

## C30645 and C30662 – 1000 nm to 1700 nm Applications

### Large Area and Low Noise InGaAs Avalanche Photodiode



#### Key Features

- Spectral response 1000 nm – 1700 nm
- High responsivity
- Low dark current and noise
- Large active areas of 80  $\mu\text{m}$  and 200  $\mu\text{m}$
- Compact, robust, TO, ceramic and SMT package
- Available with AR-coated windows
- Customizations (e.g. filters) possible
- Resistant to very high optical inputs

#### Benefits

- Increased range for LiDAR, laser scanners and range finders
- High volume SMD packages
- Improved SNR for optical time-domain reflectometer (OTDR)
- Space-qualified optical communication systems

*Excelitas' C30645 and C30662 series Avalanche Photodiodes are high speed, large area InGaAs APDs that provide high quantum efficiency and high responsivity at low noise.*

Excelitas Technologies' C30645 and C30662 Series APDs are high speed, large area InGaAs/InP avalanche photodiodes. These devices provide large quantum efficiency (QE), high responsivity and low noise in the spectral range between 1000 nm and 1700 nm. They are optimized at wavelengths of 1300 nm and 1550 nm, suitable for use in eye-safe laser range-finding and LiDAR systems.

A new enhanced low-noise option of these diodes features unparalleled noise figures that take advantage of recent improvements in our III/V wafer growth and processing architecture, enabling cutting-edge noise specifications, providing our customers with better Signal-to-Noise-Ratios (SNR), and therefore increased range from the same laser output power.

These APDs are supplied in a hermetically sealed TO-18 package, on a ceramic carrier, or in a ceramic surface mount package, which allows for easy integration into high volume applications.

Utilizing the AR coated Si window option, helps the reduction of noise from ambient light levels below 1100 nm.

Recognizing that different applications have different performance requirements, Excelitas offers a wide range of customization of these photodiodes to meet your design challenges. Responsivity and noise screening, custom device testing and incorporating band pass filters are among the application-specific solutions available.

All devices undergo extended burn-in and periodic process qualification programs to assure high reliability.



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All specifications refer to an ambient temperature of  $T_A = 22\text{ }^\circ\text{C}$ ,  $\lambda = 1550\text{ nm}$ , and  $M = 10$ , unless otherwise specified.

**Table 1: Electro-Optical Specifications 80  $\mu\text{m}$  C30645 Series**

Parameter		Symbol	Minimum	Typical	Maximum	Units
Rise Time / Fall Time <sup>1</sup>		$t_r / t_f$		0.3		ns
Bandwidth		$f_{3dB}$	1000			MHz
Capacitance	TO-can	C		1.25	1.5	pF
	SMD			1.34	1.5	
Dark Current <sup>2</sup>	Standard	$i_D$		2.5	15	nA
	Low Noise			1	5	
Dark Noise <sup>3</sup>	Standard	$i_N$		0.2	0.6	$\text{pA}/\sqrt{\text{Hz}}$
	Low Noise			0.1	0.25	
Noise Equivalent Power <sup>4</sup>	Standard	NEP		25	64	$\text{fW}/\sqrt{\text{Hz}}$
	Low Noise			11	26	
Operating Gain <sup>5</sup>		M	10	20		

**Table 2: Electrical Specifications 200  $\mu\text{m}$  C30662 Series**

Parameter		Symbol	Minimum	Typical	Maximum	Units
Rise Time / Fall Time <sup>1</sup>		$t_r / t_f$		0.4		ns
Bandwidth		$f_{3dB}$	600	850		MHz
Capacitance	TO-can	C		2.35	2.5	pF
	SMD			2.45	2.7	
Dark Current <sup>2</sup>	Standard	$i_D$		13	35	nA
	Low Noise			7.5	15	
Dark Noise <sup>3</sup>	Standard	$i_N$		0.45	1	$\text{pA}/\sqrt{\text{Hz}}$
	Low Noise			0.35	0.5	
Noise Equivalent Power <sup>4</sup>	Standard	NEP		48	106	$\text{fW}/\sqrt{\text{Hz}}$
	Low Noise			37	53	
Operating Gain <sup>5</sup>		M	10	20		
Operating Point from Breakdown <sup>6</sup>		$\Delta V$	4			V

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**Table 3: Common Specifications**

Parameter	Symbol	Minimum	Typical	Maximum	Units
Breakdown Voltage	$V_{BD}$	45	50	70	V
Spectral Range	$\Delta\lambda$	1000		1700	nm
Quantum Efficiency <sup>7,8</sup>	QE	75			%
Responsivity @1550 nm	R	9.3			A/W
Temperature Coefficient of $V_{BD}$	$\Delta V/\Delta T$		0.14	0.2	V/°C

**Note 1:** As estimated by  $t_{r/f} = \frac{0.35}{f_{3dB}}$ .

**Note 2:** Surface ( $i_{DS}$ ) and bulk ( $i_{DB}$ ) dark current are contributing to the total dark current by  $i_D = i_{DS} + i_{DB}M$ .

**Note 3:** Due to the natural fluctuations of amplified charge carriers the APD will also generate noise when not illuminated. Since the noise characteristics and hence the signal-to-noise ratio (SNR) are dependent on the bandwidth ( $f_{3dB}$ ) and operating wavelength ( $\lambda$ ) inside the final system the illuminated noise

$$i_{ill} = \sqrt{2qf_{3dB}[i_{DS} + (i_{DB}M^2 + R_0(\lambda)M^2P)F]}$$

needs to be considered. Hence the SNR defines as

$$SNR = \frac{i_P^2}{i_{ill}^2} = \frac{(PR_0(\lambda)M)^2}{i_{ill}^2}$$

with P the incident optical power in W,  $R_0(\lambda)$  the intrinsic ( $M = 1$ ) responsivity in A/W, q the carrier charge, and F the excess noise factor.

**Note 4:** The NEP is specified in dark conditions as  $NEP = \frac{i_N}{R(\lambda)}$ .

**Note 5:** These APDs can be operated at significant higher gains, but with values of dark noise correspondingly higher, as indicated in Note 3.

**Note 6:** Only C30662ECERH-1 and C30662EH-1.

**Note 7:** 1300 nm – 1550 nm.

**Note 8:** Quantum Efficiency is a not directly measurable quantity. The above specified typical parameter is linked to the typical responsivity by  $QE = \frac{1240 R}{\lambda M}$ . Please also refer to Figure 1.

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**Table 4: Absolute Maximum Ratings**

Parameter	Symbol	Value	Units
Forward Current	$I_F$	20	mA
Reverse Current	$I_R$	2	mA
Total Power Dissipation	$P_{tot}$	120	mW
Optical Damage Threshold <sup>3</sup>	$PD_{opt}$	10	MW/cm <sup>2</sup>
Storage Temperature	$T_S$	-60 ... 125	°C
Operating Temperature	$T_{Op}$	-40 ... 85	°C
Soldering Temperature <sup>4</sup>	$T_P$	250	°C

**Note 1:** Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device.

**Note 2:** Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Note 3:** Laser Operating Conditions: Pulse width = 5 ns, Repetition rate = 10 kHz.

**Note 4:** For detailed reflow information, refer to Table 6.

**Table 5: Ordering Information**

#### 5a C30645 series - 80 μm active area

Package Type	Figure	Window		Performance	Model
		Material	Aperture		
Ceramic Carrier	8	N/A	N/A		C30645ECERH
				low noise	C30645ECERH-7
Mini ceramic carrier	10	N/A	N/A		C30645ECMH
				low noise	C30645ECMH-7
TO-18, 2 pin	5	Silicon	Small <sup>2</sup>		C30645EH
				low noise	C30645EH-7
	7	Glass <sup>1</sup>	Large <sup>2</sup>		C30645EH-1
				low noise	C30645EH-17
TO-46, 3 pin	6	Glass <sup>1</sup>	Large <sup>2</sup>		C30645EH-2
				low noise	C30645EH-27
SMD	9	Glass <sup>1</sup>	N/A		C30645L-080
				low noise	C30645L-080-7
		Silicon			C30645L-080-1
				low noise	C30645L-080-17

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#### 5b C30662 series - 200 $\mu\text{m}$ active area

Package Type	Figure	Window		Performance	Model
		Material	Aperture		
Ceramic Carrier	8	N/A	N/A		C30662ECERH
				$\Delta V > 4\text{ V}$	C30662ECERH-1
				low noise	C30662ECERH-7
				$\Delta V > 4\text{V}$ , low noise	C30662ECERH-17
Mini ceramic carrier	10	N/A	N/A		C30662ECMH
				$\Delta V > 4\text{ V}$	C30662ECMH-1
				low noise	C30662ECMH-7
				$\Delta V > 4\text{V}$ , low noise	C30662ECMH-17
TO-18, 2 pin	7	Glass <sup>1</sup>	Large <sup>2</sup>		C30662EH
				$\Delta V > 4\text{ V}$	C30662EH-1
low noise	C30662EH-7				
TO-18, 2 pin	5		Small <sup>2</sup>	low noise, $\Delta V > 4\text{ V}$	C30662EH-137
				C30662EH-3	
		Silicon	Small <sup>2</sup>		C30662EH-5
		TO-46, 3 pin	6	Glass	Large <sup>2</sup>
low noise	C30662EH-27				
SMD	9	Glass	N/A		C30662L-200
				low noise	C30662L-200-7
		Silicon			C30662L-200-1
				low noise	C30662L-200-17

**Note 1:** Glass material is transparent for visible and IR wavelengths, while silicon blocks visible light up to approximately 1.1  $\mu\text{m}$ .

**Note 2:** AR-coated window.

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Figure 1: Typical Responsivity at M=10 and Quantum Efficiency vs. Wavelength

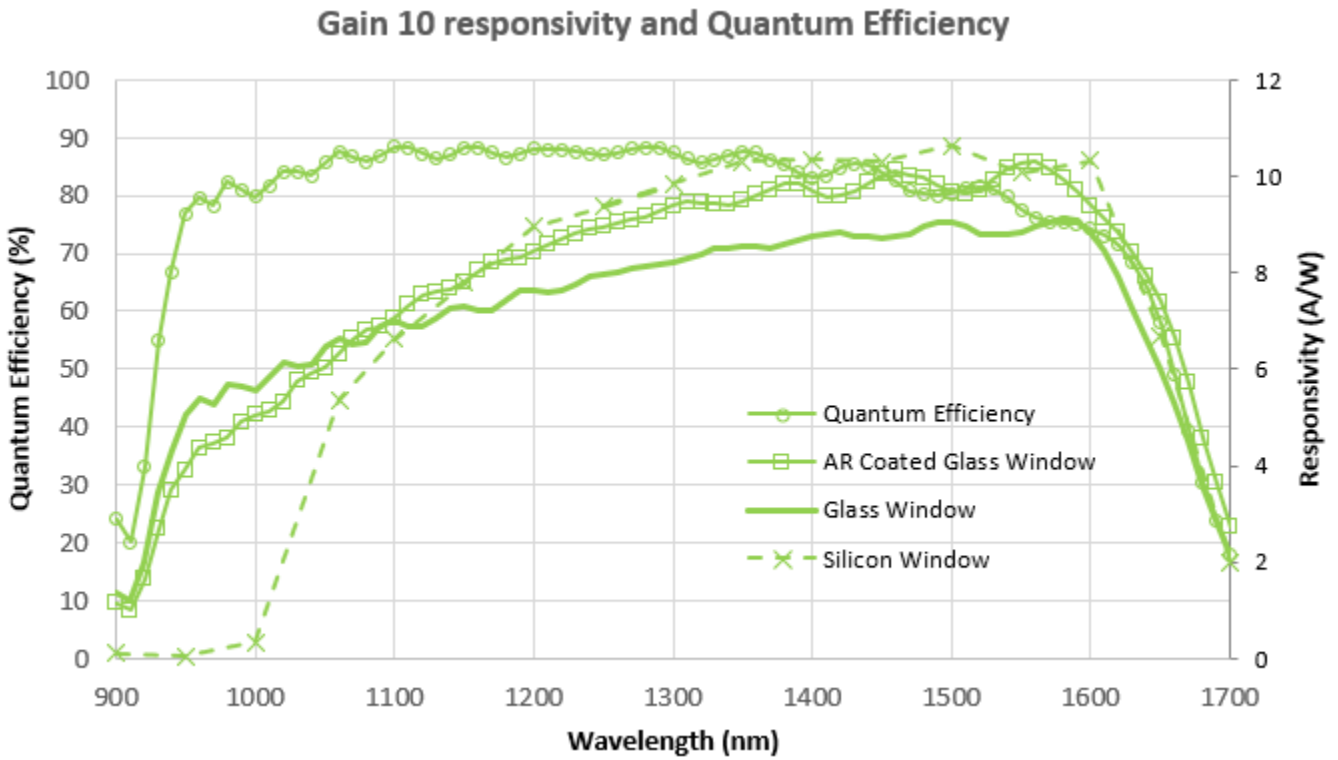
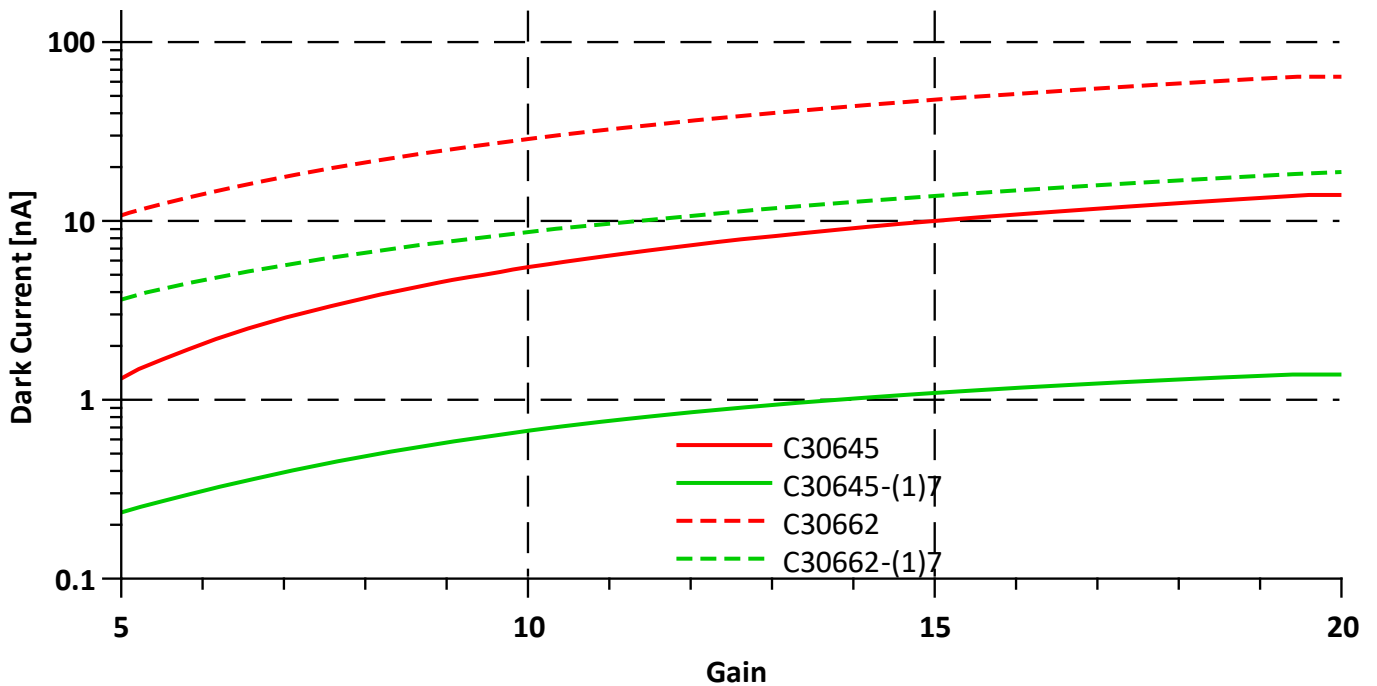


Figure 2: Typical Dark Current



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Figure 3: Typical Gain vs. Reverse Bias

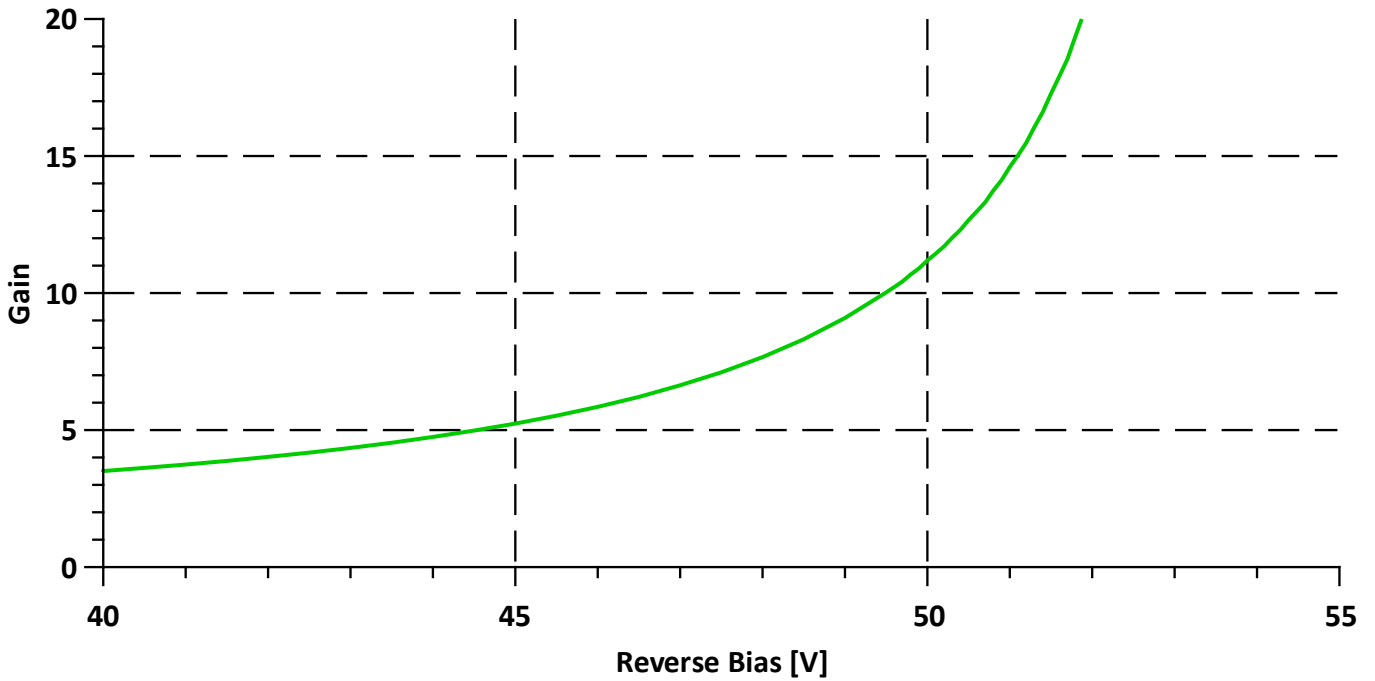
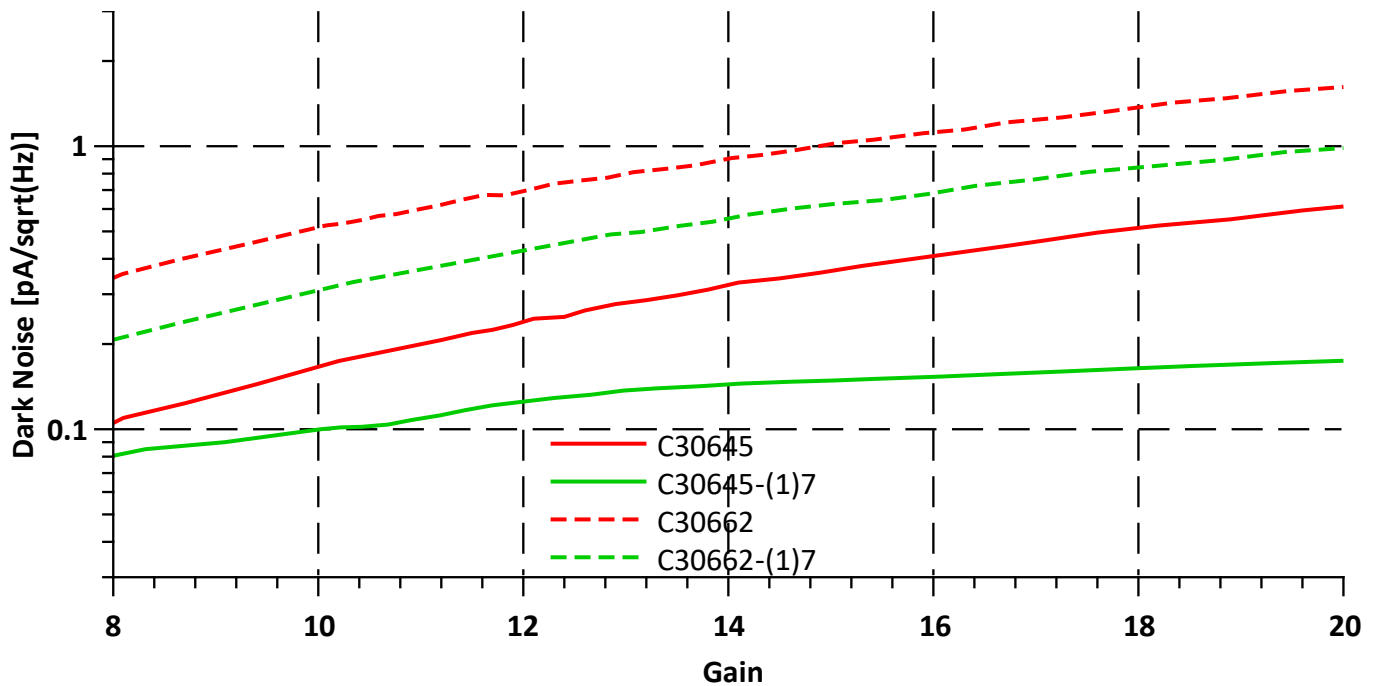


Figure 4: Typical Dark Noise vs. Gain



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Figure 5: Small Aperture TO-18 Dimensions

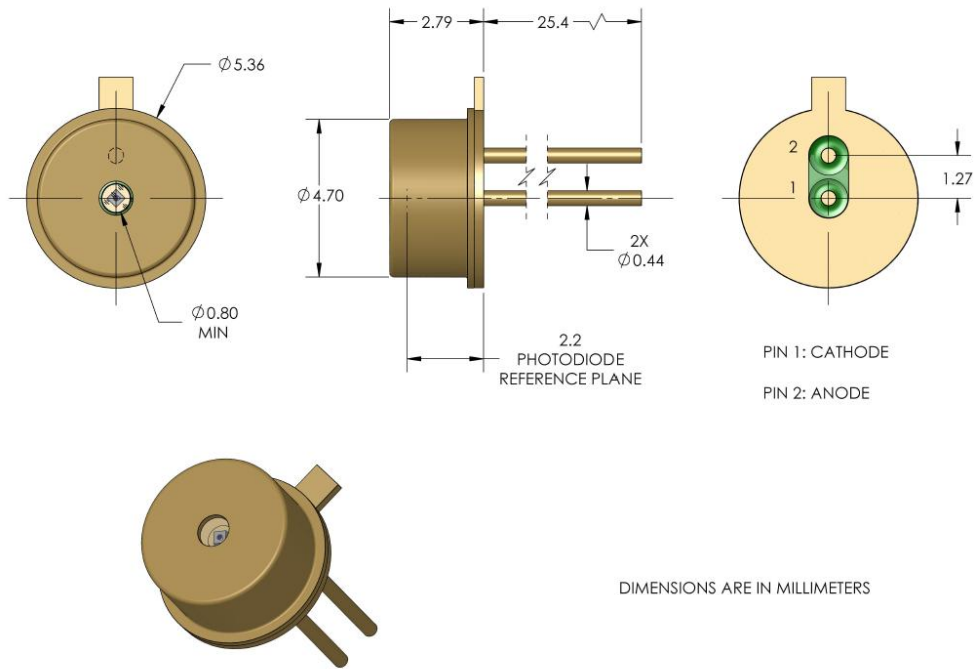
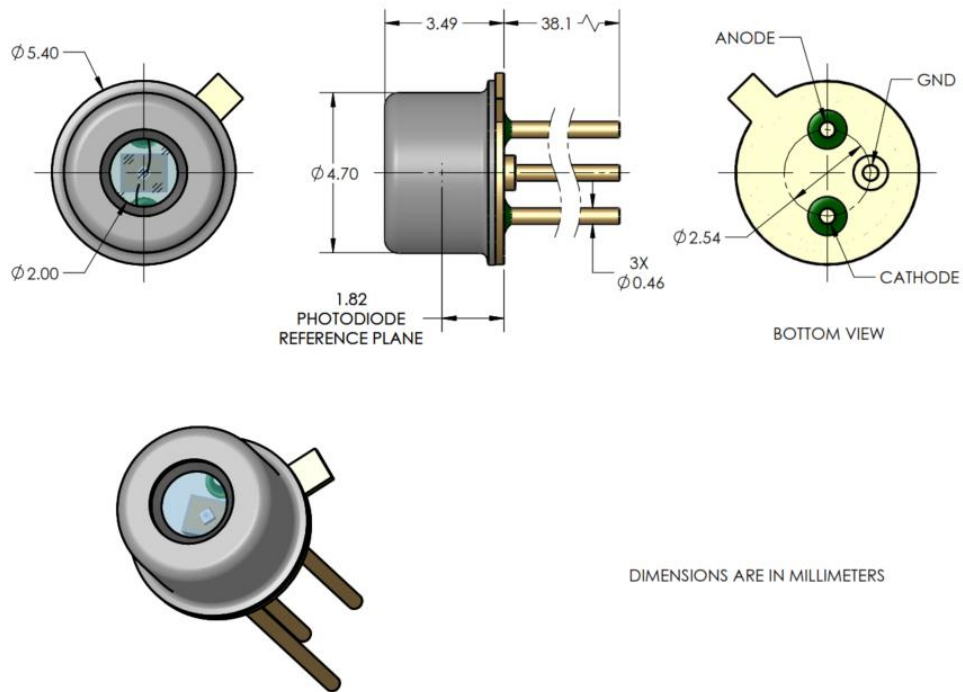


Figure 6: Large Aperture 3-pin TO-46 Dimensions



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Figure 7: Large Aperture 2-pin TO-18 Dimensions

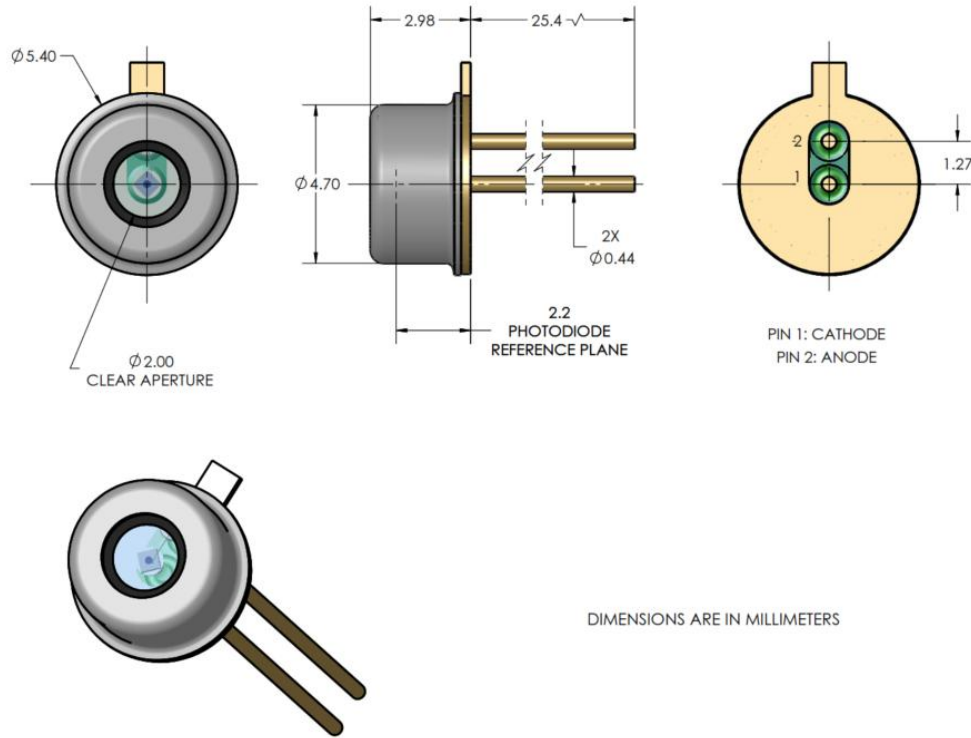
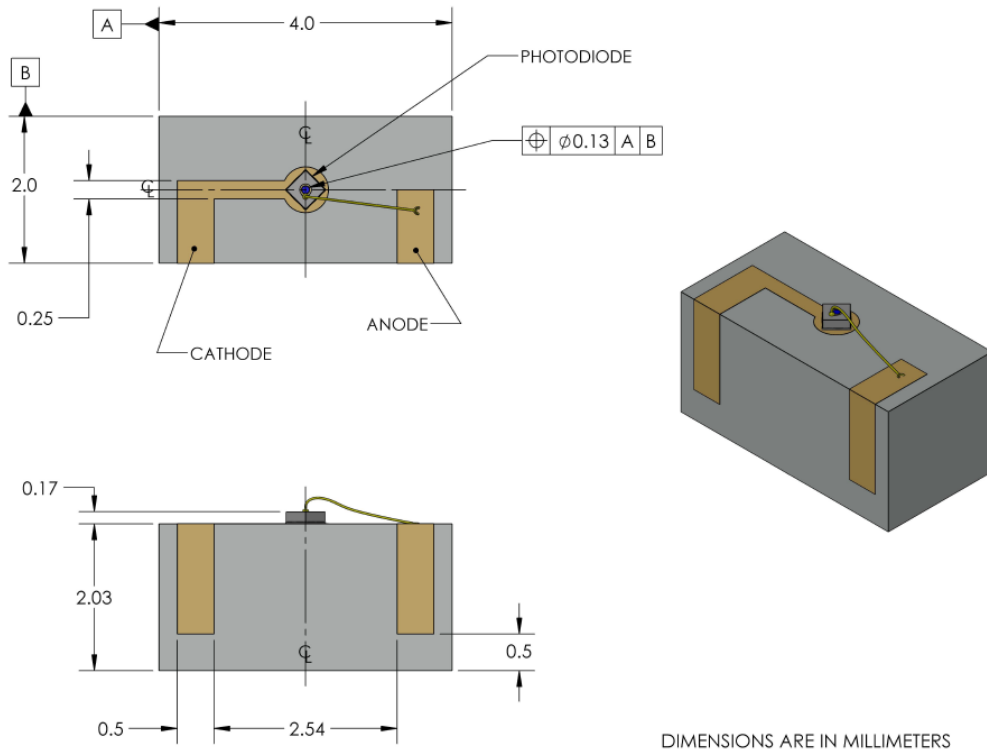


Figure 8: Ceramic Carrier Package Dimension C30645ECERH and C30662ECERH



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Figure 9: SMD Package Dimension C30645L-080 and C30662L-200

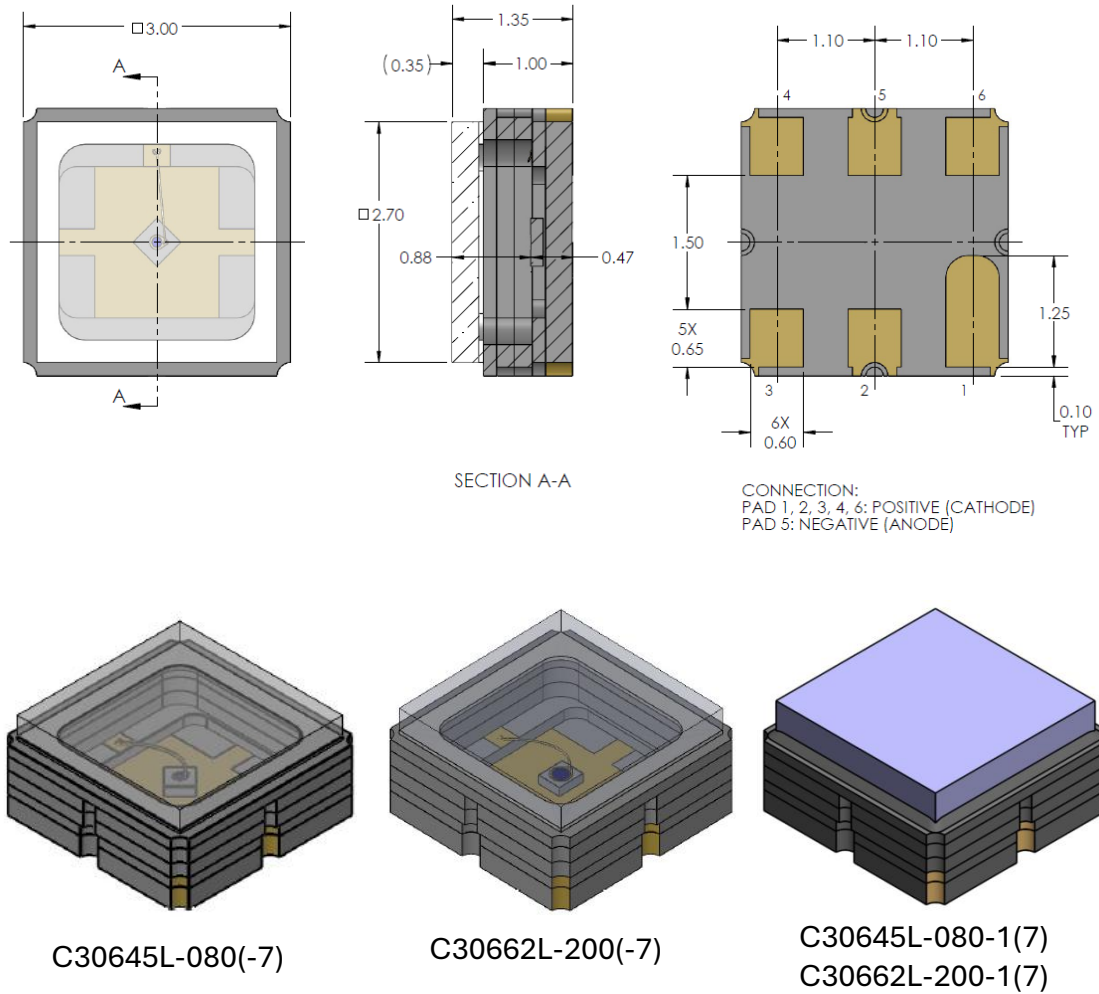
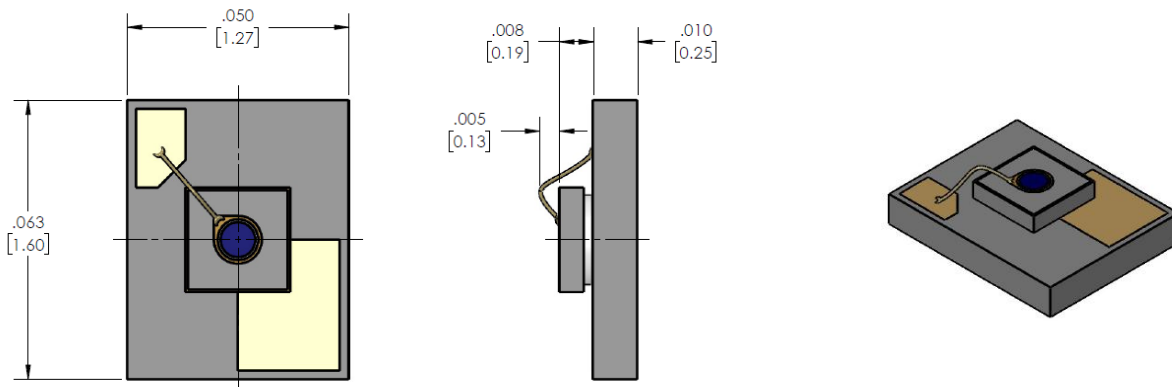


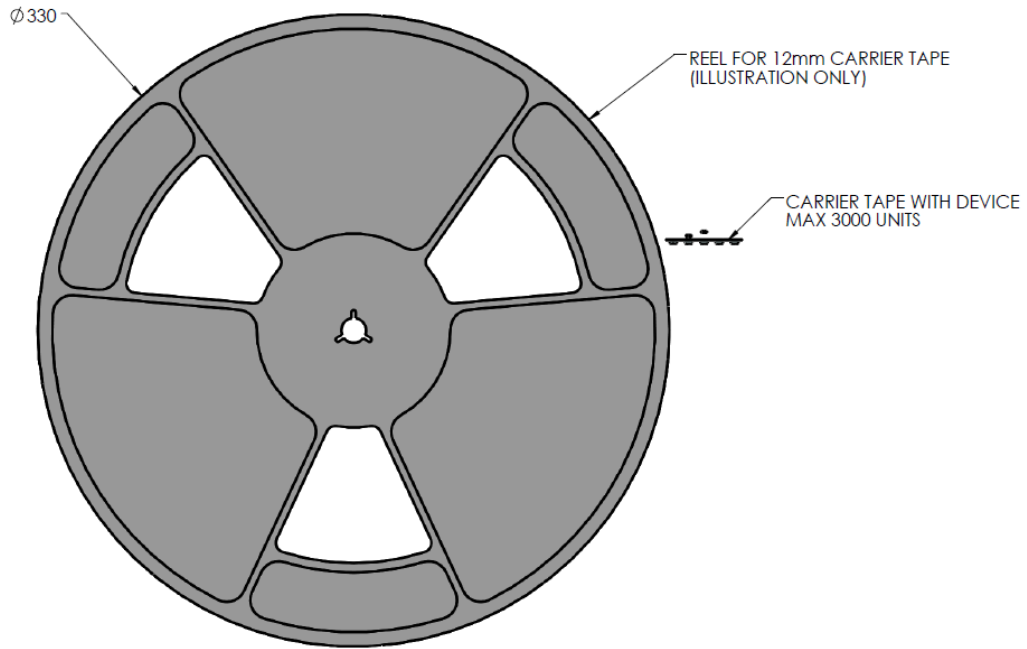
Figure 10: Mini ceramic top-looking package dimension C30645ECMH and C30662ECMH



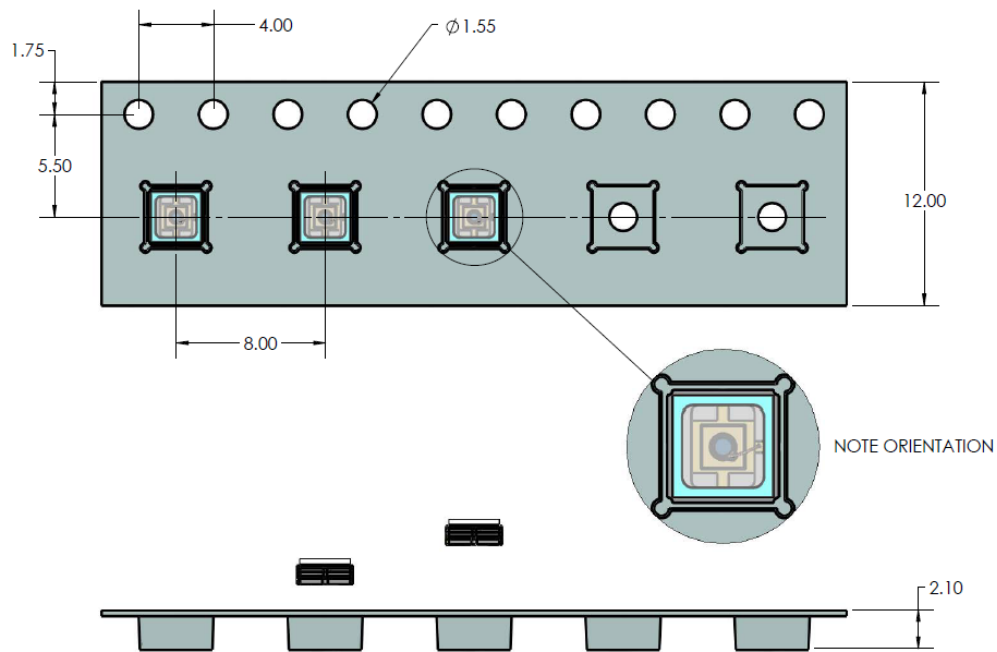
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Figure 11: Tape and Reel Packaging Specification



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#### Testing Methods

Excelitas verifies the electro optical specifications on every device. Hence, the supplied test report shows the specific operating voltage,  $V_{OP}$ , for each device. Operating the diode at this voltage (at 22 °C), will meet the electrical specifications shown above. The voltage will be within the range of the breakdown Voltage  $V_{BD}$ .

Our quality standard includes visual inspection during fabrication and removal of failed dies.

The following parameters are part of Excelitas testing procedures:

- Breakdown Voltage
- Reach-Through Voltage
- Operating Voltage (M = 10)
- Dark Current (M = 10)

Excelitas Technologies meets the certification requirements of ISO-9001 and design criteria to meet MIL-STD-883 and/or MIL-STD-750 specifications.

#### Packaging and Shipping

Parts in TO-18 are shipped in individually sealed plastic packages.

SMD parts are shipped in tape and reel packs for quantities of 3000 units per reel; as shown in Figure 10.

For sampling quantities, the SMD parts are shipped in Gel Pack packages.

#### Storage and handling

Excelitas highly recommends following the below notes:

- Keep devices in an ESD controlled environment until final assembly.
- Keep T&R closed until final assembly.
- Remove devices from T&R by using a vacuum pick-up tool.
- If a manual picking method is necessary, use a non-marring tweezer to pick the APD by the sides of the package.
- Do not make contact to the window surface.

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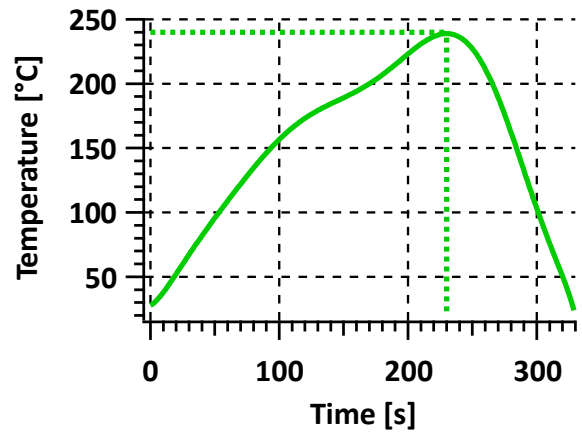
#### MSL Rating

The series of APD diodes in SMD package comply with a moisture sensitivity level (MSL) rating of 3 as defined in IPC/JEDEC-J-STD-033C. This allows for up to 168 hours floor life at  $\leq 30\text{ }^{\circ}\text{C}$  / 60% RH once removed from the sealed reel packaging. For complete details refer to the IPC/JEDEC-J-STD-033C specification.

#### Table 6: Reflow Solder Profile

The following reflow solder profile is a typically used profile for SAC305 solder alloys and is recommended for SMD packaged devices. Specific solder parameters depend on the solder alloy used.

Profile Feature	Symbol	Typical	Units
Minimum Sparkling Temperature	$T_{Smin}$	150	$^{\circ}\text{C}$
Maximum Sparkling Temperature	$T_{Smax}$	200	$^{\circ}\text{C}$
Sparkling Time	$t_s$	75	s
Minimum Reflow Temperature	$T_L$	217	$^{\circ}\text{C}$
Peak Temperature	$T_P$	244	$^{\circ}\text{C}$
Reflow Time	$t_L$	65	s
Time within $T_P - 5^{\circ}\text{C}$	$t_P$	25	s
Ramp Down Rate	$\Delta T_c$	2	$^{\circ}\text{C}/\text{s}$



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#### RoHS Compliance

This series of APD diodes is fully compliant with the European Union Directive on restrictions of the use of certain hazardous substances 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.

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