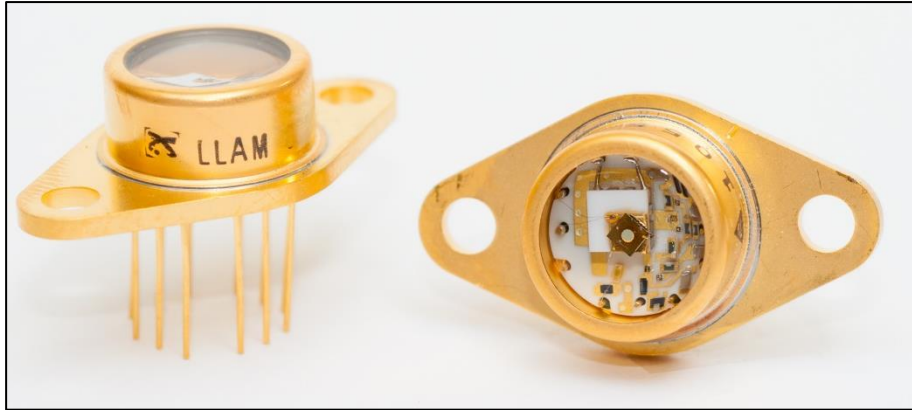


LLAM Series – 900/1060/1060E/1550/1550E

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.

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.

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.

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 1060E and 1550E exhibits enhanced 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

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

Table 1. Performance Specifications – LLAM 900/1060(E) Models (900 nm and YAG-enhanced 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 and TEC off

| Detector Type | LLAM-900-R5BH (C30902EH APD) | | | LLAM-1060-R8BH LLAM-1060E-R8BH (C30954EH APD) | | | Units |
|---|---------------------------------|--------------|-----|---|--------------|-----|-----------------|
| | Min | Typical | Max | Min | Typical | Max | |
| Photosensitive Area | | 0.5 | | | 0.8 | | mm |
| Active diameter | | 0.2 | | | 0.5 | | mm ² |
| Field of View | | | | | | | Degrees |
| Nominal field of view α (see Figure 8) | | 139 | | | 138 | | |
| Nominal field of view α' (see Figure 8) | | 142 | | | 143 | | |
| 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 1064 nm | | | | | 200 | | kV/W |
| R_f (Internal feedback resistor) | | 12 | | | 8.2 | | k Ω |
| Noise equivalent power (NEP) (Note 2) | | | | | | | |
| Average from 100 kHz to f_{-3dB} , $\Delta f = 1.0$ Hz | | | | | | | |
| at 830 nm | | 35 | 55 | | 30 | 90 | fW/ \sqrt{Hz} |
| at 900 nm | | 40 | 65 | | 25 | 80 | fW/ \sqrt{Hz} |
| at 1064 nm | | | | | 50 | 150 | fW/ \sqrt{Hz} |
| Output spectral noise voltage | | | | | | | |
| Averaged from 100 kHz to f_{-3dB} | | 15 | 25 | | 10 | 30 | nV/ \sqrt{Hz} |
| Output impedance | 33 | 40 | 50 | 33 | 40 | 50 | Ω |
| Rise time, t_r ($\lambda = 830, 900$ and 1064 nm) 10% to 90% points | | 2 | | | 2 | | ns |
| Fall time, t_f ($\lambda = 830, 900$ and 1064 nm) 90% to 10% points | | 2 | | | 2 | | ns |
| Recovery time after overload (Note 3) | | | 150 | | | 150 | ns |
| Output voltage swing (1 k Ω 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 \pm 5% | | | 5.1 \pm 5% | | k Ω |
| 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, AC-coupled
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 $r_\infty = R_0 e^{-\frac{\beta}{T_0}} \cong 0.1113$.

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

Table 2. Performance Specifications – LLAM-1550(E) 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 and TEC off

| Detector type | LLAM-1550-R2AH LLAM-1550E-R2AH (C30662EH APD) | | | LLAM-1550-R08BH LLAM-1550E-R08BH (C30645EH APD) | | | Units |
|---|---|--------------|-----|---|--------------|-----|-----------------|
| | Min | Typical | Max | Min | Typical | Max | |
| Parameter | | | | | | | |
| Photosensitive Area | | | | | | | |
| Active diameter | | 0.2 | | | 0.08 | | mm |
| Active area | | 0.03 | | | 0.005 | | mm ² |
| 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 | | | 15 | | k Ω |
| Noise equivalent power (NEP) (Note 2) | | | | | | | |
| 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 | Ω |
| 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 3) | | | 150 | | | 150 | ns |
| Output voltage swing (1 k Ω 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 \pm 5% | | | 5.1 \pm 5% | | k Ω |
| 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, AC-coupled
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 $r_{\infty} = R_0 e^{-\frac{\beta}{T_0}} \cong 0.1113$.

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

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

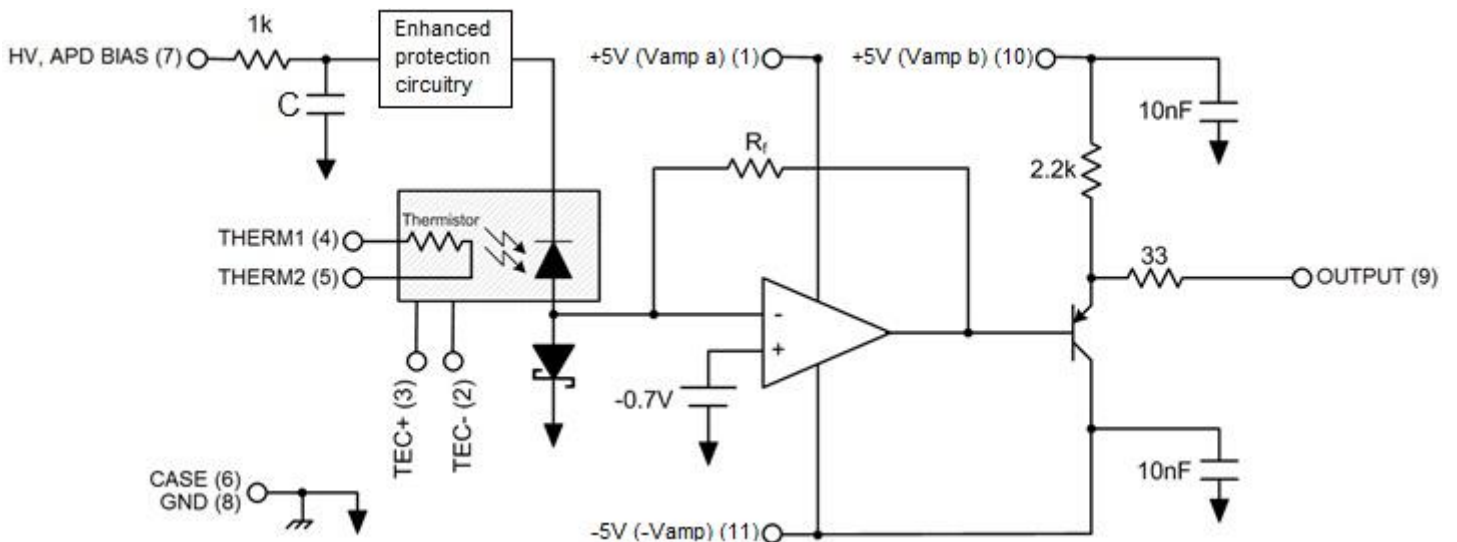
Table 3. Absolute – Maximum Ratings, Limiting Values

| Detector type | LLAM-1060(E)-R8BH (C30954EH) | | LLAM-900-R5BH (C30902EH) | | LLAM-1550(E) Models (C30645EH) (C30662EH) | | Units |
|--|---------------------------------|-------------------|-----------------------------|-------------------|---|---|--------------------------------|
| | Min | Max | Min | Max | Min | Max | |
| Photodiode HV bias voltage (Note 1) at T _A = +70°C at T _A = -40°C | | 600 300 | | 350 210 | | 100 50 | V V |
| Incident radiant flux, Φ _M , (Note 2) average (Note 3) peak (Note 4) peak (Note 5) | | 0.1 50 | | 0.1 50 | | 2 4 (for -1550) 1000 (for -1550E) | mW mW kW/cm ² |
| Case temperature storage, T _{stg} operating, T _A | -50 -40 | 85 70 | -50 -40 | 85 70 | -50 -40 | 85 70 | °C °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 V _{max} , rated at 27°C I _{max} , rated at 27°C | | 0.9 0.8 1.8 | | 0.9 0.8 1.8 | | 0.9 0.8 1.8 | W V A |

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 1mA.
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



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

Figure 2. Typical Spectral Responsivity

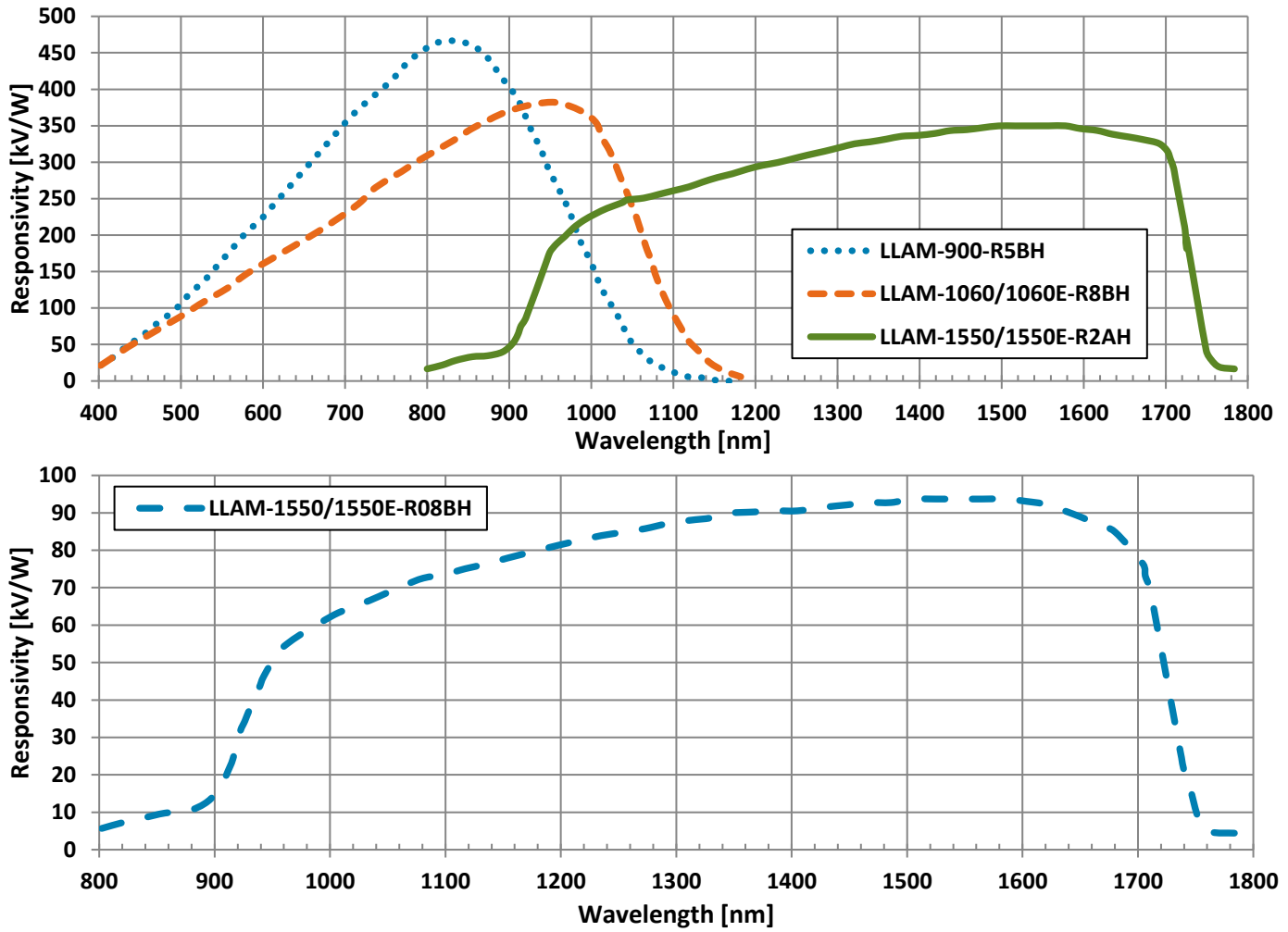
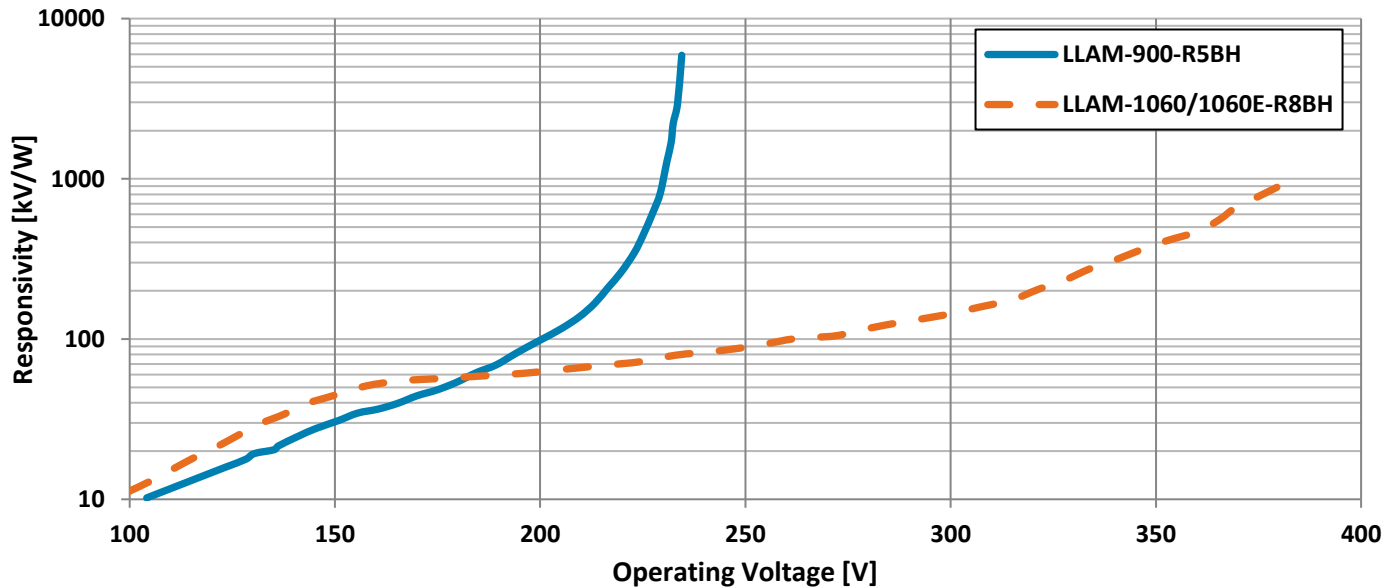


Figure 3. Typical Responsivity as a Function of Operating Voltage – LLAM-(900/1060) Series



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

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

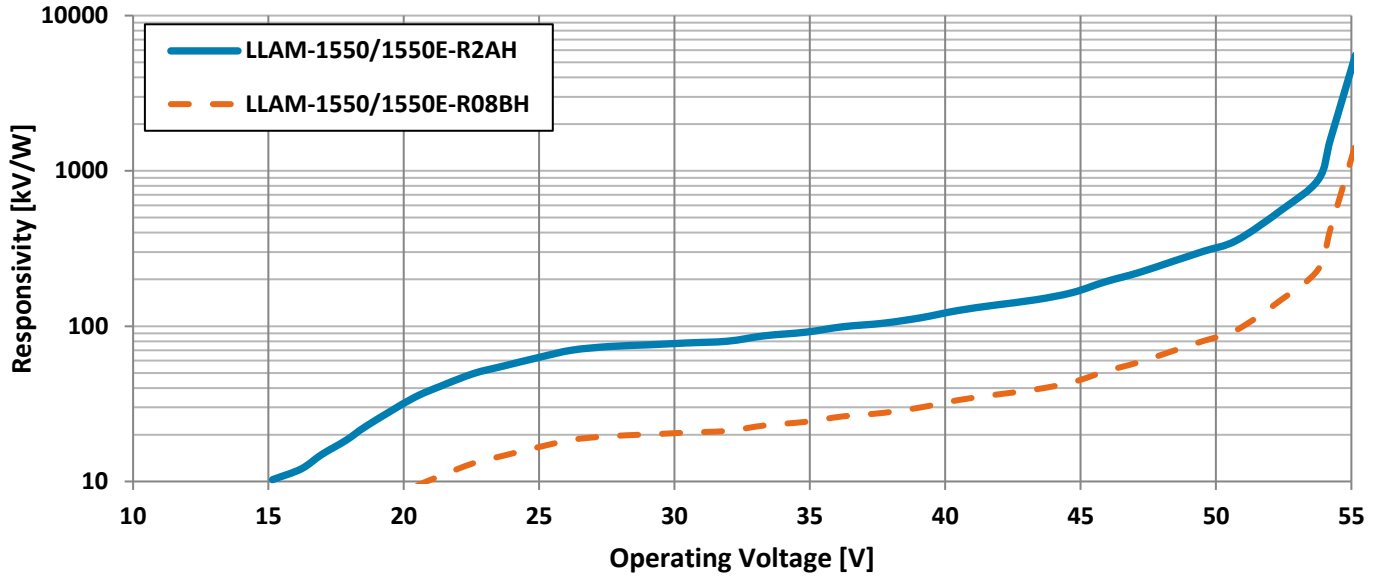
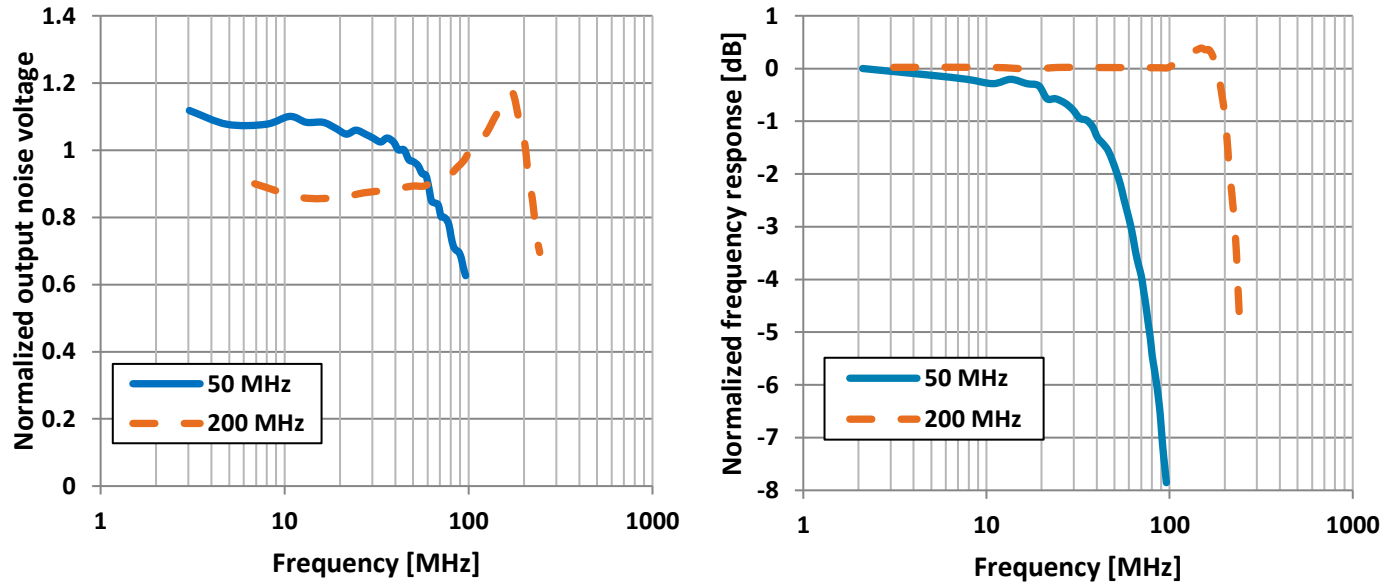


Figure 5. Typical Noise and Frequency response curves

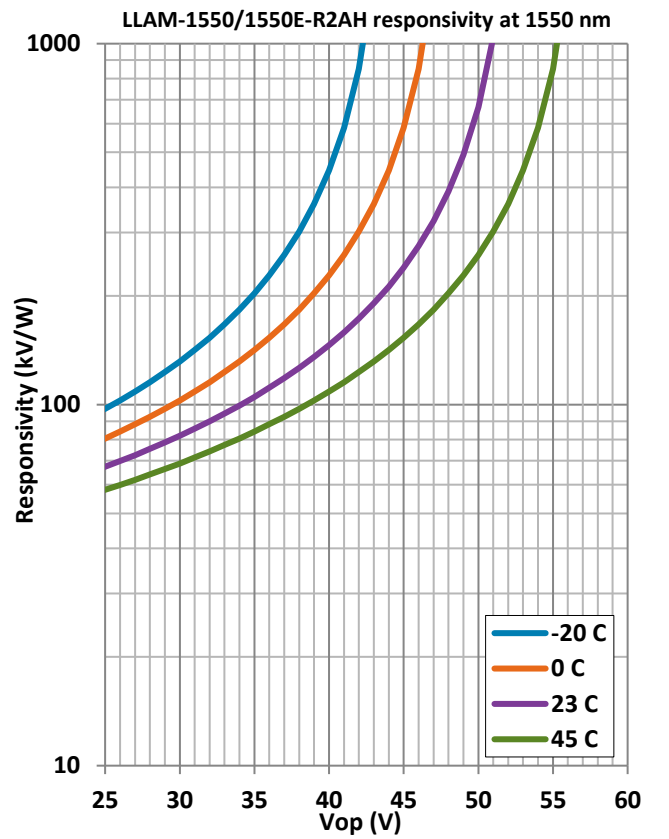
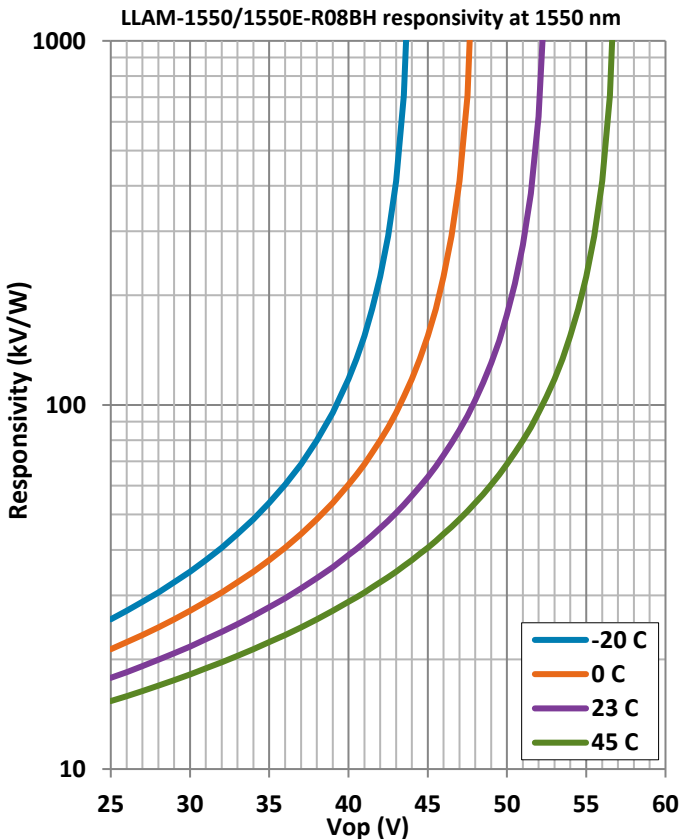
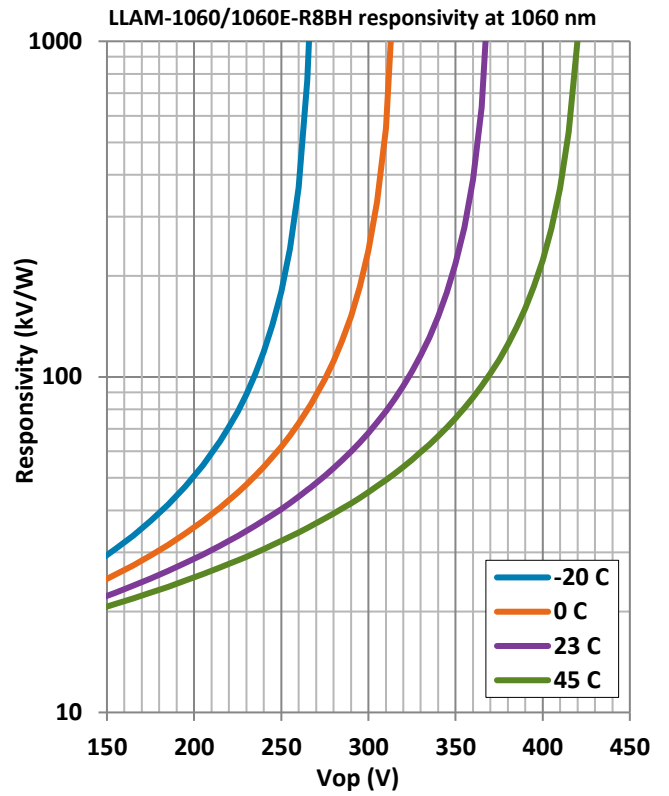
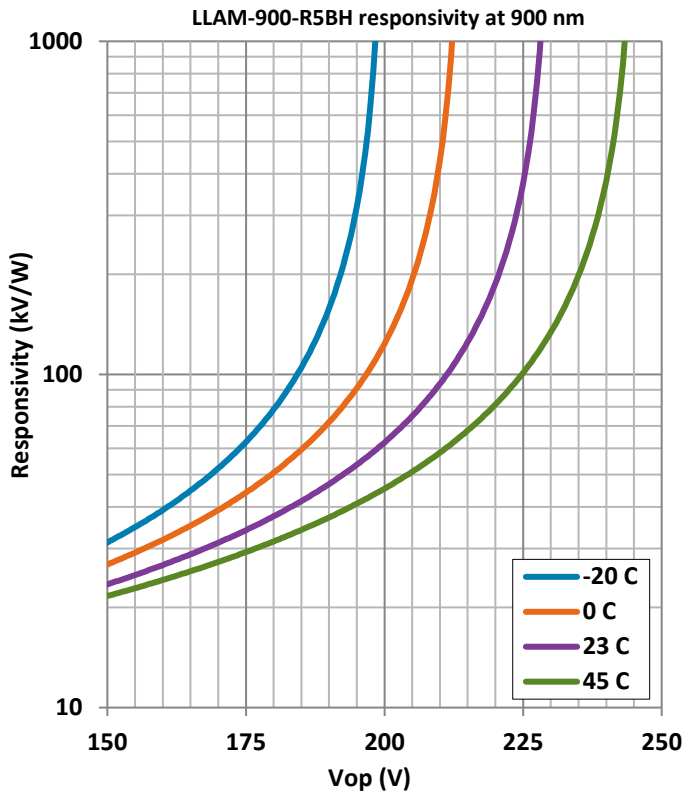


Output voltage noise normalization is calculated using the following formula:

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

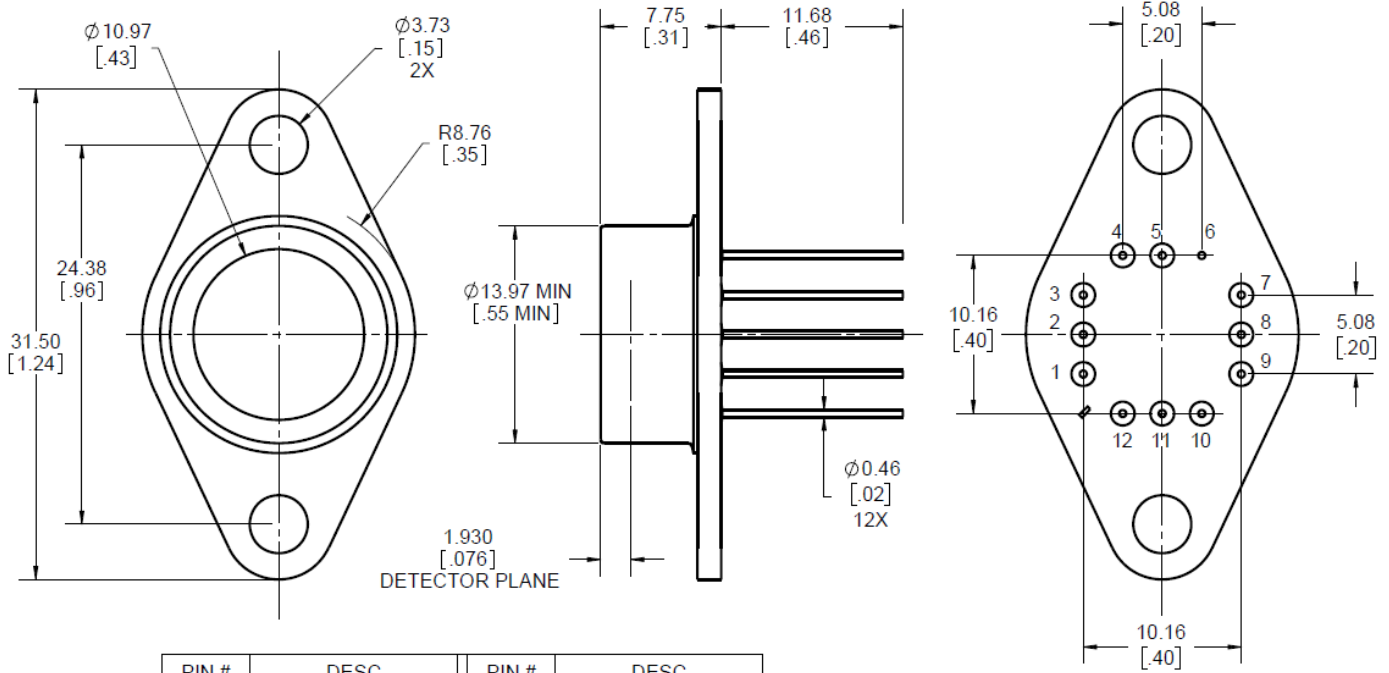
Si and InGaAs Low-Light Analog APD Receiver Modules (LLAM)

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



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

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

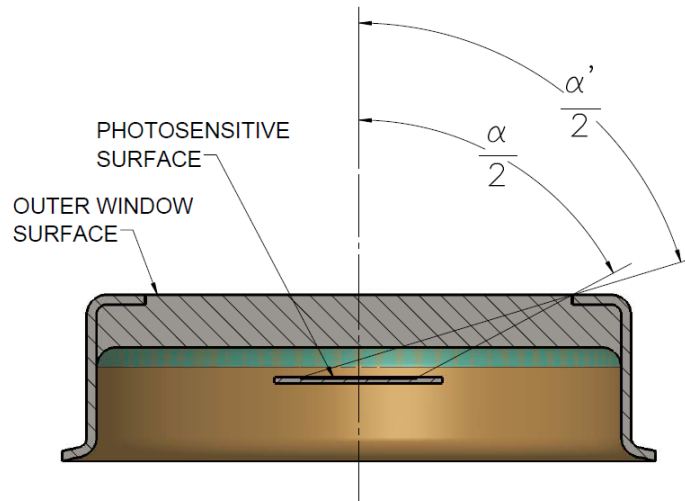
DIMENSIONS ARE IN MILLIMETERS [INCHES]
AND ARE FOR REFERENCE ONLY

VS-379R3

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

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

Table 4. Ordering Guide

| Model | Nominal Bandwidth | Wavelength Response | Detector Type | Detector Material | Active Diameter | Comments |
|------------------|-------------------|---------------------|---------------|---------------------------|-----------------|---------------------------|
| LLAM-900-R5BH | 200 MHz | 900 nm (peak) | 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 (peak) | 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 | | |

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.



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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