1	V <sub>DC</sub>
Positive supply current (V <sub>+</sub> )		20	35		20	35	mA
Negative supply current (V <sub>-</sub> )		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 calculated as the output spectral noise voltage divided by the typical responsivity.
4. 0 dBm with 250 ns pulses.
5. Pulsed operation, AC-coupled.

Si and InGaAs APD Preamplifier Modules

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

Test conditions: Case temperature = 22 °C,  $V_{amp} = \pm 5$  V,  $HV = V_{op}$  (see Note 1),  $R_L = 50 \Omega$  AC coupled

Detector type	C30659-1060-3AH (C30956EH APD)			C30659-1060-R8BH (C30954EH APD)			Units
	Min	Typical	Max	Min	Typical	Max	
Active diameter		3.0			0.8		mm
Active area		7.1			0.5		mm <sup>2</sup>
Nominal field of view $\alpha$ (see Figure 8)		136			149		Degrees
Nominal field of view $\alpha'$ (see Figure 8)		154			153		Degrees
System bandwidth, $f_{-3dB}$	40	50		175	200		MHz
Bandwidth range		50			200		MHz
Temperature coefficient of $V_{op}$ for constant gain		2.2			2.2		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		450			370		kV/W
at 1064 nm		280			200		kV/W
$R_f$ (Internal feedback resistor)		22			12		k $\Omega$
Noise equivalent power (NEP) (Note 3)							
Average from 100 kHz to $f_{-3dB}$ , $\Delta f = 1.0$ Hz							
at 900 nm		55	90		55	80	fW/ $\sqrt{Hz}$
at 1064 nm		90	125		100	150	fW/ $\sqrt{Hz}$
Output spectral noise voltage							
Averaged from 100 kHz to $f_{-3dB}$		25	35		20	30	nV/ $\sqrt{Hz}$
Output impedance	33	40	50	33	40	50	$\Omega$
Rise time, $t_r$ ( $\lambda = 900$ and 1064 nm) 10% to 90% points		7			2		ns
Fall time, $t_f$ ( $\lambda = 900$ and 1064 nm) 90% to 10% points		7			2		ns
Recovery time after overload (Note 4)			150			150	ns
Output voltage swing (1 k $\Omega$ load) (Note 5)	2	3		2	3		$V_{pp}$
Output voltage swing (50 $\Omega$ load) (Note 5)	0.7	0.9		0.7	0.9		$V_{pp}$
DC output offset voltage	-1	0.25	1	-1	0.25	1	$V_{DC}$
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 calculated as the output spectral noise voltage divided by the typical responsivity.
4. 0 dBm with 250 ns pulses.
5. Pulsed operation, AC-coupled

## C30659 Series – 900/1060/1550/1550E

### Si and InGaAs APD Preamplifier Modules

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

Test conditions: Case temperature = 22 °C,  $V_{amp} = \pm 5$  V,  $HV = V_{op}$  (see Note 1),  $R_L = 50 \Omega$  AC coupled

Detector type	C30659-1550-R2AH C30659-1550E-R2AH (C30662EH APD)			C30659-1550-R08BH C30659-1550E-R08BH (C30645EH APD)			Units
	Min	Typical	Max	Min	Typical	Max	
Parameter							
Active diameter		0.2			0.08		mm
Active area		0.03			0.005		mm <sup>2</sup>
Nominal field of view $\alpha$ (see Figure 8)		145			145		Degrees
Nominal field of view $\alpha'$ (see Figure 8)		146			146		Degrees
System bandwidth, $f_{-3dB}$	40	50		175	200		MHz
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		300			80		kV/W
at 1550 nm		340			90		kV/W
$R_f$ (Internal feedback resistor)		68			18		k $\Omega$
Noise equivalent power (NEP) (Note 3)							
Average from 100 kHz to $f_{-3dB}$ , $\Delta f = 1.0$ Hz							
at 1300 nm		150	180		250	375	fW/ $\sqrt{Hz}$
at 1550 nm		130	160		220	330	fW/ $\sqrt{Hz}$
Output spectral noise voltage							
Averaged from 100 kHz to $f_{-3dB}$		45	55		20	30	nV/ $\sqrt{Hz}$
Output impedance	33	40	50	33	40	50	$\Omega$
Rise time, $t_r$ ( $\lambda = 1300$ and $1550$ nm) 10% to 90% points		7			2		ns
Fall time, $t_f$ ( $\lambda = 1300$ and $1550$ nm) 90% to 10% points		7			2		ns
Recovery time after overload (Note 4)			150			150	ns
Output voltage swing (1 k $\Omega$ load) (Note 5)	2	3		2	3		$V_{pp}$
Output voltage swing (50 $\Omega$ load) (Note 5)	0.7	0.9		0.7	0.9		$V_{pp}$
DC output offset voltage	-1	0.25	1	-1	0.25	1	$V_{DC}$
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 calculated as the output spectral noise voltage divided by the typical responsivity.
4. 0 dBm with 250 ns pulses.
5. Pulsed operation, AC-coupled.

# C30659 Series – 900/1060/1550/1550E

## Si and InGaAs APD Preamplifier Modules

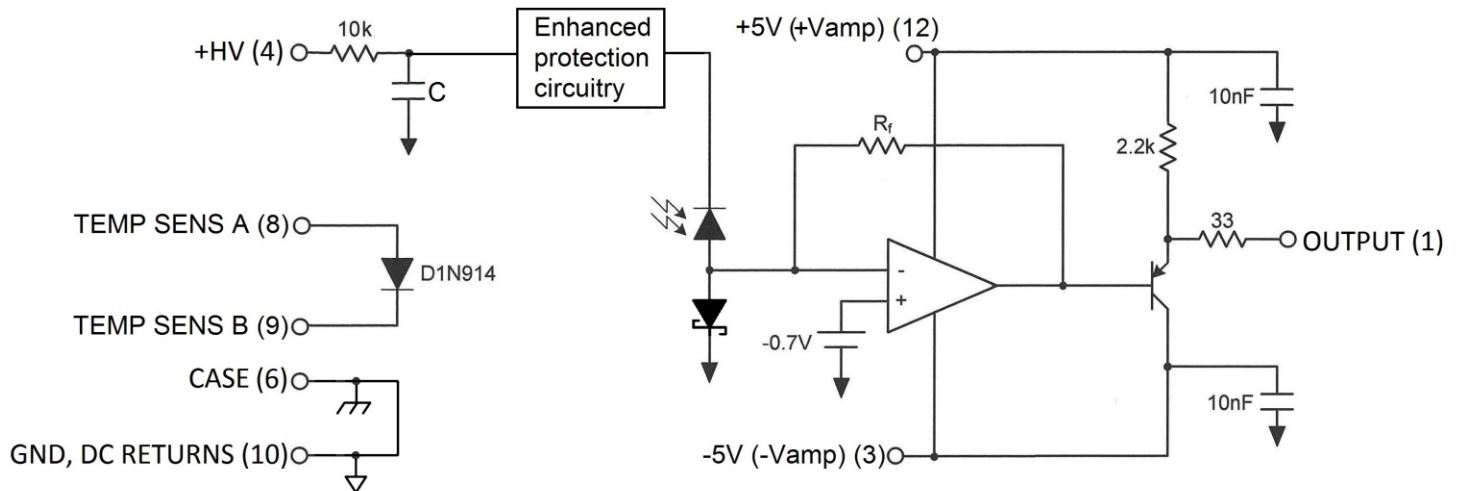
**Table 4. Absolute – Maximum Ratings, Limiting Values**

Detector type	C30659-900-R8AH (Silicon APD)		C30659-900-R5BH (Silicon APD)		C30659-1060 Models (Silicon APD)		C30659-1550(E) Models (InGaAs APD)		Units
	Min	Max	Min	Max	Min	Max	Min	Max	
Photodiode bias voltage (Note 1) at $T_A = +70^\circ\text{C}$ at $T_A = -40^\circ\text{C}$		600 300		350 210		600 300		100 50	V V
Incident radiant flux, $\Phi_M$ , (Note 2) average (Note 3) peak (Note 4) peak (Note 5)		0.1 50		0.1 50		0.1 50		2 4 (for -1550) 1000 (for 1550E)	mW mW kW/cm <sup>2</sup>
Case temperature storage, $T_{stg}$ operating, $T_A$	-50 -40	100 70	-50 -40	100 70	-50 -40	100 70	-50 -40	100 70	$^\circ\text{C}$ $^\circ\text{C}$
Preamplifier bias voltage	$\pm 4.5$	$\pm 5.5$	$\pm 4.5$	$\pm 5.5$	$\pm 4.5$	$\pm 5.5$	$\pm 4.5$	$\pm 5.5$	V

**Notes:**

1. The operating voltage ( $V_{op}$ ) must remain below the breakdown voltage ( $V_{br}$ ), these values are worst-case estimates. HV voltage current should be limited externally to less than 1 mA.
2. As demonstrated in laboratory conditions.
3. Based on 0.5 W electrical power on the high voltage (HV) supply.
4. Test with 50 ns pulse width.
5. Tested at 1064 nm, 10 ns pulse width and 1 kHz pulse repetition rate.

**Figure 1. Schematic Block Diagram – C30659 Series**



Si and InGaAs APD Preamplifier Modules

Figure 2. Typical Spectral Responsivity

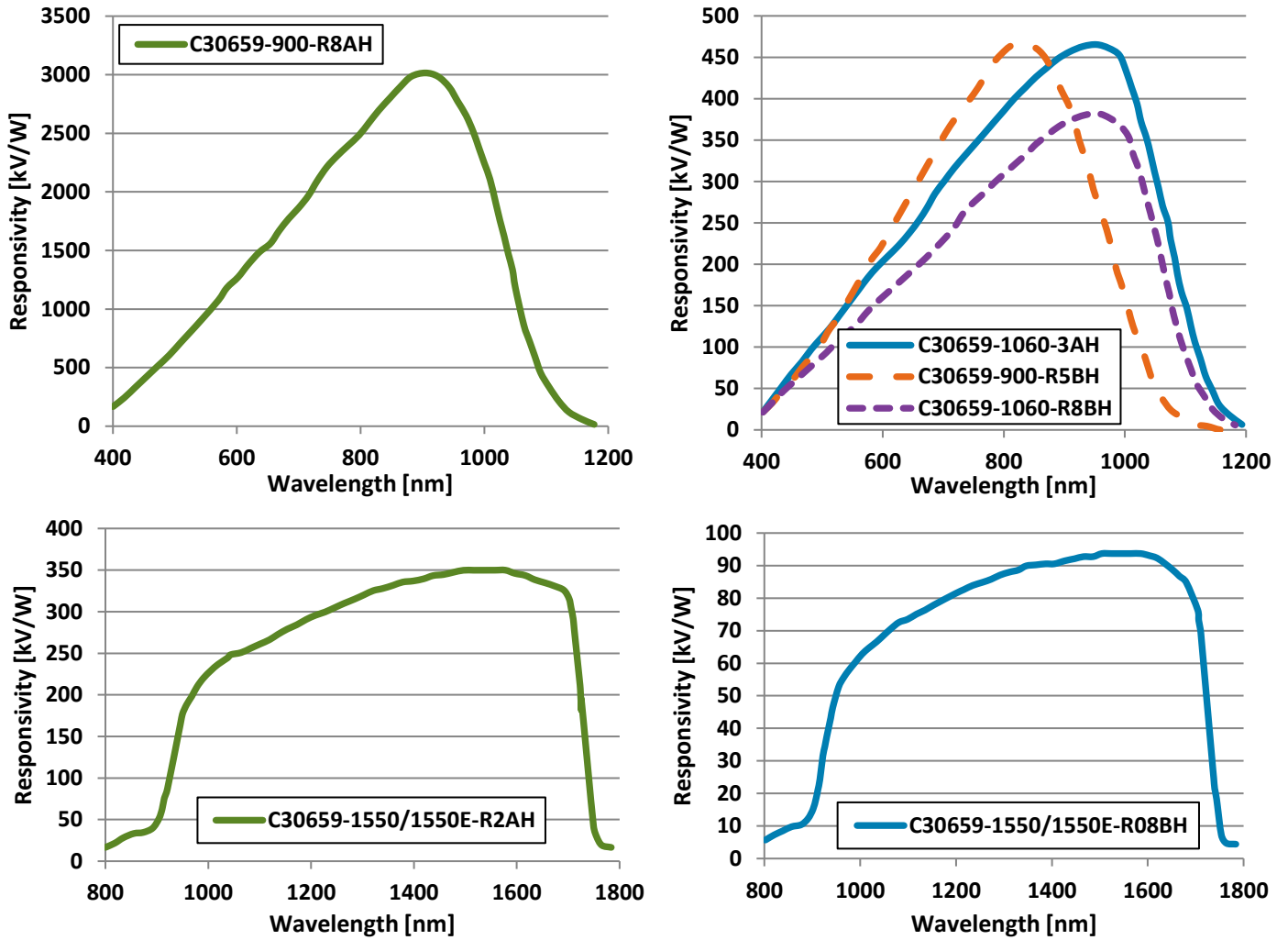
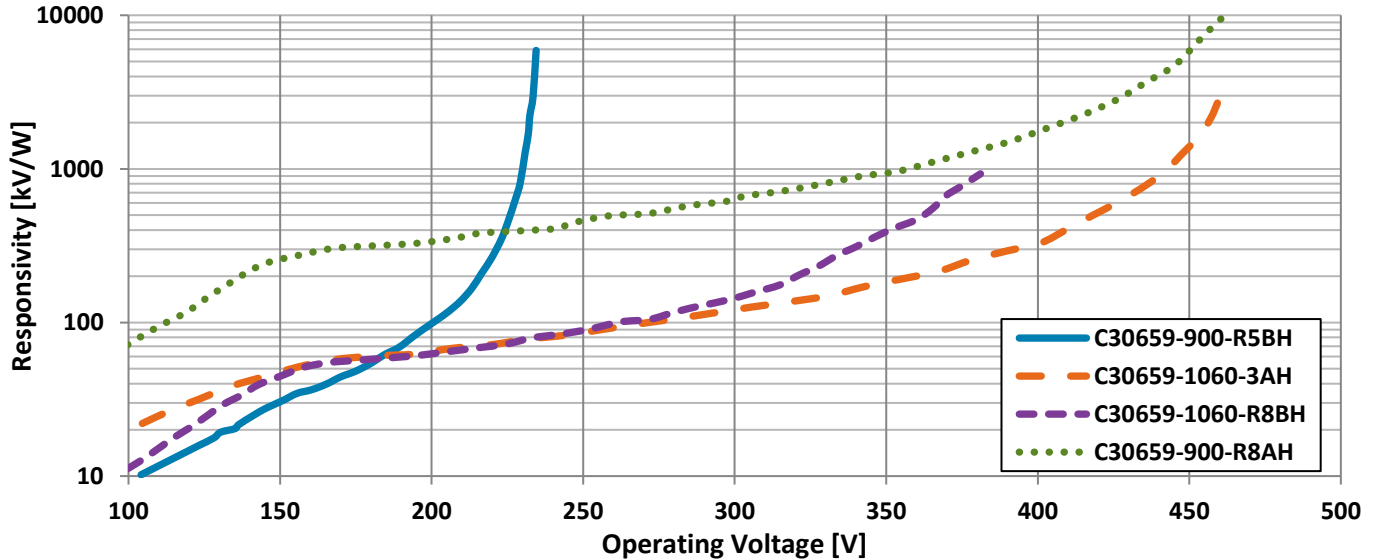


Figure 3. Typical Responsivity as a Function of Operating Voltage – C30659-(900/1060) Series



Si and InGaAs APD Preamplifier Modules

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

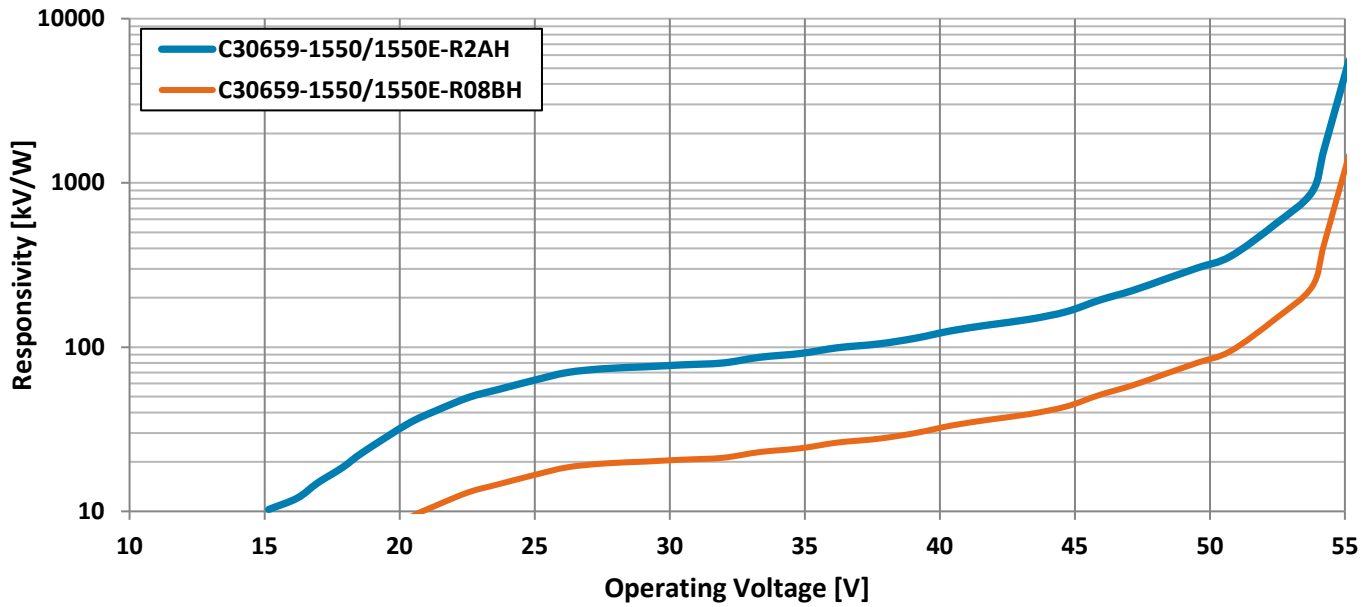
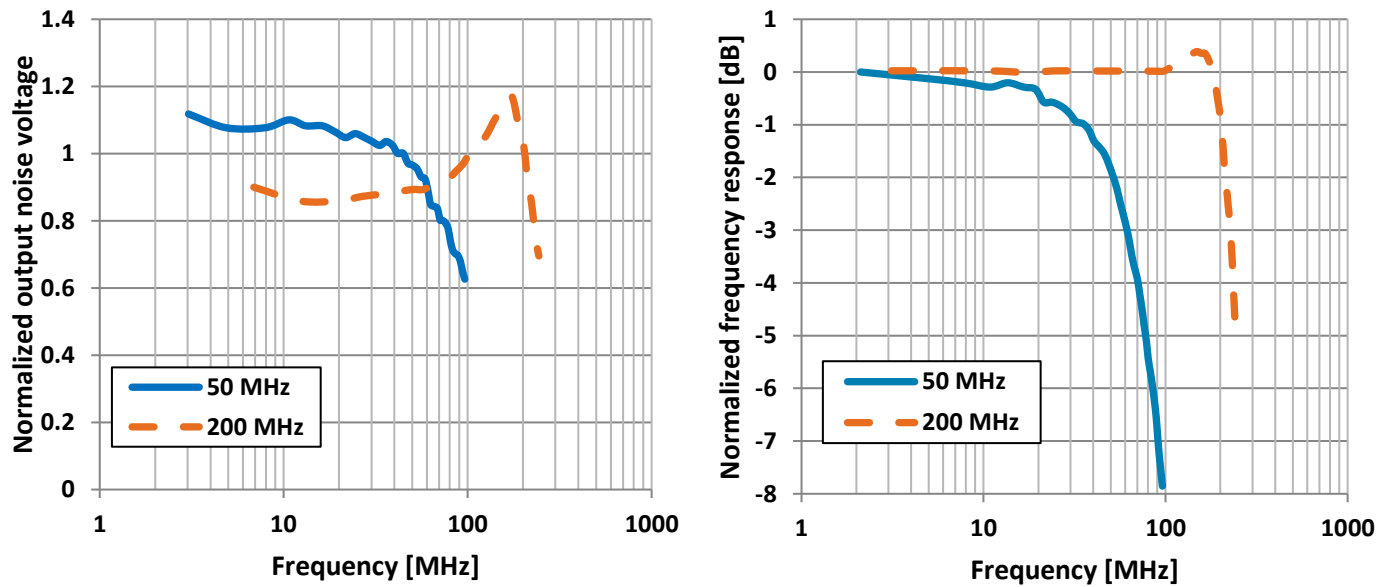


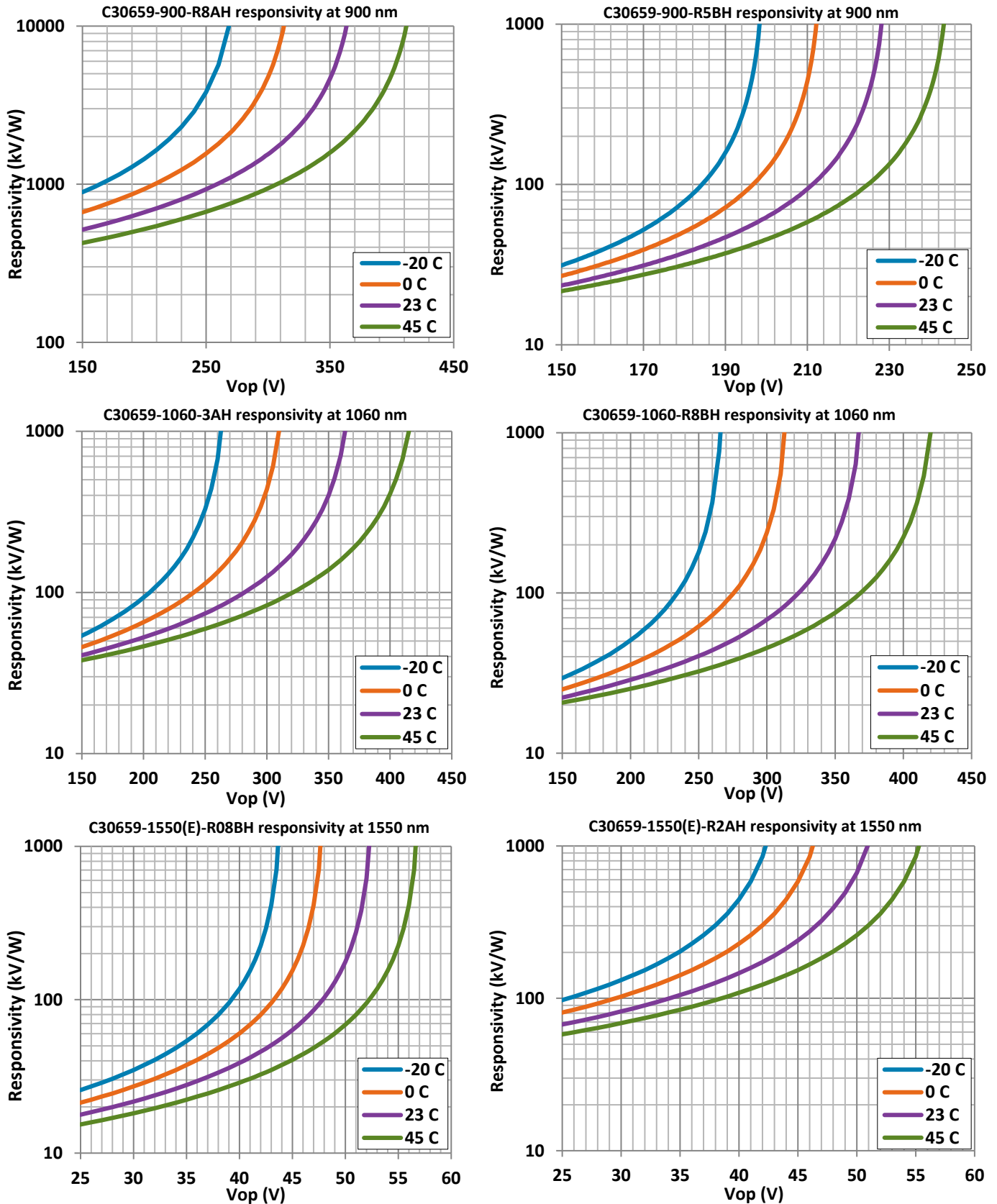
Figure 5. Typical Noise and Frequency response curves



Output voltage noise normalization is calculated using the following formula:

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

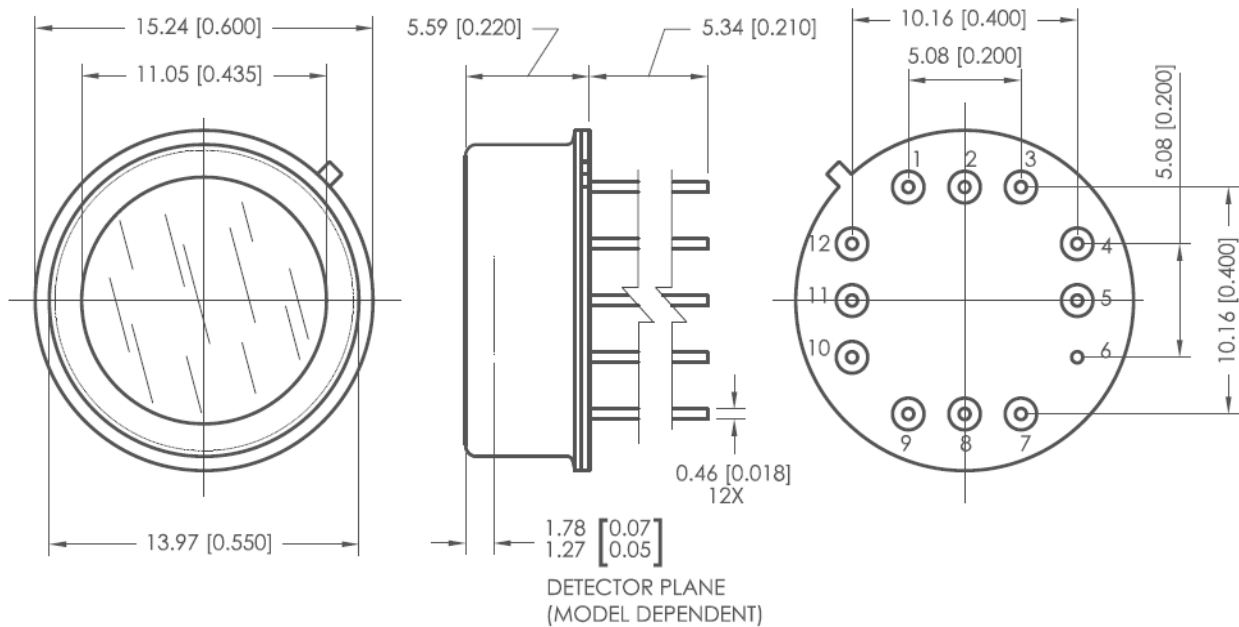
Figure 6. Typical variation of responsivity as a function of temperature





Si and InGaAs APD Preamplifier Modules

Figure 7. Mechanical Characteristics – C30659 Series – reference dimensions shown in mm [inches]



PIN #	DESC	PIN #	DESC
1	OUTPUT	7	NC
2	NC	8	TEMP SENS A
3	-5V (-Vamp)	9	TEMP SENS B
4	HV, APD BIAS	10	GND, DC RETURNS
5	NC	11	NC
6	CASE	12	+5V (+Vamp)

PIN 6 AND 10 ARE INTERNALLY CONNECTED

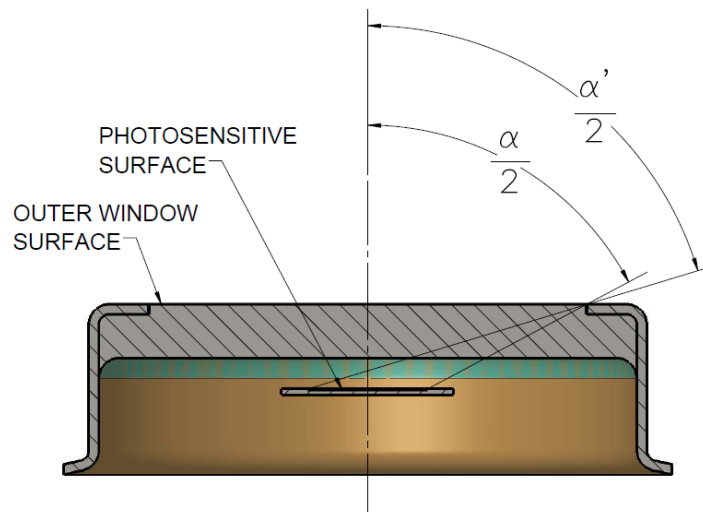
DIMENSIONS ARE IN MILLIMETERS [INCHES] AND ARE FOR REFERENCE ONLY

VS-380R3

Figure 8. Approximate field of view – C30659 Series

For incident radiation at angles  $\leq \alpha/2$ , the photosensitive surface is totally illuminated.

For incident radiation at angles  $> \alpha/2$ , but  $\leq \alpha'/2$ , the photosensitive surface is partially illuminated.



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## C30659 Series – 900/1060/1550/1550E

### Si and InGaAs APD Preamplifier Modules

**Table 5 – Ordering guide**

Model	Nominal Bandwidth	Wavelength Response	Detector Type	Detector Material	Active Diameter	Comments
C30659-900-R8AH	50 MHz	900 nm (peak)	C30817EH	Silicon	0.8 mm	
C30659-900-R5BH	200 MHz		C30902EH		0.5 mm	
C30659-1060-3AH	50 MHz	1064 nm (optimized)	C30956EH		3.0 mm	
C30659-1060-R8BH	200 MHz		C30954EH		0.8 mm	
C30659-1550-R2AH	50 MHz	1550 nm (peak)	C30662EH	InGaAs	0.2 mm	
C30659-1550E-R2AH						Enhanced damage threshold
C30659-1500-R08BH	200 MHz		C30645EH		0.08 mm	
C30659-1550E-R08BH				Enhanced damage threshold		

### RoHS Compliance

The C30659 Series of APD Preamplifier Modules are designed and built to be fully compliant with the European Union Directive 2011/65/EU – Restriction of the use of certain Hazardous Substances (RoHS) in Electrical and Electronic equipment.



### 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.

Excelitas has a long and rich history of serving our OEM customer base with optoelectronic sensors and modules for more than 45 years beginning with PerkinElmer, EG&G, and RCA. The constant throughout has been our innovation and commitment to delivering the highest quality solutions to our customers worldwide.

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 5,000 employees in North America, Europe and Asia, serving customers across the world.

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