DATASHEET
Photon Detection

LLAM Series – 900/1060/1550/1550E

Si and InGaAs Low-Light Analog APD Receiver Modules (LLAM)

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

Excelitas Technologies' LLAM series of Silicon and InGaAs avalanche photodiodes (APD) receiver modules feature an APD, thermoelectric cooler (TEC) and a hybrid, all in the same hermetically-sealed modified 12-lead TO-66 flange package for increased heat sinking. The use of a TEC eases the burden on the APD bias control to insure constant responsivity over a 5°C to 40°C ambient temperature range.

The LLAM series modules are specifically designed for the detection of high-speed, low-light analog signals. The Si APDs used in these devices are the same as used in Excelitas' C30902EH and C30954EH 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. Just like the C30659 series, the preamplifier section of the LLAM module uses a very low noise GaAs FET front end designed to operate at higher transimpedance than Excelitas' regular C30950 Series.

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 LLAM-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.

The LLAM series modules are offered as standard, RoHS-compliant, commercial off-the-shelf (COTS) products. Excelitas offers customized modules tailored for your specific needs; modifications include bandwidth and gain optimization, use of different APDs, FC-connectorized packaging.

Key Features

- System bandwidth of 50 MHz and 200MHz
- Ultra low noise equivalent power (NEP)
- Spectral response range:
  - Si APD: 400 to 1100 nm
  - InGaAs APD: 1100 to 1700 nm
- Typical power consumption: 150 mW (without TEC powered on)
- ±5 V amplifier operating voltages
- 50 Ω AC load capability (AC-Coupled)
- Hermetically-sealed TO-66 flange package for additional heat sinking
- High reliability
- Light entry angle, over 130°
- Model 1550E exhibits enhanced damage threshold
- RoHS-compliant
- Available in both COTS and custom variations

Applications

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

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Table 1. Performance Specifications – LLAM 900,1060 Models (900 nm and 1064nm enhanced Si APD)

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

Detector Type	**LLAM-900-R5BH** (C30902EH APD)			**LLAM-1060-R8BH** (C30954EH APD)			
Parameter	**Min**	**Typical**	**Max**	**Min**	**Typical**	**Max**	**Units**
Active diameter		0.5			0.8		mm
Active area		0.2			0.5		mm²
Nominal field of view α (see Figure 8)		139			138		Degrees
Nominal field of view α' (see Figure 8)		142			143		Degrees
System bandwidth, f_{-3dB}	175	200		175	200		MHz
Temperature coefficient of V_{op} for constant gain		0.7			2.2		V/˚C
V_{op} for specified responsivity	180	Note 1	260	275	Note 1	435	V
Responsivity							
at 830 nm		460			325		kV/W
at 900 nm		400			370		kV/W
at 1060 nm					200		kV/W
R_f (Internal feedback resistor)		12			12		kΩ
Noise equivalent power (NEP) (Note 2)							
Average from 100 kHz to f_{-3dB}, Δf = 1.0 Hz							
at 830 nm		35	55		30	90	fW/√Hz
at 900 nm		40	65		25	80	fW/√Hz
at 1060 nm					50	150	fW/√Hz
Output spectral noise voltage							
Averaged from 100 kHz to f_{-3dB}		15	25		10	30	nV/√Hz
Output impedance	33	40	50	33	40	50	Ω
Rise time, t_r (λ = 830, 900 and 1060 nm) 10% to 90% points		2			2		ns
Fall time, t_f (λ = 830, 900 and 1060 nm) 90% to 10% points		2			2		ns
Recovery time after overload (Note 3)			150			150	ns
Output voltage swing (1 kΩ load) (Note 4)	2	3		2	3		V
Output voltage swing (50 Ω load) (Note 4)	0.7	0.9		0.7	0.9		V
DC output offset voltage	-1	0.25	1	-1	0.25	1	V
APD temperature (case at room temperature)	-10		85	-10		85	ºC
Thermistor value (Note 5)		5.1±5%			5.1±5%		kΩ
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} within the specified range will be supplied with each device.
2. NEP is calculated as the output spectral noise voltage divided by the typical responsivity.
3. 0 dBm with 250ns pulses.
4. Pulsed operation.
5. The temperature of the thermistor in Kelvin can be calculated using the following equation: $T[K] = \frac{\beta}{\ln(R/r_\infty)}$, where R is the measured thermistor resistance in Ω, $\beta = 3200$, $R_0 = 5100\ \Omega$, $T_0 = 298.15\ K$ and $r_\infty = R_0 e^{-\frac{\beta}{T_0}} \cong 0.1113$.

Table 2. Performance Specifications – LLAM-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 and TEC off

Detector type	**LLAM-1550-R2AH** **LLAM-1550E-R2AH** (C30662EH APD)			**LLAM-1550-R08BH** **LLAM-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
Nominal field of view α (see Figure 8)		140			140		Degrees
Nominal field of view α' (see Figure 8)		141			141		Degrees
System bandwidth, f_{-3dB}	40	50		175	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
Responsivity							
at 1300 nm		300			80		kV/W
at 1550 nm		340			90		kV/W
R_f (Internal feedback resistor)		68			18		kΩ
Noise equivalent power (NEP) (Note 2)							
Average from 100 kHz to f_{-3dB}, Δf = 1.0 Hz							
at 1300 nm		150	180		250	375	fW/√Hz
at 1550 nm		130	160		220	330	fW/√Hz
Output spectral noise voltage							
Averaged from 100 kHz to f_{-3dB}		45	55		20	30	nV/√Hz
Output impedance	33	40	50	33	40	50	Ω
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 3)			150			150	ns
Output voltage swing (1 kΩ load) (Note 4)	2	3		2	3		V
Output voltage swing (50 Ω load) (Note 4)	0.7	0.9		0.7	0.9		V
DC output offset voltage	-1	0.25	1	-1	0.25	1	V
APD temperature (case at room temperature)	-10		85	-10		85	ºC
Thermistor value (Note 5)		5.1±5%			5.1±5%		kΩ
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} within the specified range will be supplied with each device.
2. NEP is calculated as the output spectral noise voltage divided by the typical responsivity.
3. 0 dBm with 250ns pulses.
4. Pulsed operation.
5. The temperature of the thermistor in Kelvin can be calculated using the following equation: $\mathrm{T[K]} = \frac{\beta}{\ln(R/r_\infty)}$, where R is the measured thermistor resistance in Ω, $\beta = 3200$, $\mathrm{R_0} = 5100\ \Omega$, $\mathrm{T_0} = 298.15\ K$ and $\mathrm{r_\infty} = \mathrm{R_0} e^{-\frac{\beta}{\mathrm{T_0}}} \cong 0.1113$.

Table 3. Absolute – Maximum Ratings, Limiting Values

Detector type	**LLAM-1060-R8BH** (Silicon APD)		**LLAM-900-R5BH** (Silicon APD)		**LLAM-1550 Models** (InGaAs APD)		**LLAM-1550E Models** (InGaAs APD)		
Parameter	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Units**
Photodiode bias voltage (Note 1)									
at T_A = +70˚C		600		350		100		100	V
at T_A = -40˚C		300		210		50		50	V
Incident radiant flux, Φ_M, (Note 2)									
average (Note 3)		0.1		0.1		2		2	mW
peak (Note 4)		50		50					mW
peak (Note 5)					4		1000		kW/cm²
Case temperature									
storage, T_{stg}	-50	100	-50	100	-50	100	-50	100	˚C
operating, T_A	-40	70	-40	70	-40	70	-40	70	˚C
Preamplifier bias voltage	±4.5	±5.5	±4.5	±5.5	±4.5	±5.5	±4.5	±5.5	V
Thermo-Electric Cooler (TEC)									
Q_{max}, heat-pumping capacity		0.9		0.9		0.9		0.9	W
V_{max}, rated at 27^{o}C		0.8		0.8		0.8		0.8	V
I_{max}, rated at 27^{o}C		1.8		1.8		1.8		1.8	A

Notes:

1. The operating voltage (V_{op}) must remain below the breakdown voltage (V_{br}), these values are worst-case estimates.
2. As demonstrated in laboratory conditions.
3. Based on 0.5 W electrical power on the high voltage (HV) supply.
4. Test with 30 ns pulse width.
5. Tested at 1060 nm, 10 ns pulse width and 1 kHz pulse repetition rate.

Figure 1. Schematic Block Diagram – LLAM Series

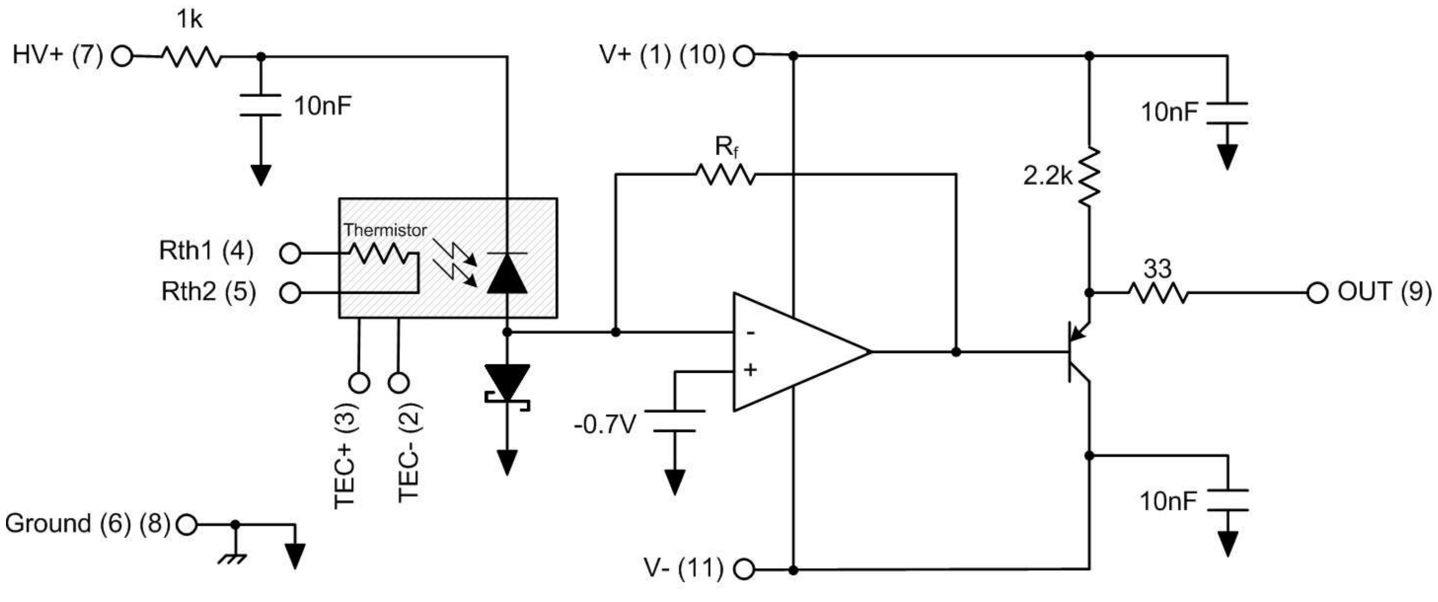


Figure 2. Typical Spectral Responsivity

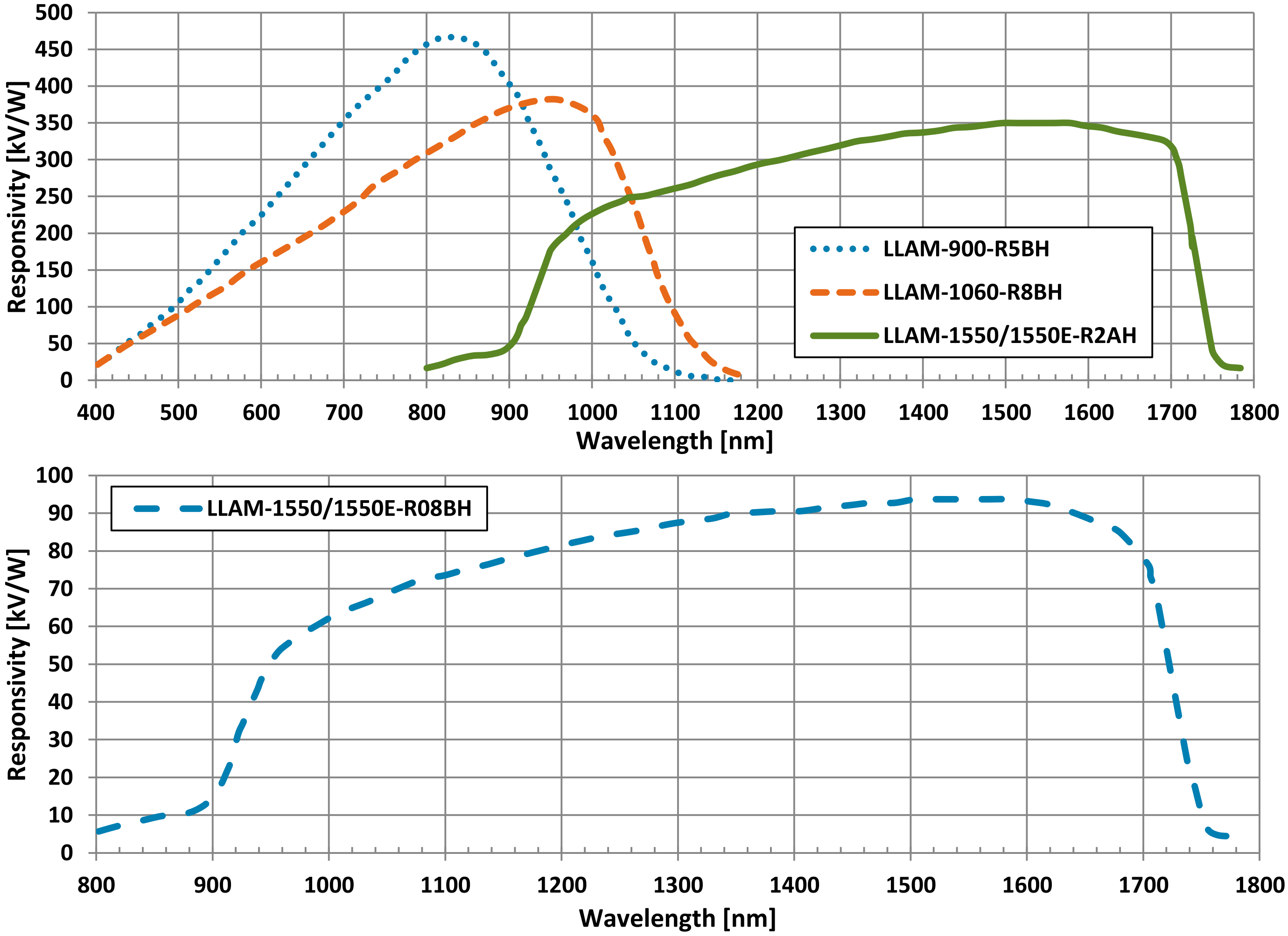


Figure 3. Typical Responsivity as a Function of Operating Voltage – LLAM-(900/1060) Series

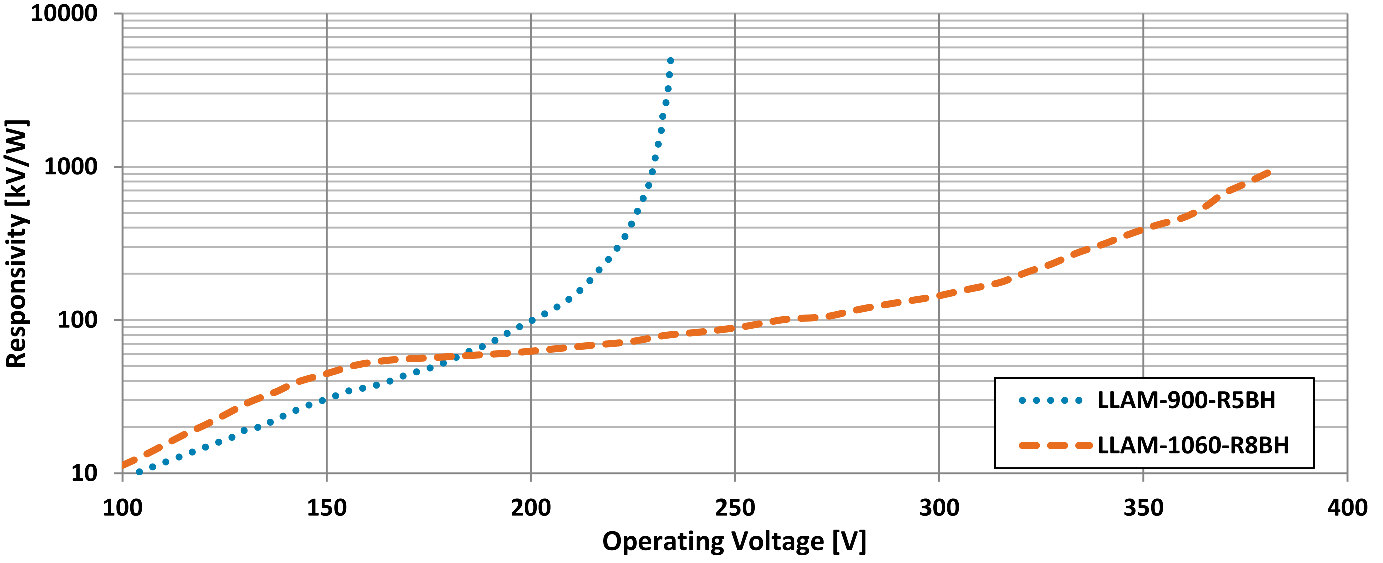


Figure 4. Typical Responsivity as a function of Operating Voltage – LLAM-(1550/1550E) Series

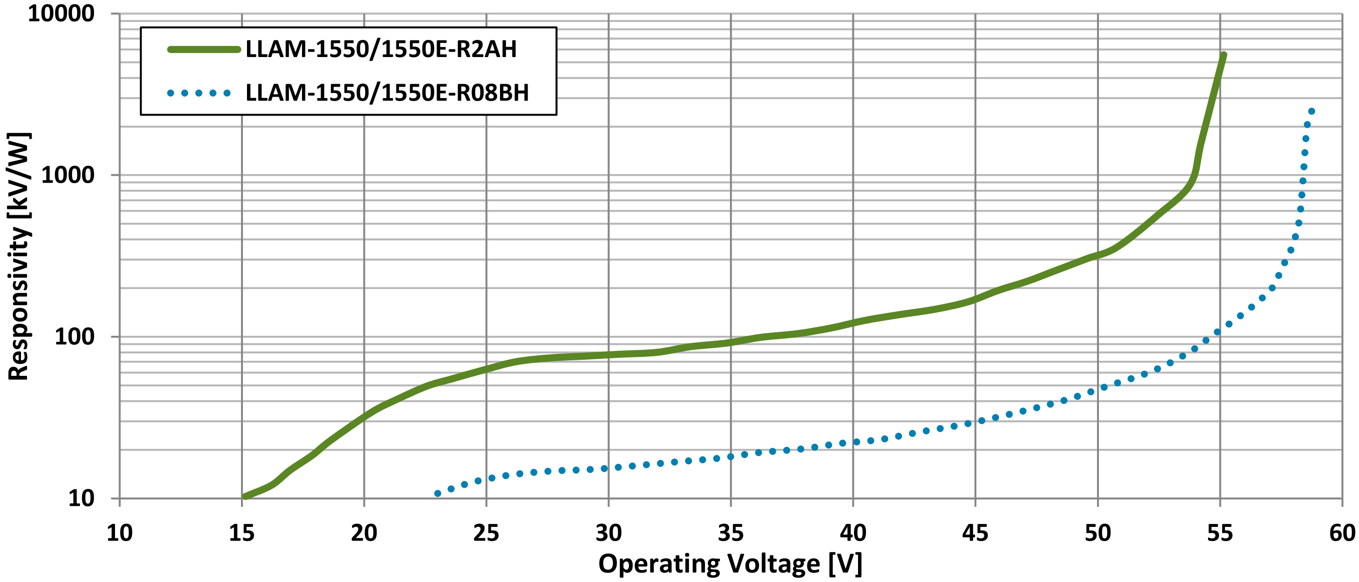
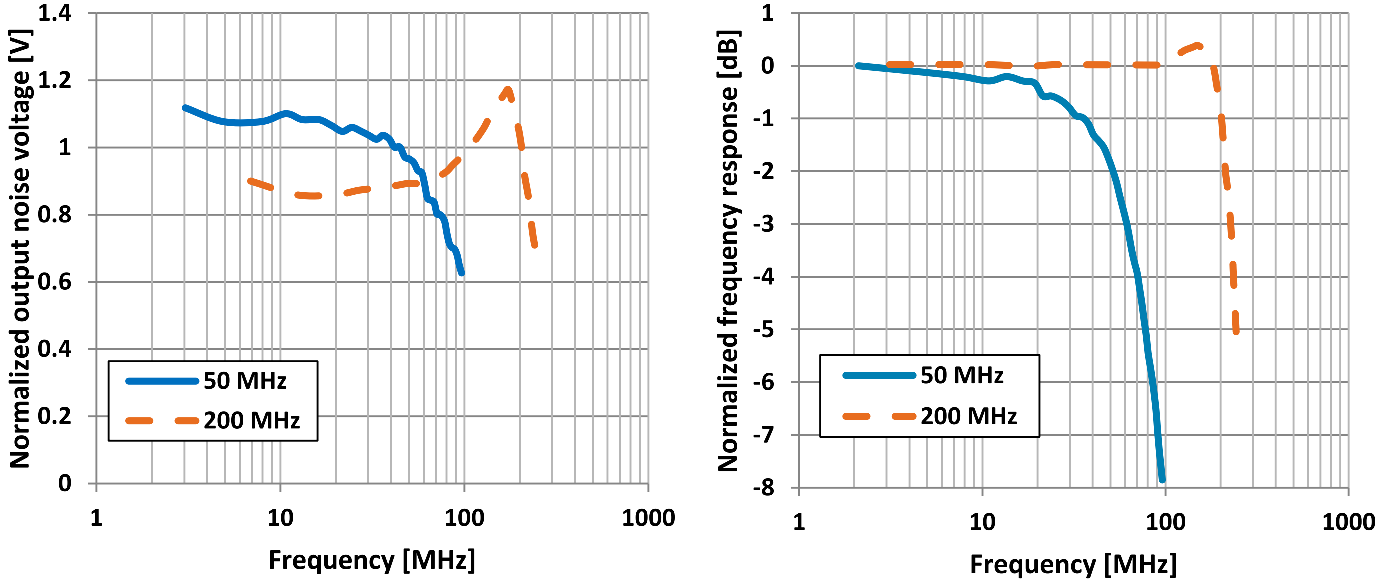


Figure 5. Typical Noise and Frequency response curves



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

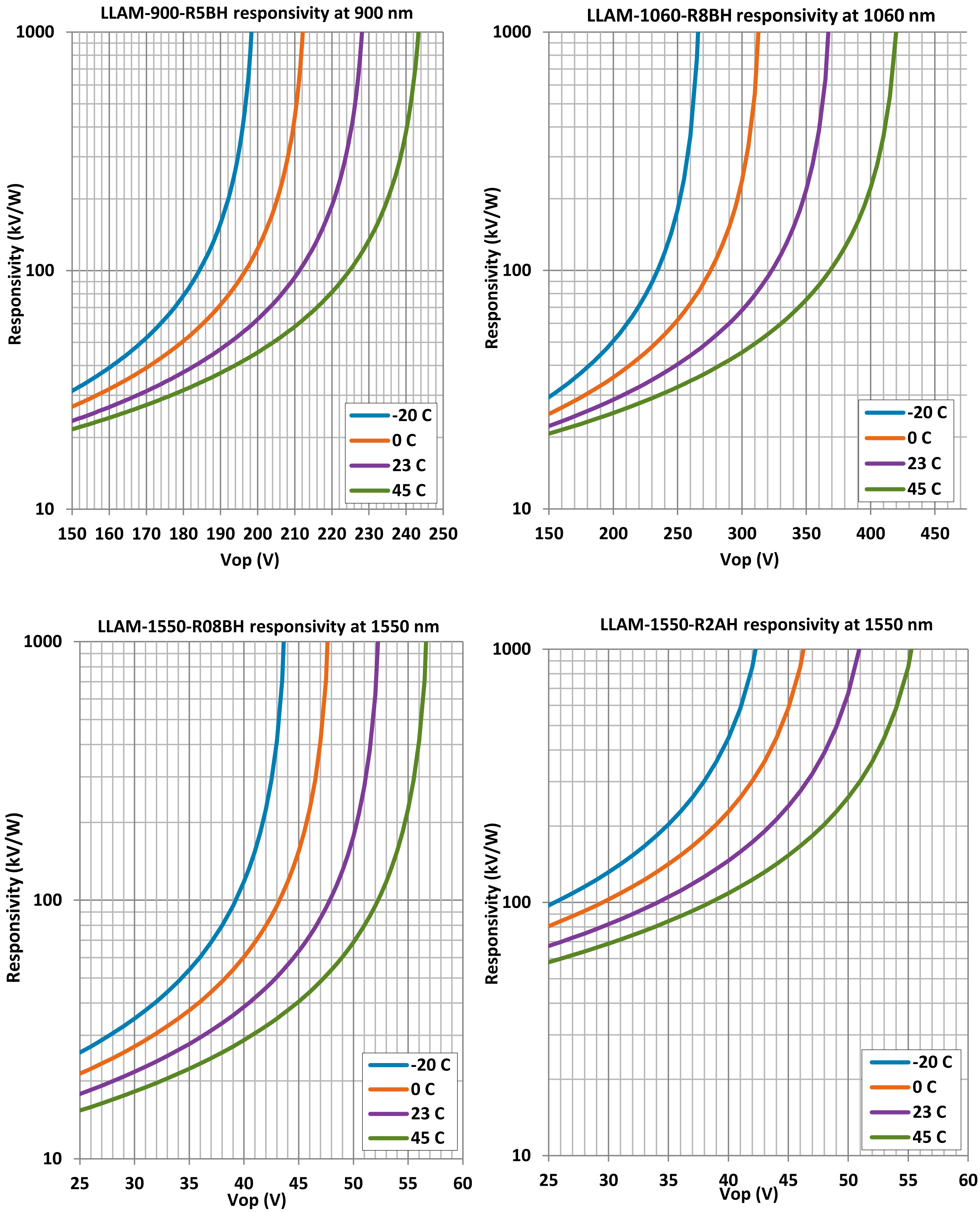
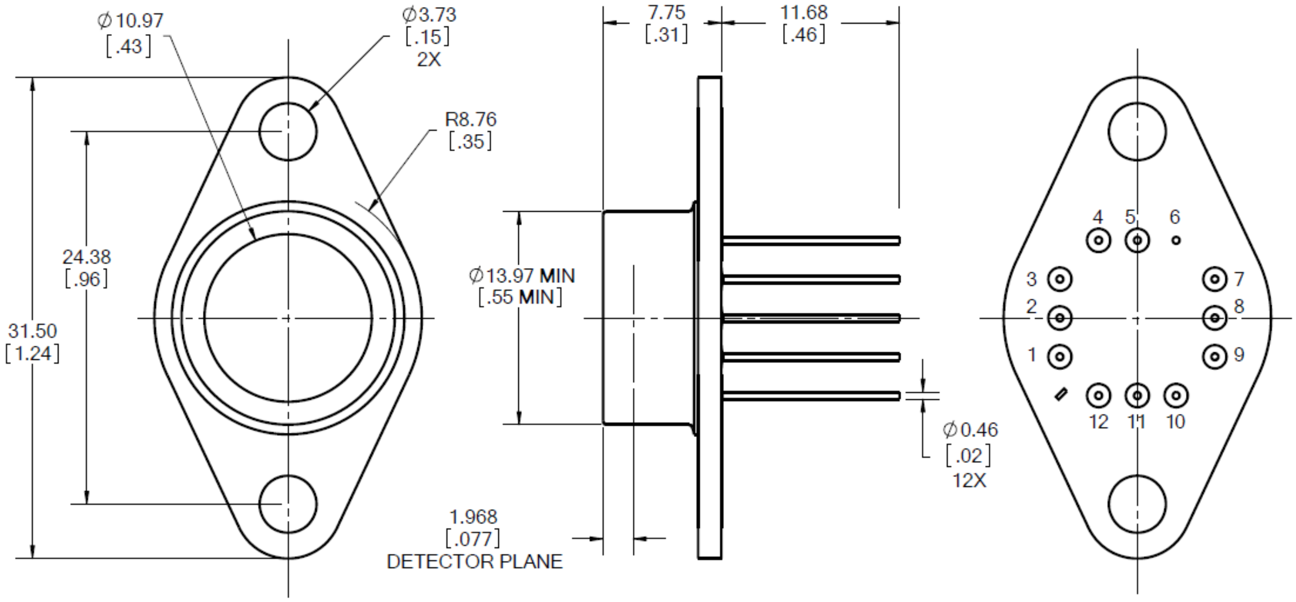


Figure 7. Mechanical Characteristics – LLAM Series – reference dimensions shown in mm [inches]



PIN #	DESC	PIN #	DESC
1	+5v	7	+HV
2	-TEC	8	GND
3	+TEC	9	Vo
4	RTH1	10	+5V
5	RTH2	11	-5V
6	CASE GND	12	NC

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

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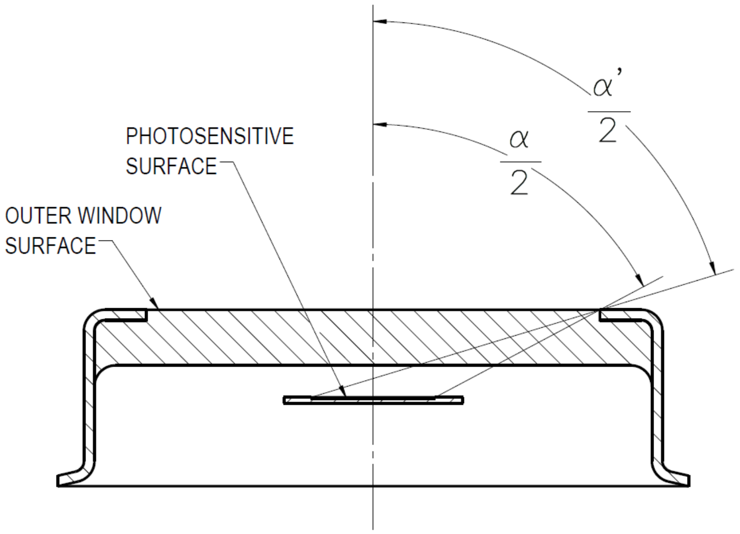
Figure 8. Approximate field of view – LLAM Series

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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Ordering Guide

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

RoHS Compliance

The LLAM 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.

RoHS COMPLIANT 2011/65/EU

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 3,000 employees in North America, Europe and Asia, serving customers across the world.

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