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 µm and 200 µm
- 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 are referring to an ambient temperature of T_A = 22 °C, λ = 1550 nm, and M = 10, unless otherwise specified.

Table 1: Electro-Optical Specifications 80 µm C30645 Series

Parameter		Symbol	Minimum	Typical	Maximum	Units
Rise Time / Fall Time[1]		t_r / t_f		0.3		ns
Bandwidth		f_{3dB}	1000			MHz
Capacitance	Standard	C		1.25		pF
	SMD			1.45		
Dark Current[2]	Standard	i_D		2.5	15	nA
	Low Noise			1	5	
Dark Noise[3]	Standard	i_N		0.2	0.6	pA/√(Hz)
	Low Noise			0.1	0.25	
Noise Equivalent Power[4]	Standard	NEP		25	64	fW/√(Hz)
	Low Noise			11	26	
Operating Gain[5]		M	10	20		

Table 2: Electrical Specifications 200 µm C30662 Series

Parameter		Symbol	Minimum	Typical	Maximum	Units
Rise Time / Fall Time[1]		t_r / t_f		0.4		ns
Bandwidth		f_{3dB}	600	850		MHz
Capacitance	Standard	C		2.5		pF
	SMD			2.7		
Dark Current[2]	Standard	i_D		13	35	nA
	Low Noise			7.5	15	
Dark Noise[3]	Standard	i_N		0.45	1	pA/√(Hz)
	Low Noise			0.35	0.5	
Noise Equivalent Power[4]	Standard	NEP		48	106	fW/√(Hz)
	Low Noise			37	53	
Operating Gain[5]		M	10	20		
Operating Point from Breakdown[6]		ΔV	4			V

Table 3: Common Specifications

Parameter	Symbol	Minimum	Typical	Maximum	Units
Breakdown Voltage	V_{BD}	45	50	70	V
Spectral Range	Δλ	1000		1700	nm
Quantum Efficiency[7,8]	QE	75			%
Responsivity @1550 nm	R	9.3			A/W
Temperature Coefficient of V_{BD}	ΔV/ΔT		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 (λ) 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

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

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.

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[3]	PD_{opt}	10	MW/cm²
Storage Temperature	T_S	-60 … 125	°C
Operating Temperature	T_{Op}	-40 … 85	°C
Soldering Temperature[4]	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.

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Table 5: Ordering Information

C30645 series - 80 µm active area

Model	Package Type	Figure	Window		Comments
			Material	Aperture	
C30645ECERH	Ceramic Carrier	8	N/A	N/A	
C30645EH	TO-18	5	Silicon	Small[2]	
C30645EH-1		7	Glass[1]	Large[2]	
C30645EH-2	TO-46	6			3. ground pin
C30645EH-7	TO-18	7			low noise
C30645EH-27	TO-46	6			low noise, 3. ground pin
C30645L-080	SMD	9	Glass[1]	N/A	
C30645L-080-1			Silicon		
C30645L-080-7			Glass		low noise
C30645L-080-17			Silicon		

C30662 series - 200 µm active area

Model	Package Type	Figure	Window		Comments
			Material	Aperture	
C30662ECERH	Ceramic Carrier	8	N/A	N/A	
C30662ECERH-1					ΔV > 4 V
C30662EH	TO-18	7	Glass[1]	Large[2]	
C30662EH-1					ΔV > 4 V
C30662EH-2	TO-46	6			3. ground pin
C30662EH-137	TO-18	5		Small	low noise, ΔV > 4 V
C30662EH-3					
C30662EH-5			Silicon	Small[2]	
C30662EH-7		7	Glass[1]	Large[2]	low noise
C30662EH-27	TO-46	6			low noise, 3. ground pin
C30662L-200	SMD	9		N/A	
C30662L-200-1			Silicon		
C30662L-200-7			Glass[1]		low noise
C30662L-200-17			Silicon		

Note 1: Glass material is transparent for visible and IR wavelengths, while silicon blocks visible light up to about 1.1 µm.

Note 2: AR-coated window.

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

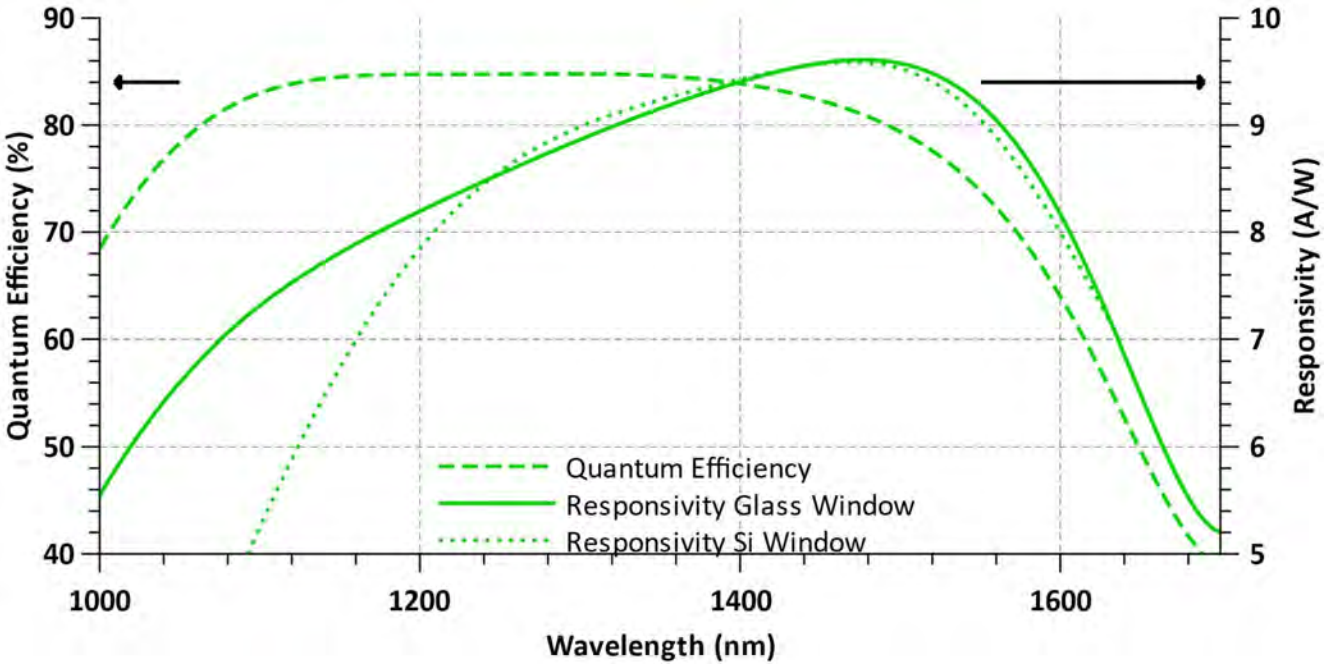


Figure 2: Typical Dark Current

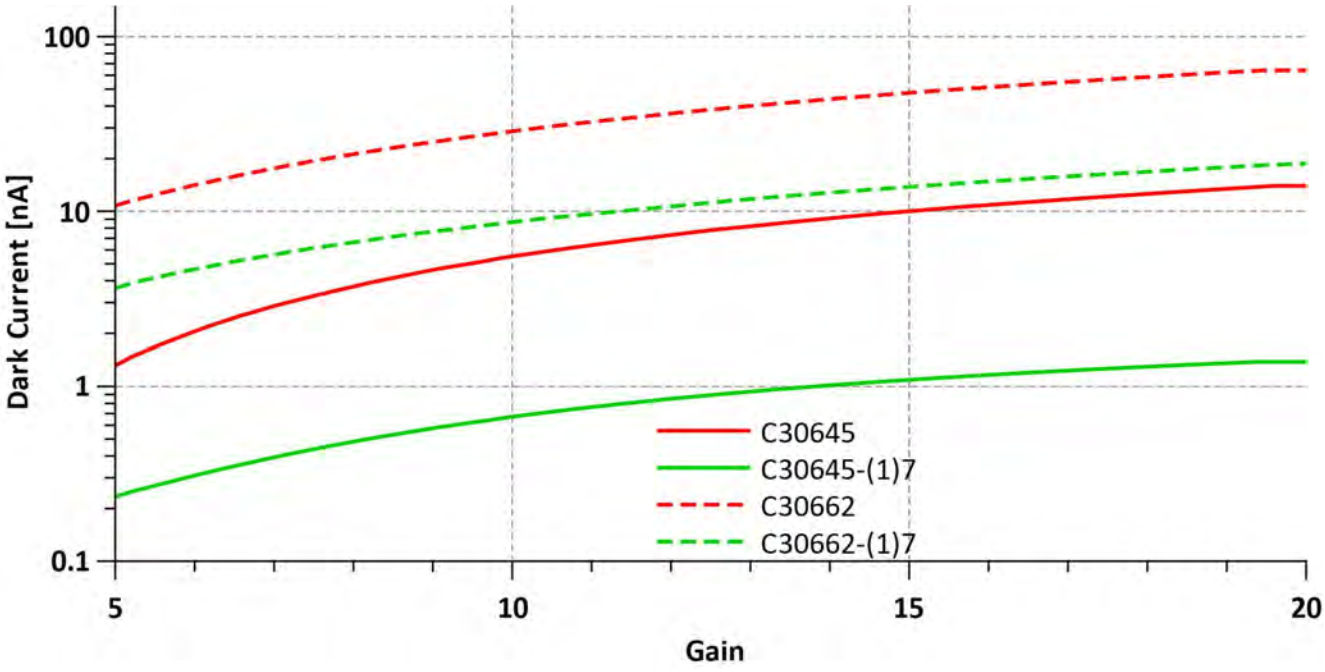


Figure 3: Typical Gain vs. Reverse Bias

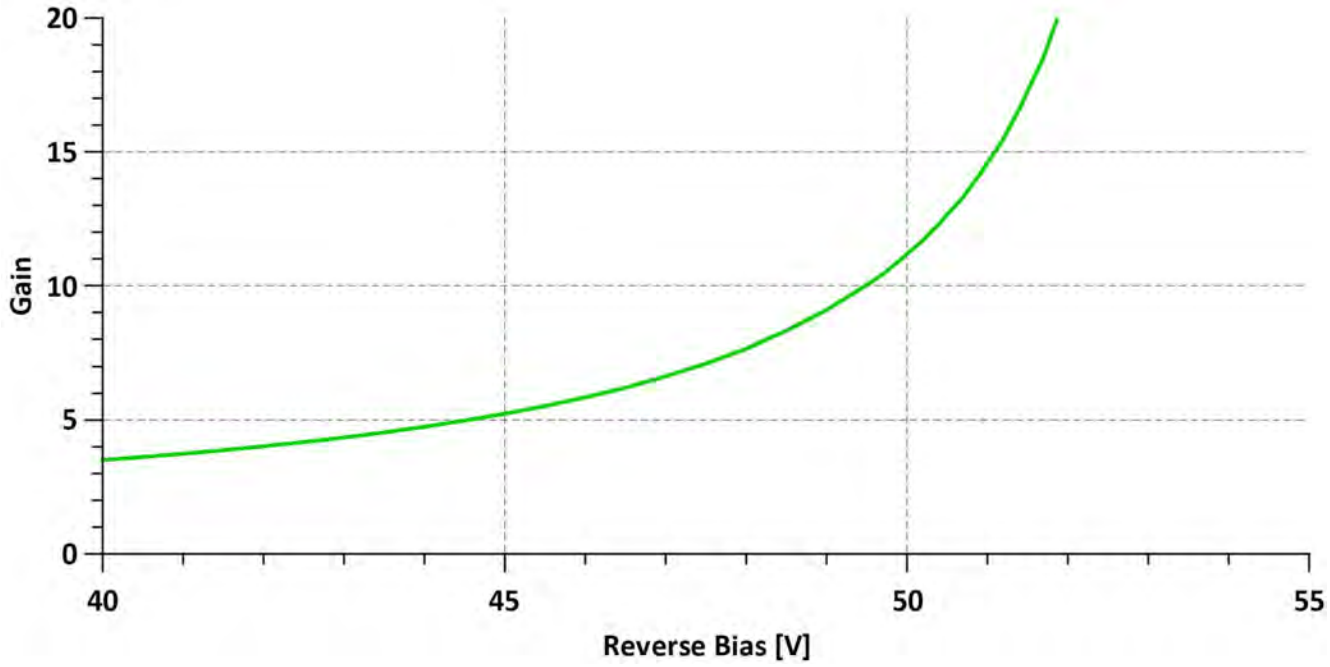


Figure 4: Typical Dark Noise vs. Gain

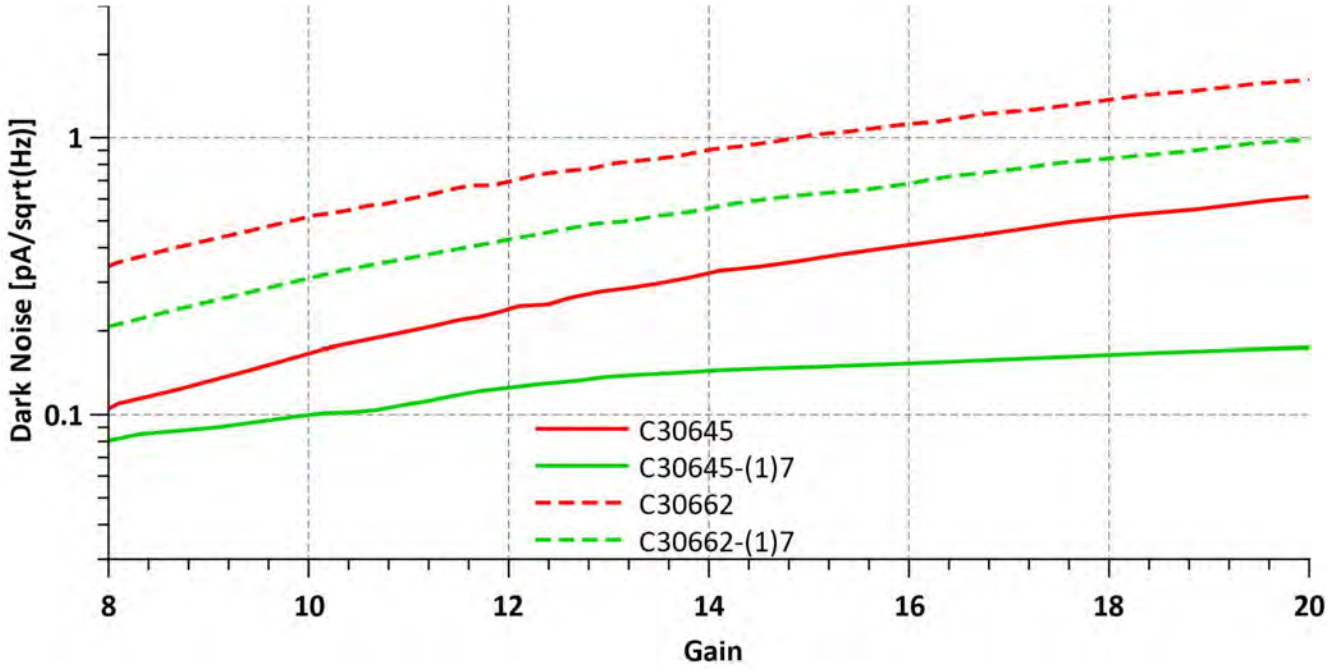


Figure 5: Small Aperture TO-18 Dimensions

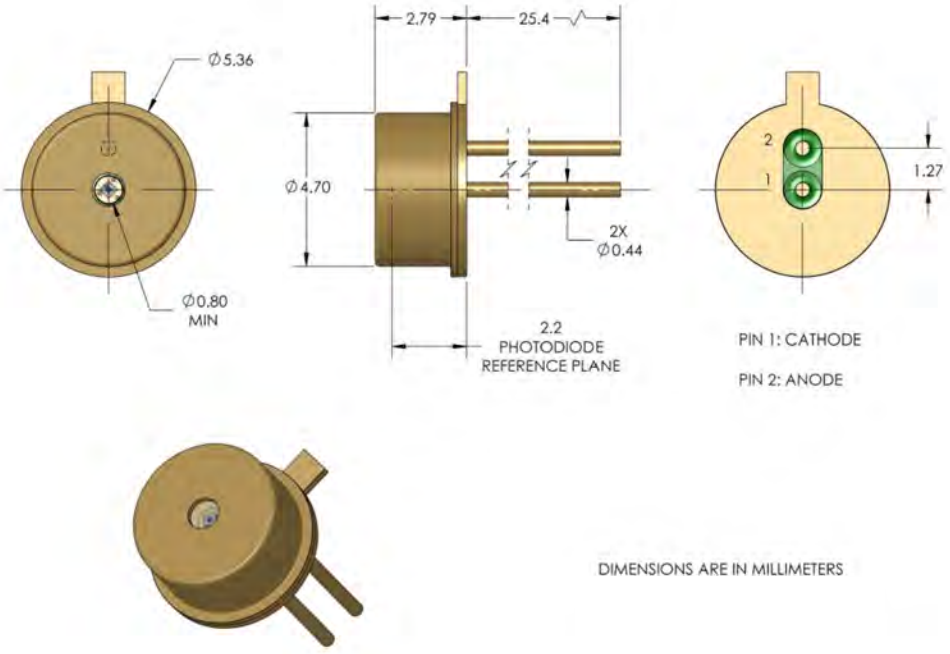


Figure 6: Large Aperture 3-pin TO-46 Dimensions

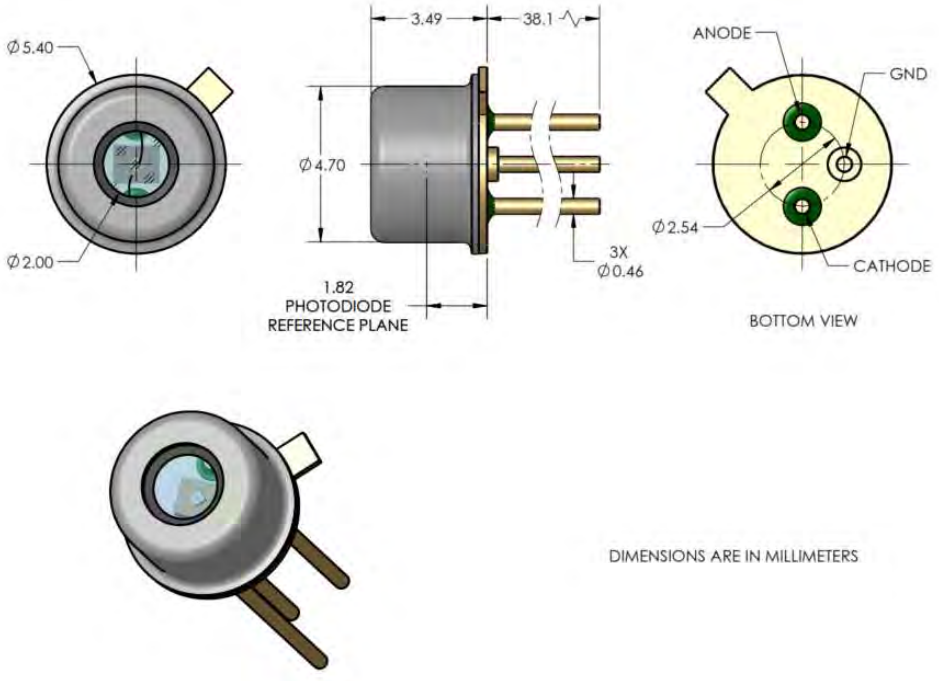


Figure 7: Large Aperture 2-pin TO-18 Dimensions

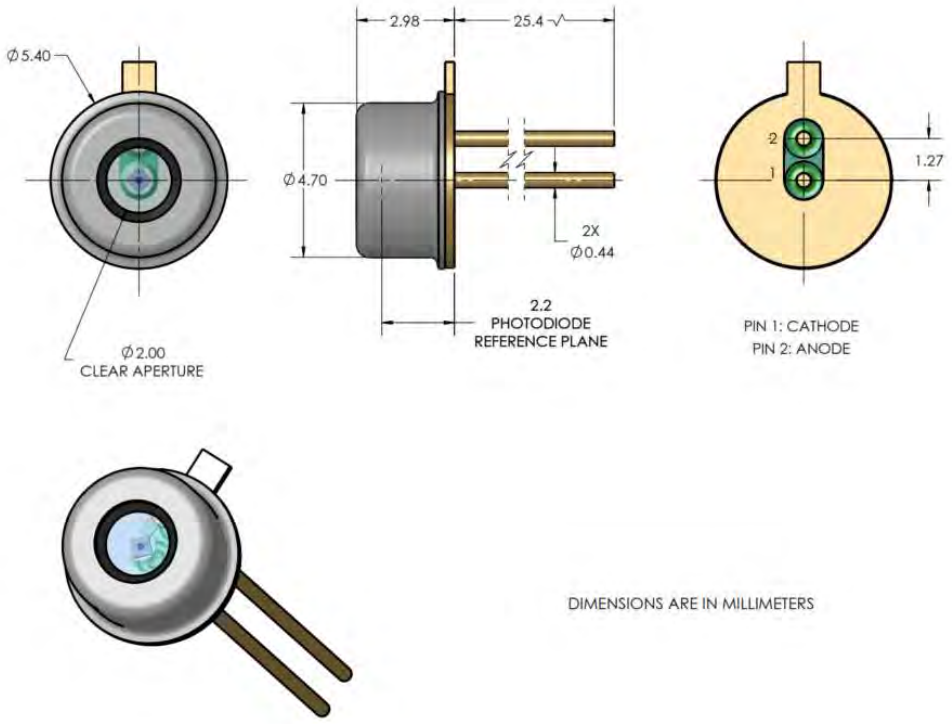


Figure 8: Ceramic Carrier Package Dimension C30645ECERH and C30662ECERH

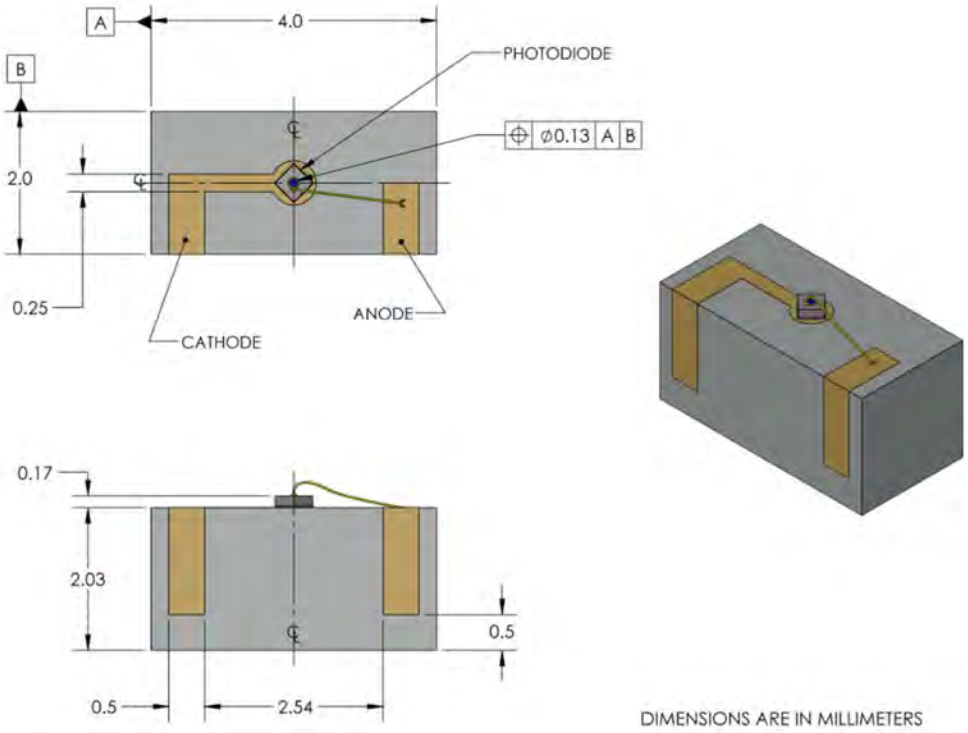
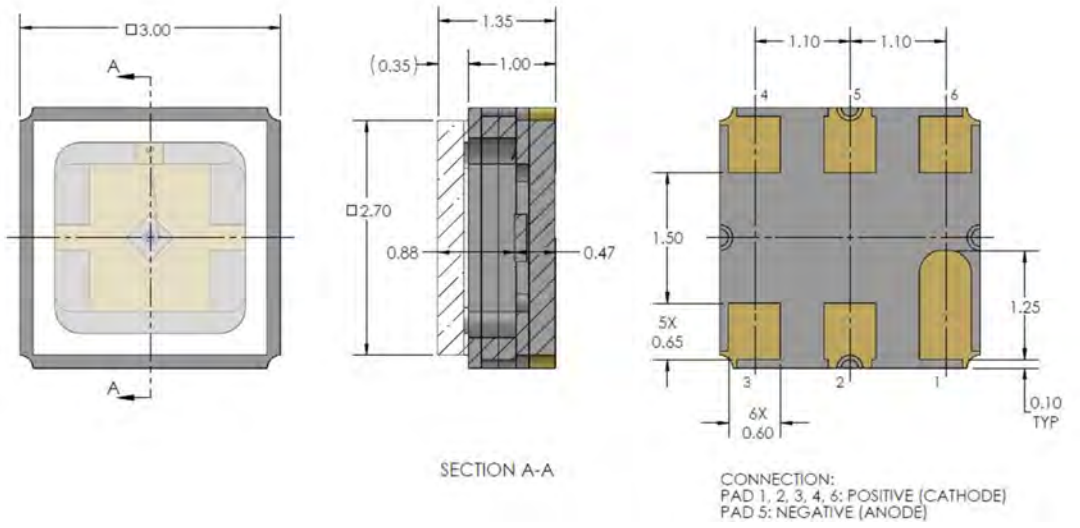
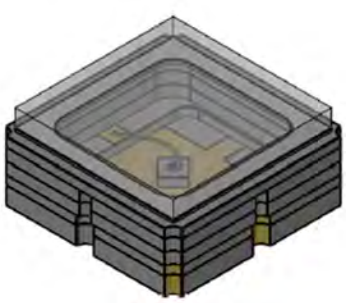
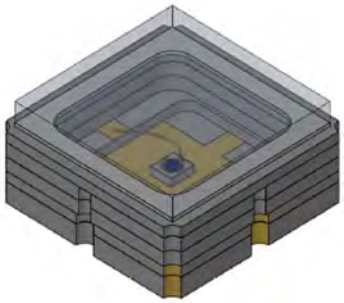


Figure 9: SMD Package Dimension C30645L-080 and C30662L-200

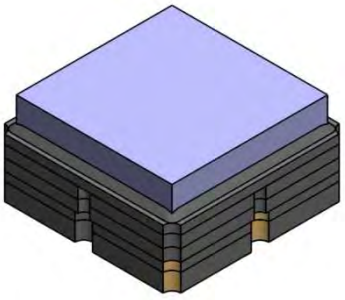




C30645L-080(-7)

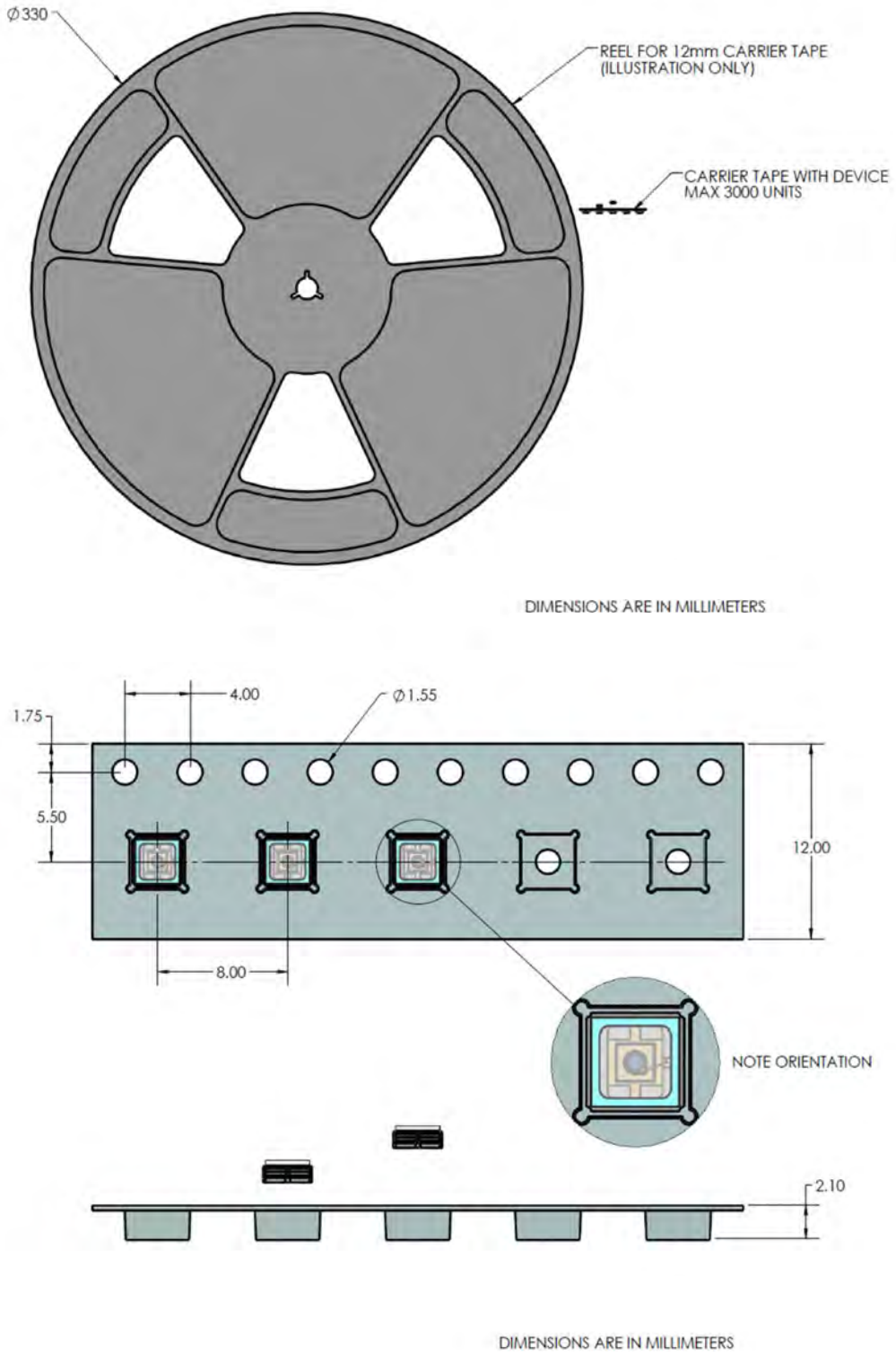


C30662L-200(-7)



C30645L-080-1(7)
C30662L-200-1(7)

Figure 10: Tape and Reel Packaging Specification



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.

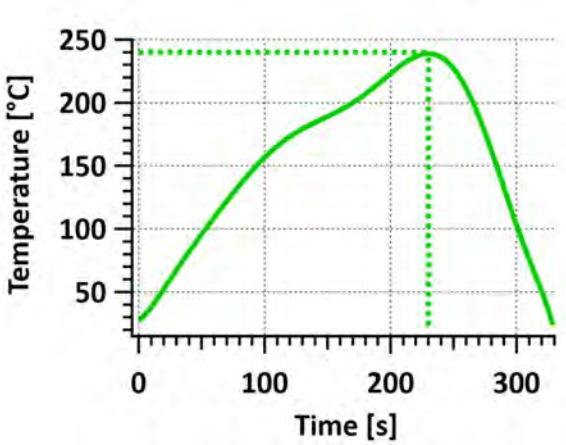
MSL Rating

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 ≤ 30 °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 typical 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	°C
Maximum Sparkling Temperature	T_{Smax}	200	°C
Sparkling Time	t_S	75	s
Minimum Reflow Temperature	T_L	217	°C
Peak Temperature	T_P	244	°C
Reflow Time	t_L	65	s
Time within T_P - 5°C	t_P	25	s
Ramp Down Rate	ΔT_c	2	°C/s



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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