LLAM Series – 900/1060/1060E/1550/1550E

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

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

Key Features

- System bandwidth of 50 MHz and 200 MHz
- Ultra-low noise equivalent power (NEP)
- Spectral response range:
  - Si APD: 400 nm to 1100 nm
  - InGaAs APD: 1100 nm 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 1060E and 1550E exhibits enhanced optical damage threshold
- RoHS-compliant
- Available in both COTS and custom variations

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

EXCELITAS® TECHNOLOGIES

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Table 1. Ordering Guide

Model	Nominal Bandwidth	Wavelength Response	Detector Type	Detector Material	Active Diameter	Comments
LLAM-900-R5BH	200 MHz	900 nm	C30902EH	Silicon	0.5 mm	
LLAM-1060-R8BH		1064 nm (optimized)	C30954EH		0.8 mm	
LLAM-1060E-R8BH						Enhanced damage threshold
LLAM-1550-R2AH	50 MHz	1550 nm	C30662EH	InGaAs	0.2 mm	
LLAM-1550E-R2AH						Enhanced damage threshold
LLAM-1500-R08BH	175 MHz		C30645EH		0.08 mm	
LLAM-1550E-R08BH						Enhanced damage threshold

Table 2. Absolute – Maximum Ratings, Limiting Values

Detector type	LLAM-1060(E)-R8BH (C30954EH)		LLAM-900-R5BH (C30902EH)		LLAM-1550(E) Models (C30645EH) (C30662EH)		
Parameter	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Unit**
Photodiode HV bias voltage (Note 1)							
at T_A = +70˚C		600		350		100	V
at T_A = -40˚C		300		210		50	V
Incident radiant flux, Φ_M, (Note 2)							
average (Note 3)		0.1		0.1		2	mW
peak (Note 4)		50		50			mW
peak (Note 5)					4 (-1550) 1000 (- 1550E)		kW/cm² kW/cm²
Case temperature							
storage, T_{stg}	-50	85	-50	85	-50	85	˚C
operating, T_A	-40	70	-40	70	-20	70	˚C
Preamplifier bias voltage	±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	W
V_{max}, rated at 27°C		0.8		0.8		0.8	V
I_{max}, rated at 27°C		1.8		1.8		1.8	A

Note 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.

Note 2: As demonstrated in laboratory conditions.

Note 3: Based on 0.5 W electrical power on the high voltage (HV) supply.

Note 4: Test with 30 ns pulse width.

Note 5: Tested at 1060 nm, 10 ns pulse width and 1 kHz pulse repetition rate

Note 6: Stresses above those listed under above values may cause permanent damage to the device.

Note 7: Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 3. Performance Specifications – LLAM 900/1060(E) Models (900 nm and YAG-enhanced Si APD)

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

Detector Type	LLAM-900-R5BH (C30902EH APD)			LLAM-1060-R8BH LLAM-1060E-R8BH (C30954EH APD)			
Parameter	**Min**	**Typical**	**Max**	**Min**	**Typical**	**Max**	**Unit**
Photosensitive Area Active diameter Active area		0.5 0.2			0.8 0.5		mm mm²
Field of View Nominal field of view α (see Figure 8) Nominal field of view α' (see Figure 8)		139 142			138 143		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 at 900 nm at 1064 nm R_f (Internal feedback resistor)		460 400 12			325 370 200 8.2		kV/W kV/W kV/W kΩ
Noise equivalent power (NEP) (Note 2) Average from 100 kHz to f_{-3dB}, Δf = 1.0 Hz at 830 nm at 900 nm at 1064 nm Output spectral noise voltage Averaged from 100 kHz to f_{-3dB}		35 40 15	55 65 25		30 25 50 10	90 80 150 30	fW/√Hz fW/√Hz fW/√Hz nV/√Hz
Output impedance	33	40	50	33	40	50	Ω
Rise time, t_r (λ = 830, 900 and 1064 nm) 10% to 90% points		2			2		ns
Fall time, t_f (λ = 830, 900 and 1064 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_{pp}
Output voltage swing (50 Ω load) (Note 4)	0.7	0.9		0.7	0.9		V_{pp}
DC output offset voltage	-1	0.25	1	-1	0.25	1	V_{DC}
APD temperature (case at room temperature)	-10		85	-10		85	°C
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

Note 1: A specific value of V_{op} within the specified range will be supplied with each device.
Note 2: NEP is calculated as the output spectral noise voltage divided by the typical responsivity.
Note 3: 0 dBm with 250 ns pulses.
Note 4: Pulsed operation, AC-coupled
Note 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 4. Performance Specifications – LLAM-1550(E) Models (1550 nm peak response InGaAs APD)

Test conditions: Case temperature = 22˚C, V_{amp} = ±5 V, HV = V_{op} (see Note 1), RL = 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**	**Unit**
Photosensitive Area							
Active diameter		0.2			0.08		mm
Active area		0.03			0.005		mm²
Field of View							
Nominal field of view α (see Figure 8)		140			140		Degrees
Nominal field of view α' (see Figure 8)		141			141		
System bandwidth, f_{-3dB}	40	50		150	175		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			12		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_{pp}
Output voltage swing (50 Ω load) (Note 4)	0.7	0.9		0.7	0.9		V_{pp}
DC output offset voltage	-1	0.25	1	-1	0.25	1	V_{DC}
APD temperature (case at room temperature)	-10		85	-10		85	°C
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

Note 1: A specific value of V_{op} within the specified range will be supplied with each device.
Note 2: NEP is calculated as the output spectral noise voltage divided by the typical responsivity.
Note 3: 0 dBm with 250 ns pulses.
Note 4: Pulsed operation, AC-coupled
Note 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 $\mathrm{r_\infty} = \mathrm{R_0} e^{-\frac{\beta}{T_0}} \cong 0.1113$.

Figure 1. Schematic Block Diagram – LLAM Series

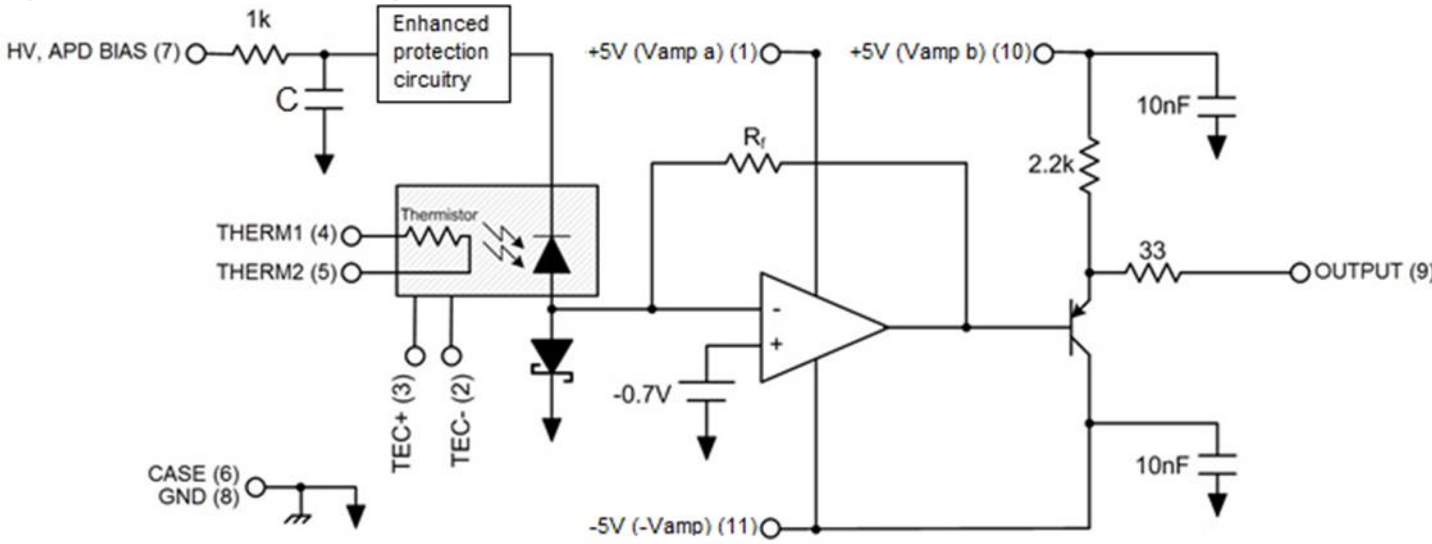
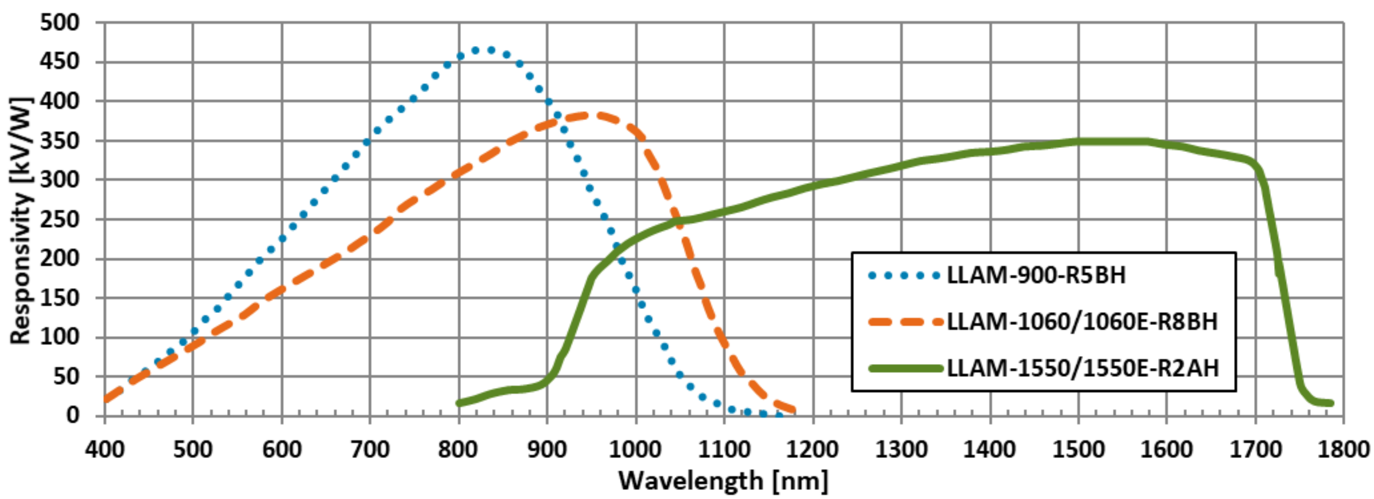


Figure 2. Typical Spectral Responsivity



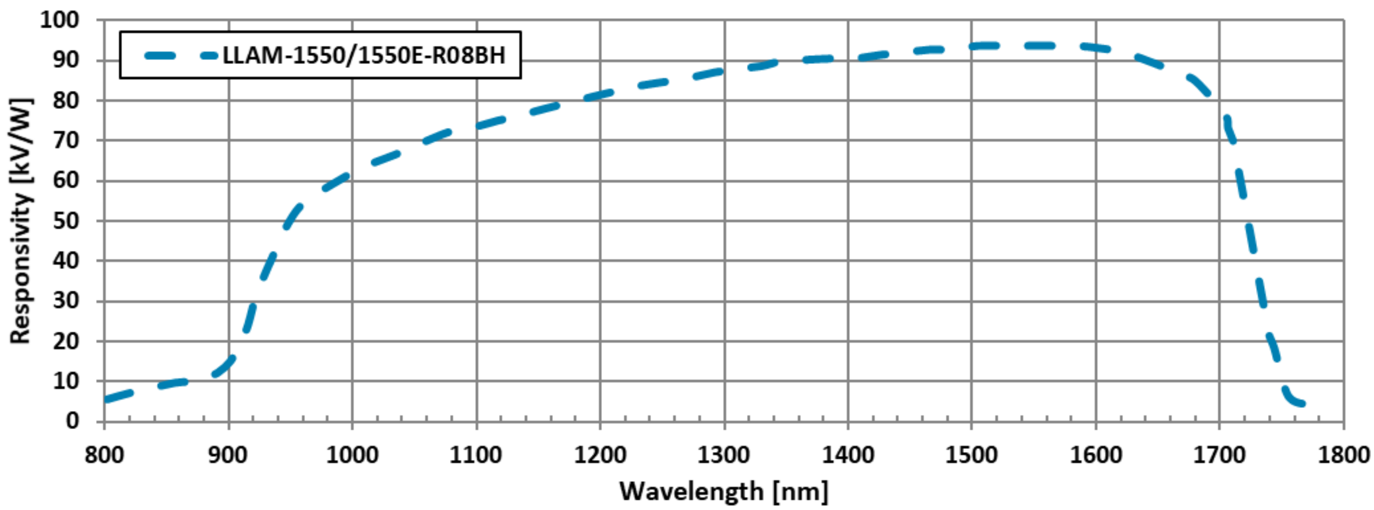


Figure 3. Typical Responsivity as a Function of Operating Voltage – LLAM-(900/1060) Series

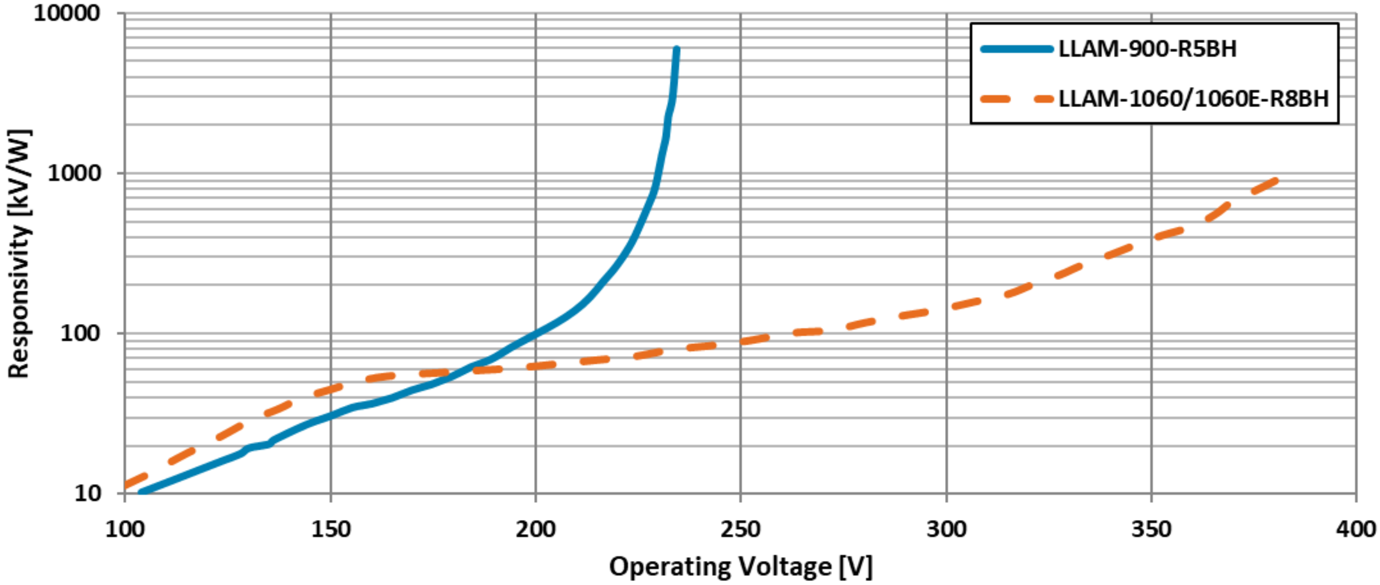


Figure 4. Typical Responsivity as a function of Operating Voltage – LLAM-(1550/1550E) Series

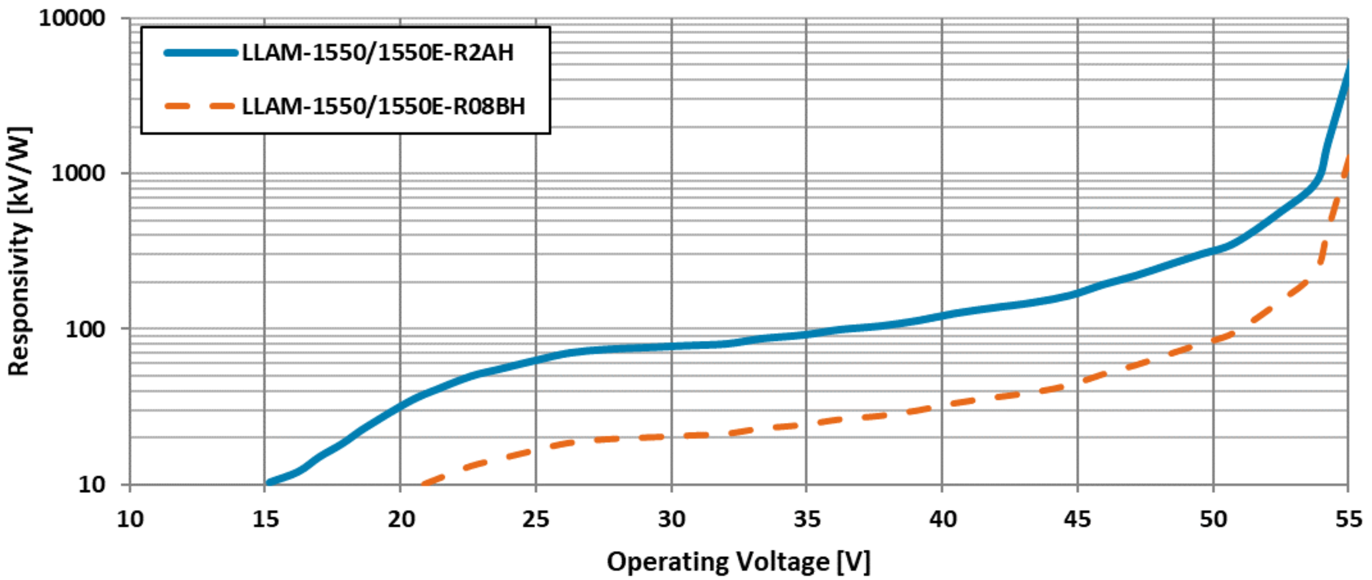


Figure 4. Typical Responsivity as a function of Operating Voltage – LLAM-(1550/1550E) Series

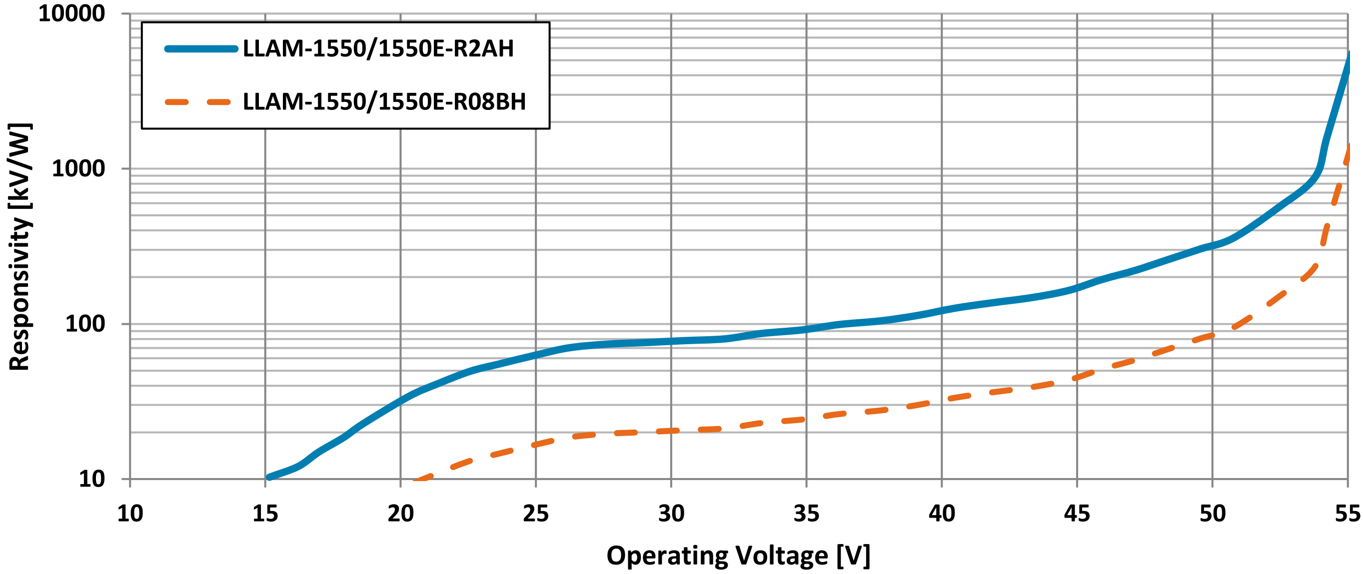
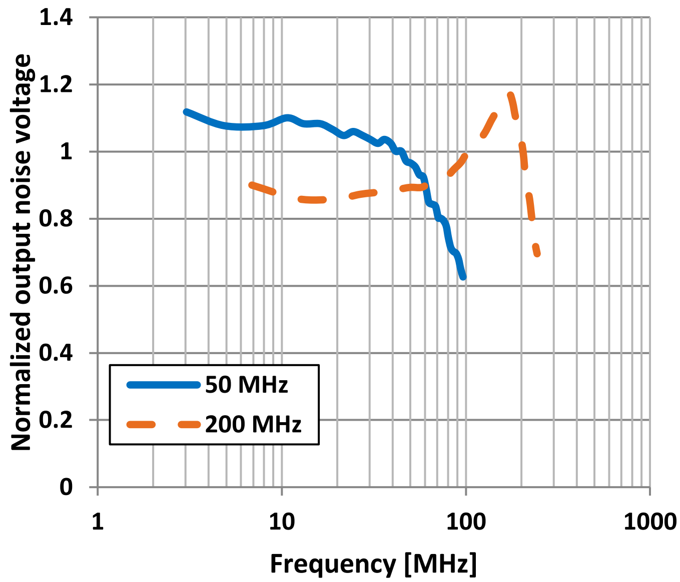
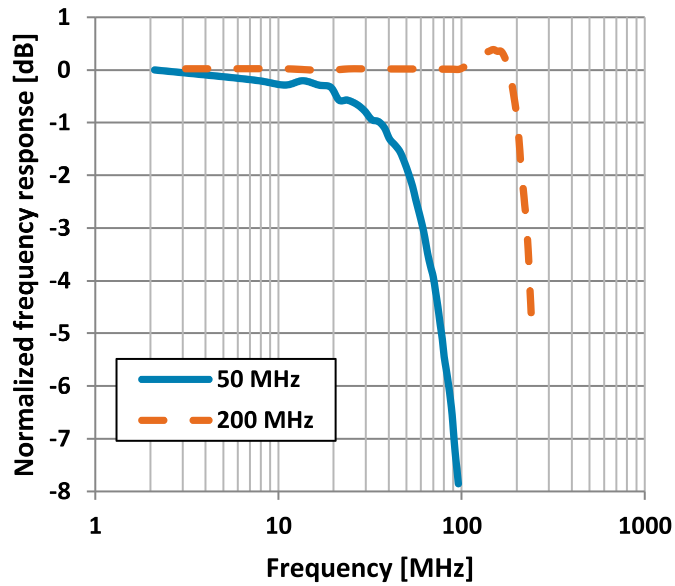


Figure 5. Typical Noise and Frequency response curves





Output voltage noise normalization is calculated using the following formula:

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

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

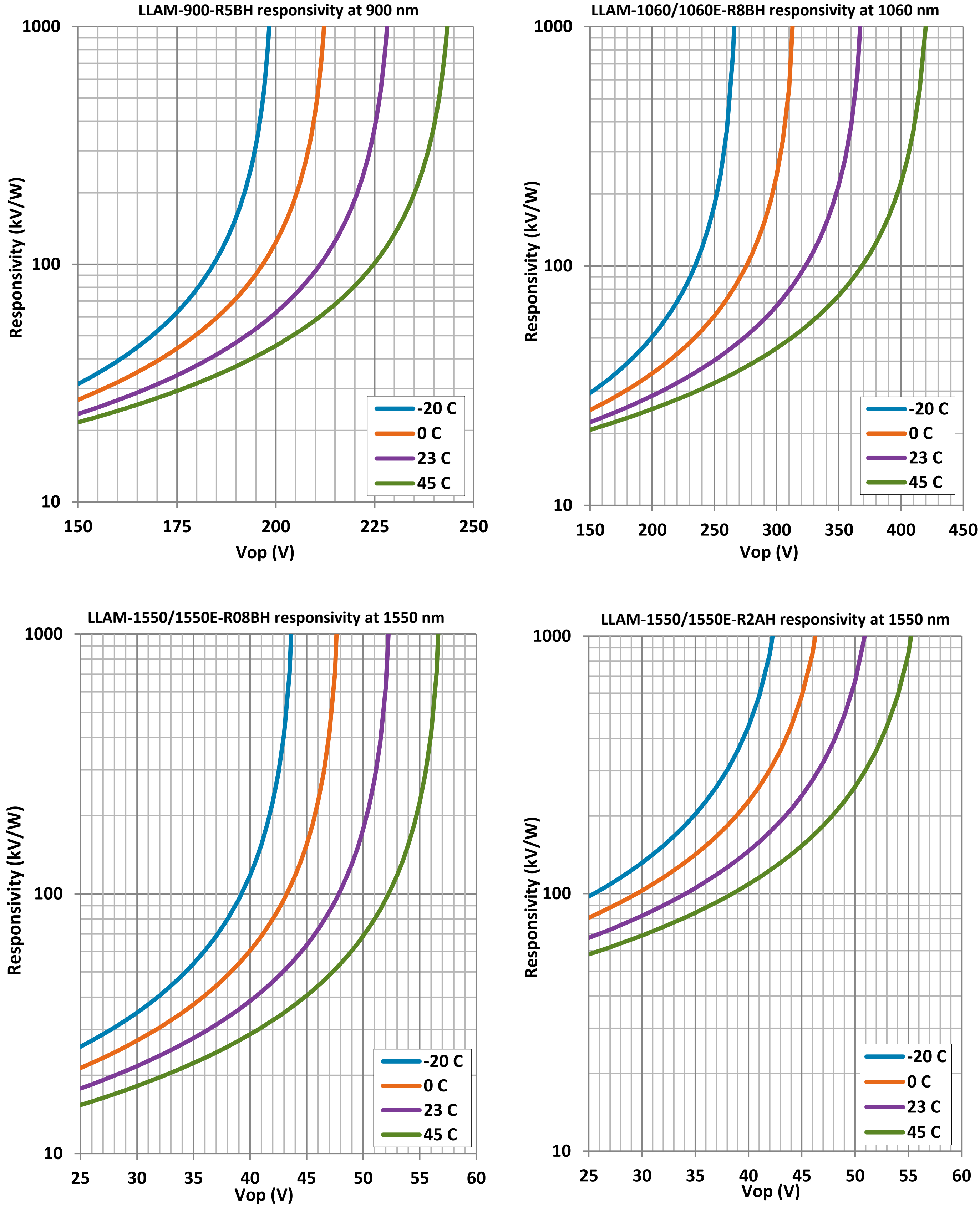
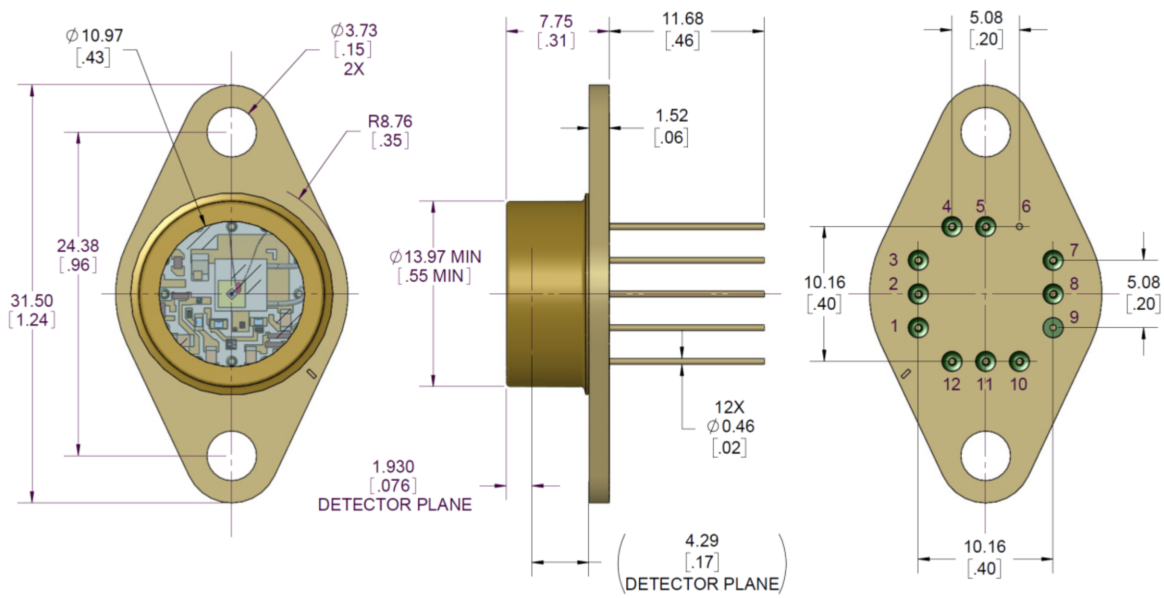


Figure 7. Mechanical Characteristics – LLAM Series – reference dimensions shown in mm [inches]



PIN #	DESC	PIN #	DESC
1	+5V (+Vamp a)	7	HV, APD BIAS
2	TEC-	8	GND
3	TEC+	9	OUTPUT
4	THERM 1	10	+5V (+Vamp b)
5	THERM 2	11	-5V (-Vamp)
6	CASE	12	NC

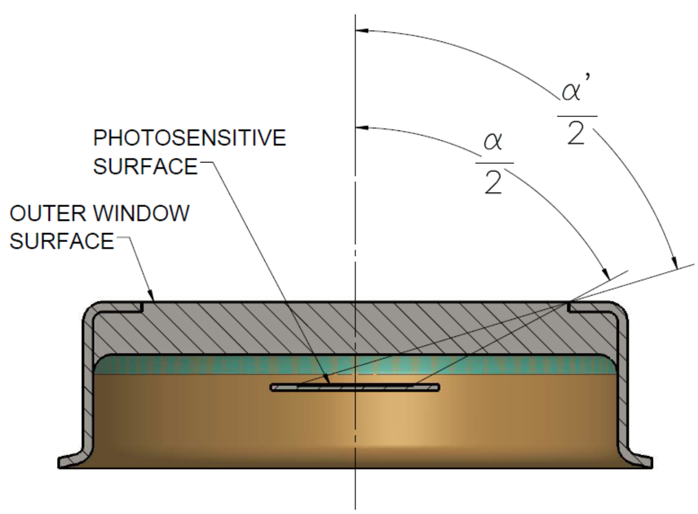
PIN 1 AND 10 ARE NOT INTERNALLY CONNECTED
PIN 6 AND 8 ARE INTERNALLY CONNECTED

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

VS-379R4

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.



VS-383

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

Information

Excelitas Technologies' LLAM series of Silicon and InGaAs avalanche photodiodes (APD) receiver modules feature an APD, thermoelectric cooler (TEC) and an amplification circuit, 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^{o}C to 40^{o}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 nm 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.

The LLAM is an inverting amplifier design with an emitter follower 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 kΩ. For field use, it is recommended that a temperature compensated HV supply be employed to maintain a constant responsivity over temperature.

Excelitas' InGaAs LLAM-1060E and -1550E Preamplifier Modules, 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.

RoHS Compliance

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

Warranty

A standard 12-month warranty following shipment applies.

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 7,000 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

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

Excelitas Technologies Singapore, Pte. Ltd.
8 Tractor Road
Singapore 627969
Telephone: (+65) 6775 2022 (Main number)
Telephone: (+65) 6770 4366 (Customer Service)
Fax: (+65) 6778-1752

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Contact us at http://www.excelitas.com/contact

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