

## Miniature Surface-Mount Ambient Light Photo Sensor

## Data Sheet

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**Description**

The APDS-9009 is a low cost analog-output ambient light photo sensor in an 8-pin ODFN lead-free surface mount package. It consists of a photo sensor, whose spectral response is close to the CIE standard photopic observer, as show in [Figure 2](#). The APDS-9009 is ideal for applications in which the measurement of ambient light is used to control display backlighting. Mobile appliances such as the mobile phones and PDAs that draw heavy current from display backlighting will benefit from incorporating these photo sensor products in their designs by reducing power consumption significantly.

**Application Support Information**

The Application Engineering Group is available to assist you with the application design associated with APDS-9009 ambient light photo sensor module. You can contact them through your local sales representatives for additional details.

**Features**

- Spectral responsivity close to that of human eye
- 8-pin ODFN lead-free surface-mount package
  - Height – 0.34 mm
  - Width – 2.00 mm
  - Depth – 2.00 mm
- Low sensitivity variation across various light sources
- Recommended operating temperature: –40 °C to 85 °C
- Vcc supply 1.8 to 5.5 V
- Lead-free package, RoHS compliance
- Output linearity across wide illumination range

**Applications**

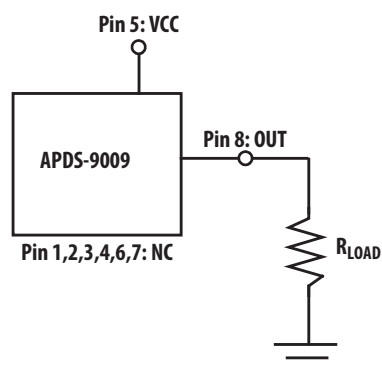
- Detection of ambient light to control display backlighting
  - Mobile devices – Mobile phones, PDAs
  - Computing devices – Notebooks, Webpads
  - Consumer devices – TVs, Video Cameras, Digital Still Camera
- Automatic Residential and Commercial Lighting Management
- Electronic Signs and Signals

**Ordering Information**

| Part Number | Packaging Type | Package            | Quantity |
|-------------|----------------|--------------------|----------|
| APDS-9009   | Tape and Reel  | 8-pin ODFN package | 2500     |

## Typical Application Circuit

Figure 1 Typical Application Circuit for APDS-9009



| Component  | Recommended Application Circuit Component |
|------------|---|
| $R_{LOAD}$ | 1 k ohm                                   |

**NOTE** See Figure 11 for General Luminance Vs. Typical Output Voltage for different  $R_{LOAD}$  values.

## Absolute Maximum Ratings

For implementations where case to ambient thermal resistance is 50 °C /W.

| Parameter             | Symbol   | Min. | Max. | Units |
|-----------------------|----------|------|------|-------|
| Storage Temperature   | $T_S$    | -40  | 85   | °C    |
| Operating temperature | $T_A$    | -40  | 85   | °C    |
| Supply Voltage        | $V_{CC}$ | 0    | 6    | V     |

## Recommended Operating Conditions

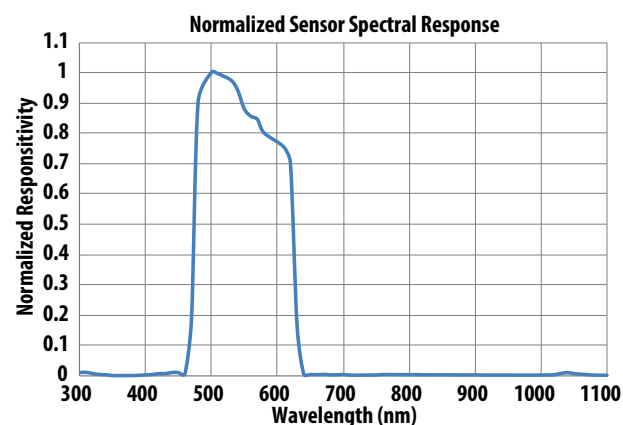
| Parameter      | Symbol | Min. | Max. | Units | Conditions |
|----------------|--------|------|------|-------|------------|
| Supply Voltage | VCC    | 1.8  | 5.5  | V     |            |

**CAUTION** It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD

## I/O Pins Configuration Table

| Pin | Symbol    | Description |
|-----|-----------|-------------|
| 1   | NC        | No Connect  |
| 2   | NC        | No Connect  |
| 3   | NC        | No Connect  |
| 4   | NC        | No Connect  |
| 5   | VCC       | VCC         |
| 6   | NC        | No Connect  |
| 7   | NC        | No Connect  |
| 8   | $I_{out}$ | Out         |

Figure 2 Relative Spectral Response Vs. Wavelength



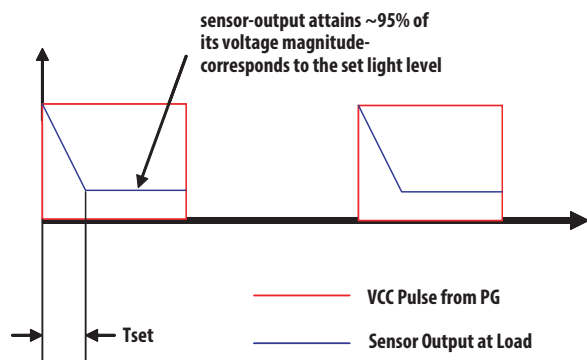
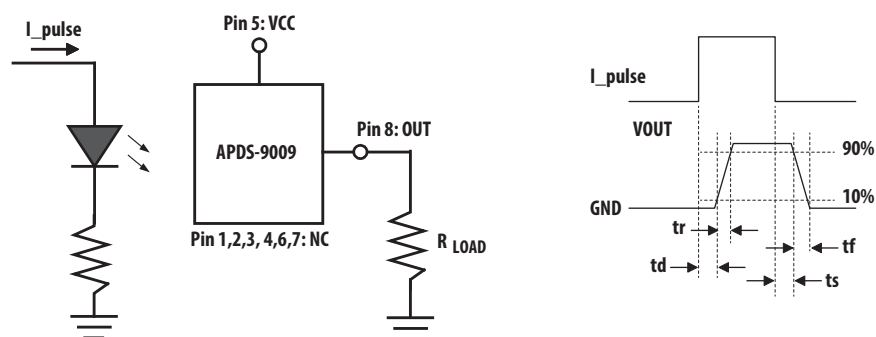
## Electrical and Optical Specifications (Ta = 25 °C)

| Parameter                   | Symbol                              | Min. | Typ. | Max. | Units | Conditions  |
|-----------------------------|-------------------------------------|------|------|------|-------|---|
| Photo Current <sup>a</sup>  | I <sub>PH1</sub>                    | 21   | 30   | 39   | uA    | V <sub>CC</sub> = 1.8V, Lux = 100 <sup>b</sup>                                  |
| Photo Current <sup>b</sup>  | I <sub>PH2</sub>                    | —    | 33   | —    | uA    | V <sub>CC</sub> = 1.8V, Lux = 100 <sup>a</sup>                                  |
| Dark Current                | I <sub>DARK</sub>                   | —    | 300  | —    | nA    | V <sub>CC</sub> = 3V, Lux = 0   |
| Light Current Ratio         | I <sub>PH2</sub> / I <sub>PH1</sub> | —    | 1.1  | —    | —     |   |
| Rise Time                   | T <sub>r</sub>                      | —    | 5    | —    | ms    | RI = 1K ohm, Lux = 100  |
| Fall Time                   | T <sub>f</sub>                      | —    | 5    | —    | ms    | R1 = 1 Kohm, Lux=100  |
| Peak sensitivity wavelength | λ                                   | —    | 500  | —    | nm    |   |
| Settling Time pulsed at Vcc | T <sub>set</sub>                    | —    | 10   | —    | ms    | V <sub>CC</sub> pulsed = 0V to 3V;<br>Rload = 2.4 Kohms; Lux = 100 <sup>b</sup> |
| Propagation delay           | T <sub>d</sub>                      | —    | 5    | —    | ms    | RI = 1 Kohm, Lux = 100  |
| Storage delay               | T <sub>s</sub>                      | —    | 5    | —    | ms    | R1 = 1 Kohm, Lux=100  |
| Saturation voltage          | V <sub>sat</sub>                    | 1.0  | —    | —    | V     | R1 = 150 Kohm, Lux = 100  |

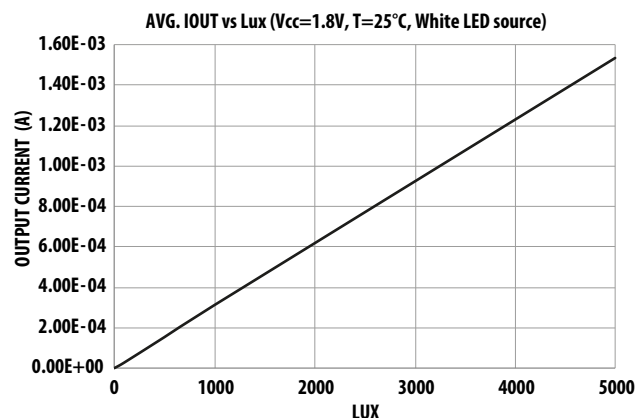
a. Illuminance by incandescent lamp

b. White LED is used as a light source

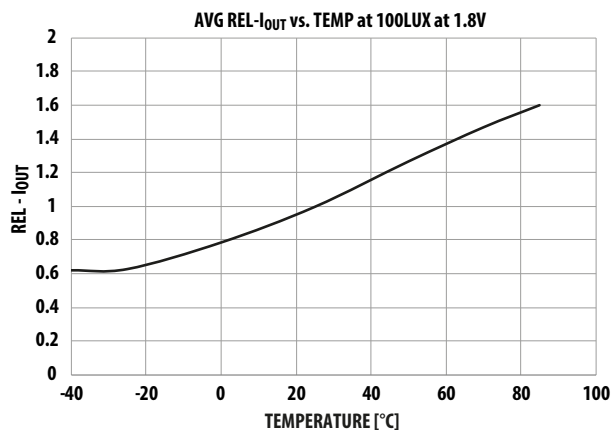
## Light Measurement Circuit and Waveforms



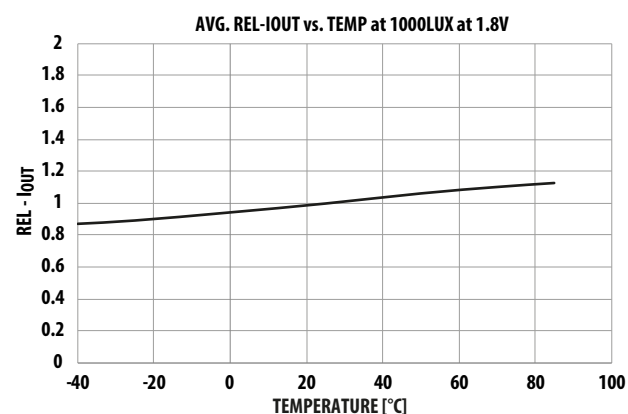
**Figure 3 Average IOUT Vs. Lux (Vcc = 1.8V, T=25 °C, White LED Source)**



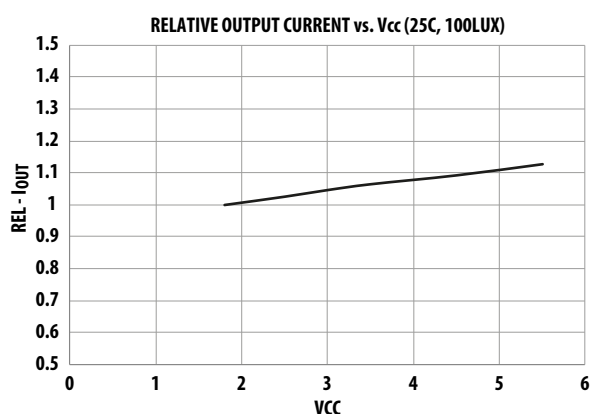
**Figure 4 Average relative IOUT Vs. Temp (Vcc = 1.8V, T=25 °C, 100 Lux)**



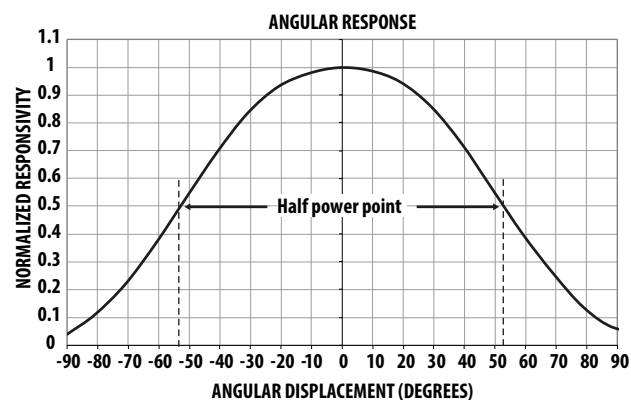
**Figure 5 Relative Output Current Vs. Temp (Vcc = 1.8V, 100 Lux)**



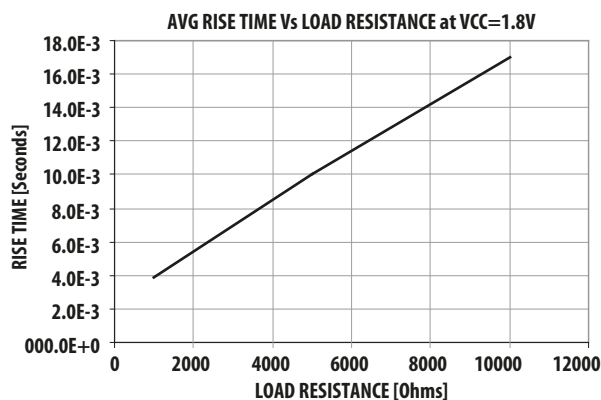
**Figure 6 Relative Output Current Vs. Vcc (Ta = 25 °C, 100Lux)**



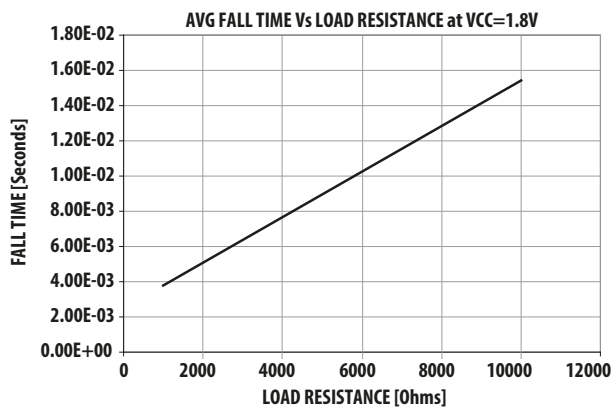
**Figure 7 Relative IOUT Vs. Angle (Vcc = 1.8V, Ta = 25 °C)**



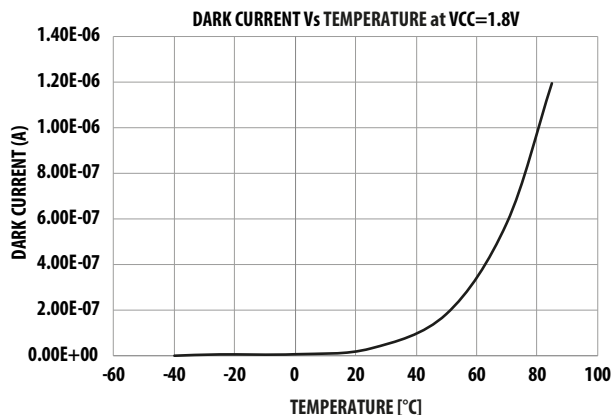
**Figure 8 Average Rise Time Vs. Load Resistance at Vcc = 1.8V**



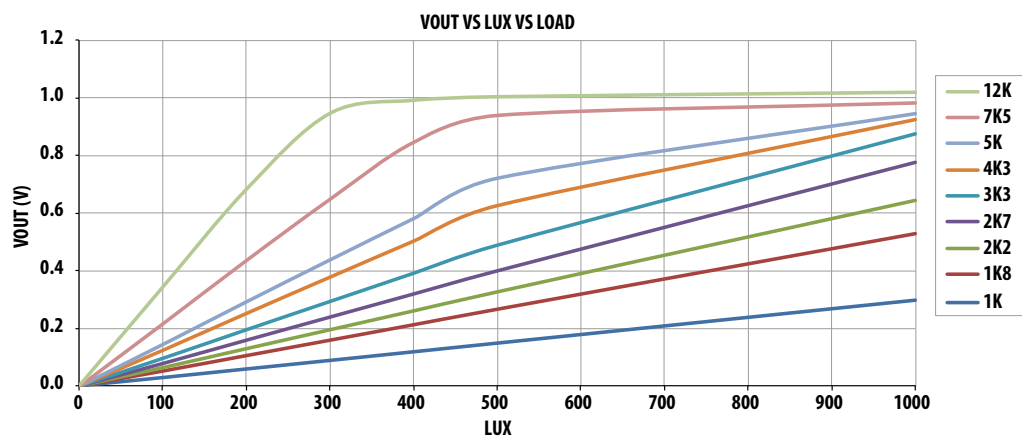
**Figure 9 Average Fall Time Vs. Load Resistance at Vcc = 1.8V**



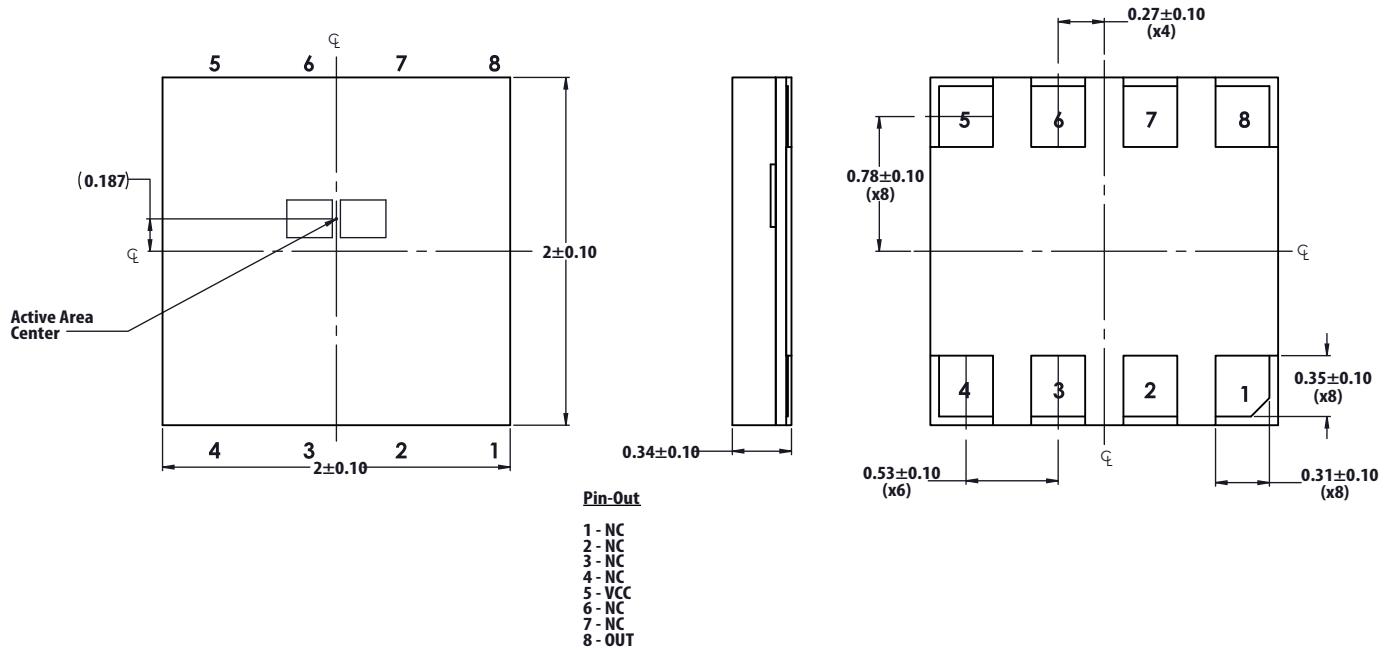
**Figure 10 Dark Current Vs. Temperature**



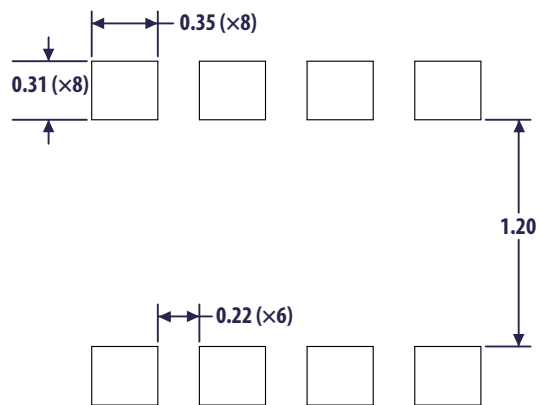
**Figure 11 General Luminance vs Typical Output Voltage (Vcc = 1.8V, T = 25 °C, Light Source = White LED)**



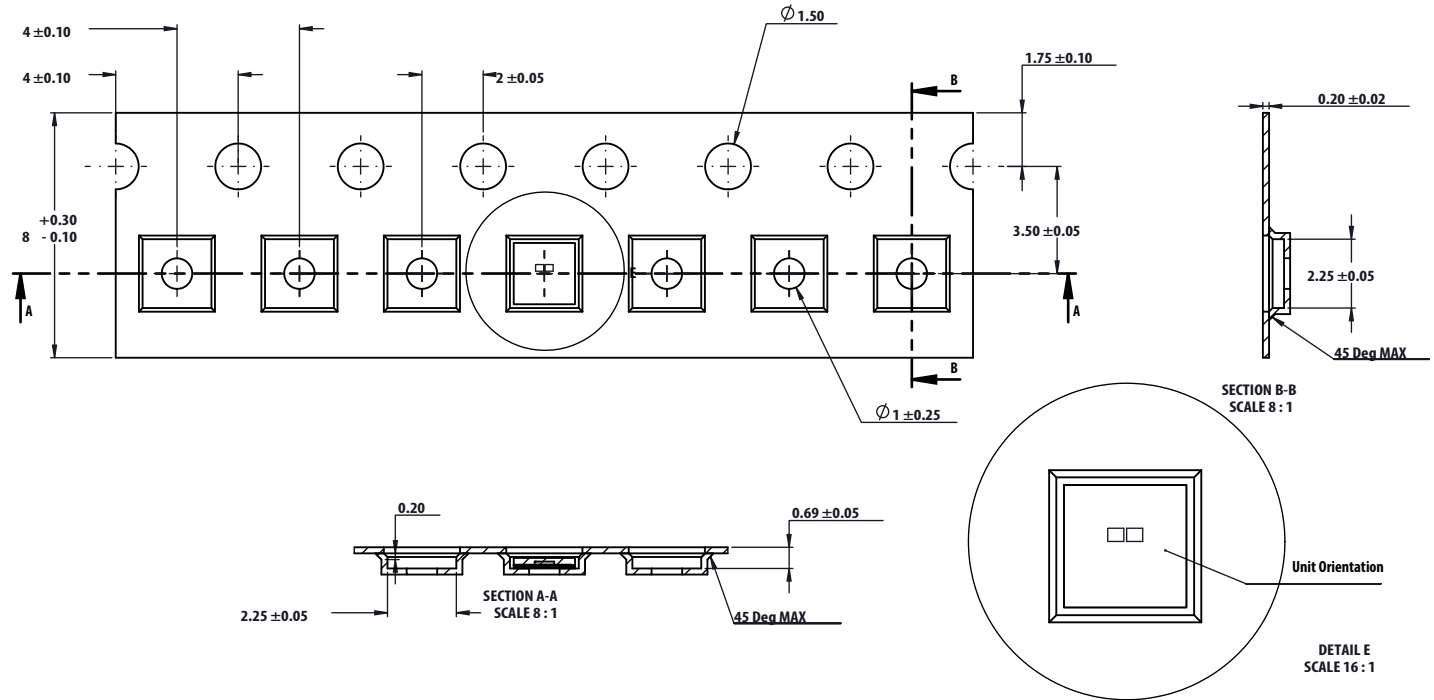
## APDS-9009 Package Outline



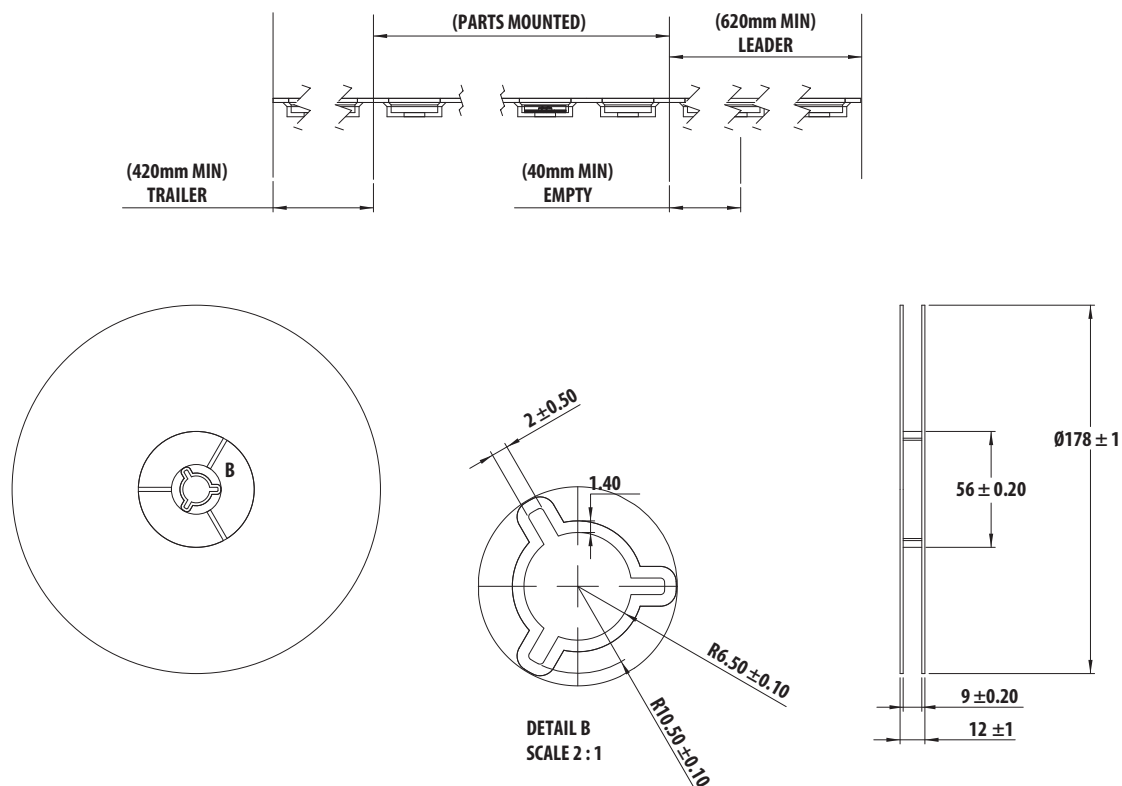
## PCB Pad Layout



## APDS-9009 Tape Dimensions

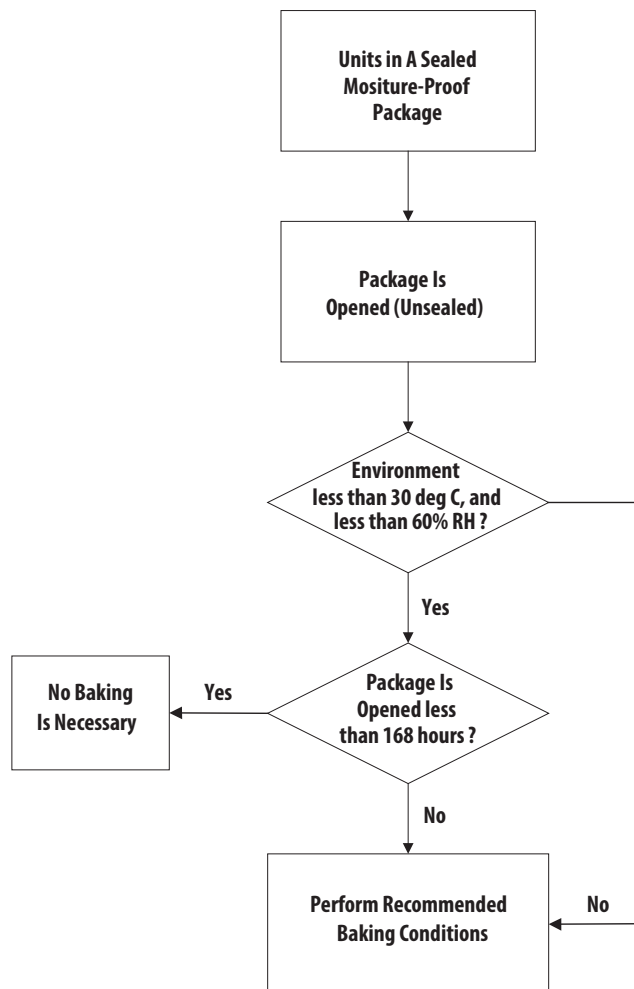


## APDS-9009 Reel Dimensions



## Moisture Proof Packaging

All APDS-9009 options are shipped in moisture proof package. Once opened, moisture absorption begins. This part is compliant to JEDEC Level 3.



## Baking Conditions

If the parts are not stored in dry conditions, they must be baked before reflow to prevent damage to the parts.

| Package | Temperature | Time     |
|---------|-------------|----------|
| In Reel | 60 °C       | 48 hours |
| In Bulk | 100 °C      | 4 hours  |

Baking should only be done once.

## Recommended Storage Conditions

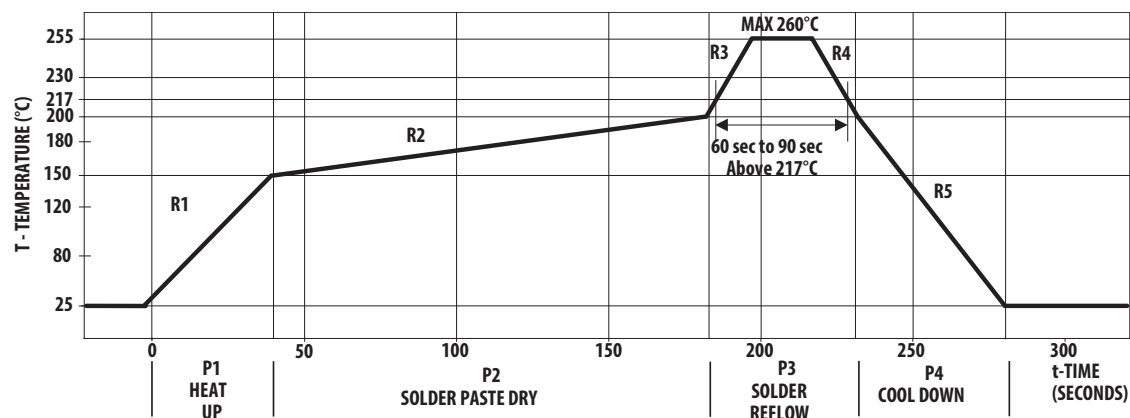
|                     |                |
|---------------------|----------------|
| Storage Temperature | 10 °C to 30 °C |
| Relative Humidity   | below 60% RH   |

### Time from unsealing to soldering:

After removal from the bag, the parts should be soldered within 7 days and if stored at the recommended storage conditions. If times longer than 7 days are needed, the parts must be stored in a dry box.



## Recommended Reflow Profile



| Process Zone                                | Symbol | $\Delta T$       | Maximum $\Delta T/\Delta \text{time}$ or Duration |
|---|--------|------------------|---|
| Heat Up                                     | P1, R1 | 25 °C to 150 °C  | 3 °C/s  |
| Solder Paste Dry                            | P2, R2 | 150 °C to 200 °C | 100 s to 180s                                     |
| Solder Reflow                               | P3, R3 | 200 °C to 255 °C | 3 °C/s  |
|   | P3, R4 | 255 °C to 200 °C | -6 °C/s   |
| Cool Down                                   | P4, R5 | 200 °C to 25 °C  | -6 °C/s   |
| Time maintained above 217 °C                |        | > 217 °C         | 60 s to 90 s                                      |
| Peak Temperature                            |        | 260 °C           |   |
| Time within 5 °C of actual Peak Temperature |        | > 255 °C         | 20 s to 40 s                                      |
| Time 25 °C to Peak Temperature              |        | 25 °C to 260 °C  | 8 mins  |

The reflow profile is a straight-line representation of a nominal temperature profile for a convective reflow solder process. The temperature profile is divided into four process zones, each with different  $\Delta T/\Delta \text{time}$  temperature change rates or duration. The  $\Delta T/\Delta \text{time}$  rates or duration are detailed in the preceding table. The temperatures are measured at the component to printed circuit board connections.

**Process zone P1**, the PC board and APDS-9009 pins are heated to a temperature of 150 °C to activate the flux in the solder paste. The temperature ramp up rate, R1, is limited to 3 °C per second to allow for even heating of both the PC board and APDS-9009 pins.

**Process zone P2** should be of sufficient time duration (100 to 180 seconds) to dry the solder paste. The temperature is raised to a level just below the liquidus point of the solder, usually 200 °C (392 °F).

**Process zone P3** is the solder reflow zone. In zone P3, the temperature is quickly raised above the liquidus point of solder to 255 °C (491 °F) for optimum results. The dwell time above the liquidus point of solder should be between 20 and 40 seconds. It usually takes about 20 seconds to assure proper coalescing of the solder balls into liquid solder and the formation of good solder connections. Beyond a dwell time of 40 seconds, the intermetallic growth within the solder connections becomes excessive, resulting in the formation of weak and unreliable connections. The temperature is then rapidly reduced to a point below the solidus temperature of the solder, usually 200°C (392°F), to allow the solder within the connections to freeze solid.

**Process zone P4** is the cool down after solder freeze. The cool down rate, R5, from the liquidus point of the solder to 25 °C (77 °F) should not exceed 6 °C per second maximum. This limitation is necessary to allow the PC board and APDS-9009 pins to change dimensions evenly, putting minimal stresses on the APDS-9009.

It is recommended to perform reflow soldering no more than twice.

## Appendix A: General Application Guide for APDS-9009

The APDS-9009 is a low cost analog-output ambient light photo sensor whose spectral response closely emulates the human eyes. APDS-9009 consists of a photo sensor that is able to produce a high gain photo current to a sufficient level that can be converted to voltage with a standard value of external resistor. APDS-9009 can easily be integrated into systems that use ADC input which is available for sampling of the external source, as shown in Figure 12.

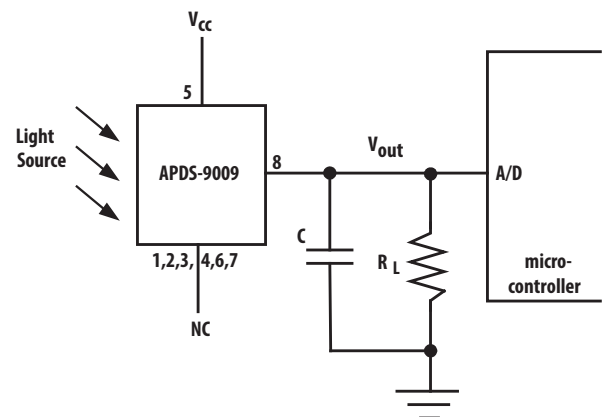
The amount of converted voltage,  $V_{out}$ , is mainly dependent proportionally on the photo current that generated by the brightness of the light shone on the photo sensor and the load resistor used,  $R_L$ . Increasing the brightness of the light or/and the load resistor will increase the output voltage.

Brightness is measured as "LUX" unit, which describes how intense a light source that our eyes perceive. LUX meter is the equipment for "LUX" measurement. Light sources with the same LUX level appear at the same brightness to the human eyes.

Selection of the load resistor  $R_L$  will determine the amount of current-to-voltage conversion in the circuit.

Light source, e.g., fluorescent light consists of ac noise frequency of about 100Hz. A capacitor of 10  $\mu$ F, which act as a low-pass filter, is recommended to add in parallel with the load resistor to reduce the ripples.

Figure 12 Configuration of APDS-9009



For product information and a complete list of distributors, please go to our web site:

[www.avagotech.com](http://www.avagotech.com)

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