

## **HLMP-EGxx, HLMP-ELxx**

### **T-1¾ (5 mm) High Brightness AlInGaP**

### **Red and Amber LEDs**

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## **Description**

The Broadcom® Precision Optical Performance AlInGaP LEDs provide superior light output for excellent readability in sunlight and are extremely reliable. AlInGaP LED technology provides extremely stable light output over long periods of time. Precision Optical Performance lamps utilize the aluminum indium gallium phosphide (AlInGaP) technology.

These LED lamps are untinted, T-1¾ packages incorporating second-generation optics, producing well-defined spatial radiation patterns at specific viewing cone angles.

These lamps are made with an advanced optical grade epoxy offering superior high temperature and high moisture resistance performance in outdoor signal and sign application. The maximum LED junction temperature limit of +130°C enables high temperature operation in bright sunlight conditions. The epoxy contains UV inhibitor to reduce the effects of long-term exposure to direct sunlight.

## **Benefits**

- Superior performance for outdoor environment
- Suitable for auto-insertion onto PC board

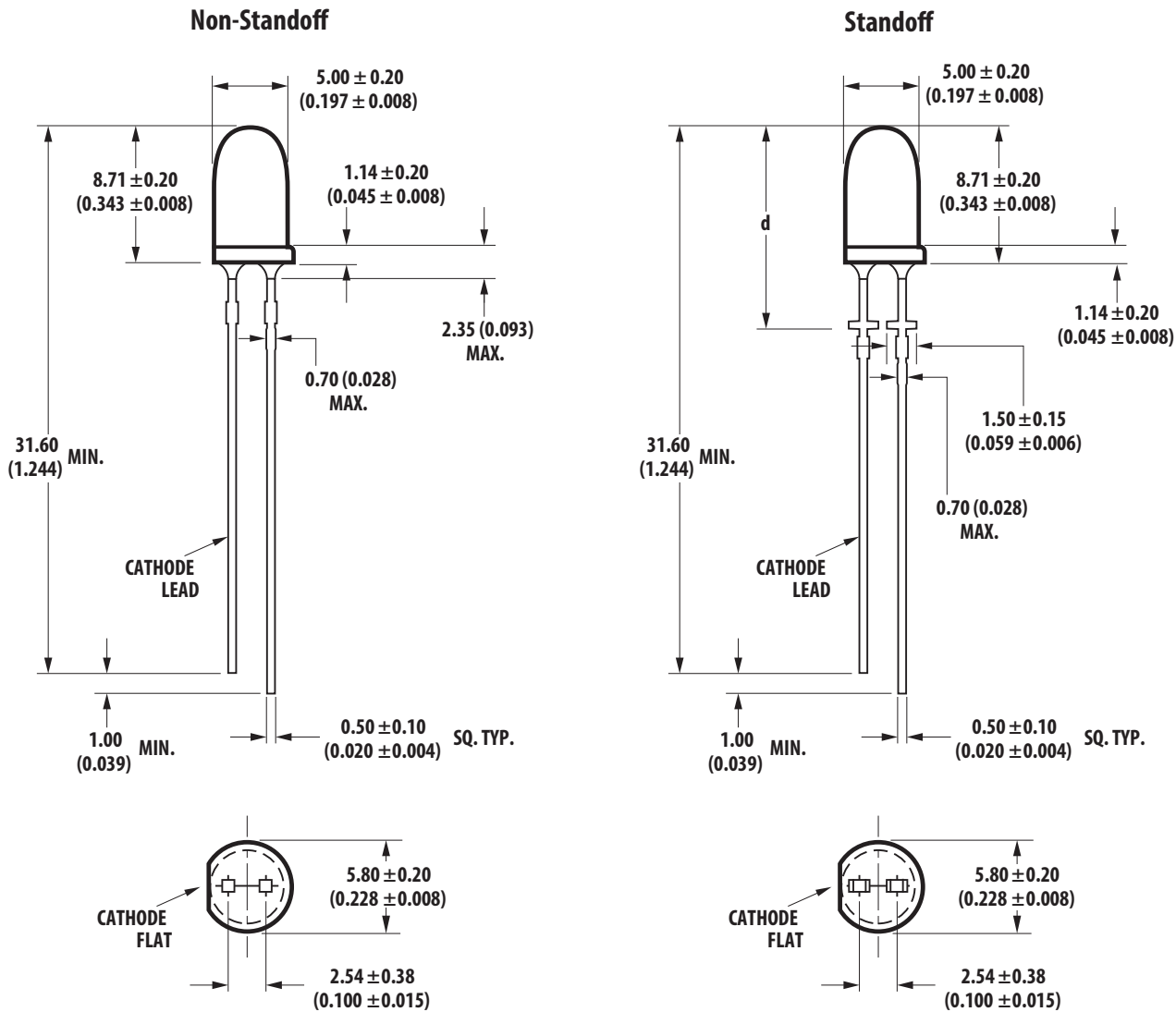
## **Features**

- Viewing angle: 15°, 23°, and 30°
- Well-defined spatial radiation pattern
- High brightness material
- Available in Red and Amber
  - Red AlInGaP 626 nm
  - Amber AlInGaP 590 nm
- Superior resistance to moisture
- Standoff and non-standoff package

## **Applications**

- Traffic management:
  - Traffic signals
  - Pedestrian signals
  - Work zone warning lights
  - Variable message signs
- Solar power signs
- Commercial outdoor advertising
  - Signs
  - Marquee

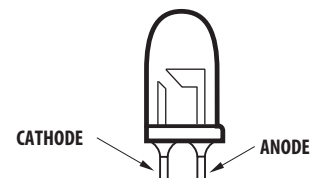
Figure 1: Package Dimensions



| Part Number                     | Dimension d     |
|---------------------------------|-----------------|
| HLMP-EG1H-xxxxx                 | 12.30 ± 0.25 mm |
| HLMP-EL1H-xxxxx                 | 12.64 ± 0.25 mm |
| HLMP-EG2H-xxxxx                 | 12.10 ± 0.25 mm |
| HLMP-EL2H-xxxxx                 | 12.14 ± 0.25 mm |
| HLMP-EG3H-xxxxx/HLMP-EL3H-xxxxx | 12.10 ± 0.25 mm |

**NOTE:**

1. All dimensions in millimeters (inches).
2. Tolerance is ±0.20 mm unless other specified.
3. Leads are mild steel with tin plating.
4. The epoxy meniscus is 1.21 mm max.
5. For identification of polarity after the leads are trimmed off, refer to the illustration:



## Device Selection Guide

| Part Number     | Color and Dominant Wavelength, $\lambda_d$ (nm)<br>Typ <sup>a</sup> | Luminous Intensity, $I_V$ (mcd)<br>at 20 mA <sup>b,c,d</sup> |       | Standoff | Typical Viewing Angle (°) <sup>e</sup> |
|-----------------|---------------------------------------------------------------------|--------------------------------------------------------------|-------|----------|----------------------------------------|
|                 |                                                                     | Min                                                          | Max   |          |                                        |
| HLMP-EG1G-Y10DD | Red 626                                                             | 9300                                                         | 21000 | No       | 15                                     |
| HLMP-EG1H-Y10DD | Red 626                                                             | 9300                                                         | 21000 | Yes      |                                        |
| HLMP-EL1G-130DD | Amber 590                                                           | 16000                                                        | 35000 | No       |                                        |
| HLMP-EL1H-130DD | Amber 590                                                           | 16000                                                        | 35000 | Yes      |                                        |
| HLMP-EG2G-XZ0DD | Red 626                                                             | 7200                                                         | 16000 | No       | 23                                     |
| HLMP-EG2H-XZ0DD | Red 626                                                             | 7200                                                         | 16000 | Yes      |                                        |
| HLMP-EL2G-XZKDD | Amber 590                                                           | 7200                                                         | 16000 | No       |                                        |
| HLMP-EL2H-XZKDD | Amber 590                                                           | 7200                                                         | 16000 | Yes      |                                        |
| HLMP-EG3G-VX0DD | Red 626                                                             | 4200                                                         | 9300  | No       | 30                                     |
| HLMP-EG3H-VX0DD | Red 626                                                             | 4200                                                         | 9300  | Yes      |                                        |
| HLMP-EL3G-VX0DD | Amber 590                                                           | 4200                                                         | 9300  | No       |                                        |
| HLMP-EL3H-VX0DD | Amber 590                                                           | 4200                                                         | 9300  | Yes      |                                        |

- The dominant wavelength,  $\lambda_d$ , is derived from the CIE Chromaticity Diagram and represents the color of the lamp.
- The luminous intensity,  $I_V$ , is measured on the mechanical axis of the lamp package, and it is tested with pulsing condition.
- The optical axis is closely aligned with the package mechanical axis.
- Tolerance for each bin limit is  $\pm 15\%$ .
- $\theta_{1/2}$  is the off-axis angle where the luminous intensity is half the on-axis intensity.

## Absolute Maximum Ratings ( $T_J = 25^\circ\text{C}$ )

| Parameter                         | Red/ Amber  | Unit |
|-----------------------------------|-------------|------|
| DC Forward Current <sup>a</sup>   | 50          | mA   |
| Peak Forward Current <sup>b</sup> | 100         | mA   |
| Power Dissipation                 | 120         | mW   |
| LED Junction Temperature          | 130         | °C   |
| Operating Temperature Range       | -40 to +100 | °C   |
| Storage Temperature Range         | -40 to +100 | °C   |

- Derate linearly as shown in [Figure 6](#).
- Duty Factor 30%, frequency 1 kHz.

## Electrical/Optical Characteristics ( $T_J = 25^\circ\text{C}$ )

| Parameter                                          | Symbol                   | Min.           | Typ.           | Max.           | Unit                 | Test Conditions                                                                |
|----------------------------------------------------|--------------------------|----------------|----------------|----------------|----------------------|--------------------------------------------------------------------------------|
| Forward Voltage<br>Red and Amber                   | $V_F$                    | 1.8            | 2.1            | 2.4            | V                    | $I_F = 20\text{ mA}$                                                           |
| Reverse Voltage <sup>a</sup><br>Red and Amber      | $V_R$                    | 5              | —              | —              | V                    | $I_R = 100\text{ }\mu\text{A}$                                                 |
| Dominant Wavelength <sup>b</sup><br>Red<br>Amber   | $\lambda_d$              | 618.0<br>584.5 | 626.0<br>590.0 | 630.0<br>594.5 | nm                   | $I_F = 20\text{ mA}$                                                           |
| Peak Wavelength<br>Red<br>Amber                    | $\lambda_{\text{PEAK}}$  | —<br>—         | 634<br>594     | —<br>—         | nm                   | Peak of Wavelength of Spectral Distribution at $I_F = 20\text{ mA}$            |
| Thermal Resistance                                 | $R_{\theta\text{J-PIN}}$ | —              | 240            | —              | $^\circ\text{C/W}$   | LED junction to pin                                                            |
| Luminous Efficacy <sup>c</sup><br>Red<br>Amber     | $\eta_V$                 | —<br>—         | 190<br>490     | —<br>—         | lm/W                 | Emitted Luminous Power/<br>Emitted Radiant Power                               |
| Thermal Coefficient of $\lambda_d$<br>Red<br>Amber |                          | —<br>—         | 0.05<br>0.09   | —<br>—         | nm/ $^\circ\text{C}$ | $I_F = 20\text{ mA}$ ;<br>$+25^\circ\text{C} \leq T_J \leq +100^\circ\text{C}$ |

- a. Indicates product final testing condition; long-term reverse bias is not recommended.
- b. The dominant wavelength is derived from the Chromaticity Diagram and represents the color of the lamp.
- c. The radiant intensity,  $I_e$  in watts per steradian, can be found from the equation  $I_e = I_V/\eta_V$ , where  $I_V$  is the luminous intensity in candela and  $\eta_V$  is the luminous efficacy in lumens/watt.

## Part Numbering System

H L M P - 

|                |                |                |                |
|----------------|----------------|----------------|----------------|
| x <sub>1</sub> | x <sub>2</sub> | x <sub>3</sub> | x <sub>4</sub> |
|----------------|----------------|----------------|----------------|

 - 

|                |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|
| x <sub>5</sub> | x <sub>6</sub> | x <sub>7</sub> | x <sub>8</sub> | x <sub>9</sub> |
|----------------|----------------|----------------|----------------|----------------|

| Code                          | Description                      | Option                                            |                             |
|-------------------------------|----------------------------------|---------------------------------------------------|-----------------------------|
| x <sub>1</sub>                | Package Type                     | E                                                 | 5-mm Standard Round AlInGaP |
| x <sub>2</sub>                | Color                            | G                                                 | Red                         |
|                               |                                  | L                                                 | Amber                       |
| x <sub>3</sub> x <sub>4</sub> | Viewing Angle and Lead Standoffs | 1G                                                | 15° without lead standoffs  |
|                               |                                  | 1H                                                | 15° with lead standoffs     |
|                               |                                  | 2G                                                | 23° without lead standoffs  |
|                               |                                  | 2H                                                | 23° with lead standoffs     |
|                               |                                  | 3G                                                | 30° without lead standoffs  |
|                               |                                  | 3H                                                | 30° with lead standoffs     |
| x <sub>5</sub>                | Minimum Intensity Bin            | Refer to <a href="#">Device Selection Guide</a> . |                             |
| x <sub>6</sub>                | Maximum Intensity Bin            |                                                   |                             |
| x <sub>7</sub>                | Color Bin Selection              | 0                                                 | Full range                  |
|                               |                                  | K                                                 | Color bin 2 and 4           |
|                               |                                  | L                                                 | Color bin 4 and 6           |
| x <sub>8</sub> x <sub>9</sub> | Packaging Option                 | DD                                                | Ammopack                    |

## Bin Information

### Intensity Bin Limit Table (1.3 : 1 I<sub>V</sub> Bin Ratio)

| Bin | Intensity (mcd) at 20 mA |       |
|-----|--------------------------|-------|
|     | Min                      | Max   |
| U   | 3200                     | 4200  |
| V   | 4200                     | 5500  |
| W   | 5500                     | 7200  |
| X   | 7200                     | 9300  |
| Y   | 9300                     | 12000 |
| Z   | 12000                    | 16000 |
| 1   | 16000                    | 21000 |
| 2   | 21000                    | 27000 |
| 3   | 27000                    | 35000 |

Tolerance for each bin limit is  $\pm 15\%$ .

### V<sub>F</sub> Bin Table (V at 20 mA)

| Bin ID | Min | Max |
|--------|-----|-----|
| VD     | 1.8 | 2.0 |
| VA     | 2.0 | 2.2 |
| VB     | 2.2 | 2.4 |

Tolerance for each bin limit is  $\pm 0.05V$ .

## Red Color Range

| Min Dom | Max Dom | X Min  | Y Min  | X Max  | Y Max  |
|---------|---------|--------|--------|--------|--------|
| 618.0   | 630.0   | 0.6872 | 0.3126 | 0.6890 | 0.2943 |
|         |         | 0.6690 | 0.3149 | 0.7080 | 0.2920 |

Tolerance for each bin limit is  $\pm 0.5$  nm.

## Amber Color Range

| Bin | Min Dom | Max Dom | X Min  | Y Min  | X Max  | Y Max  |
|-----|---------|---------|--------|--------|--------|--------|
| 1   | 584.5   | 587.0   | 0.5420 | 0.4580 | 0.5530 | 0.4400 |
|     |         |         | 0.5370 | 0.4550 | 0.5570 | 0.4420 |
| 2   | 587.0   | 589.5   | 0.5570 | 0.4420 | 0.5670 | 0.4250 |
|     |         |         | 0.5530 | 0.4400 | 0.5720 | 0.4270 |
| 4   | 589.5   | 592.0   | 0.5720 | 0.4270 | 0.5820 | 0.4110 |
|     |         |         | 0.5670 | 0.4250 | 0.5870 | 0.4130 |
| 6   | 592.0   | 594.5   | 0.5870 | 0.4130 | 0.5950 | 0.3980 |
|     |         |         | 0.5820 | 0.4110 | 0.6000 | 0.3990 |

Tolerance for each bin limit is  $\pm 0.5$  nm.

**NOTE:** All bin categories are established for classification of products. Products may not be available in all bin categories. Please contact your Broadcom representative for further information.

Figure 2: Color Bin on CIE 1931 Chromaticity Diagram

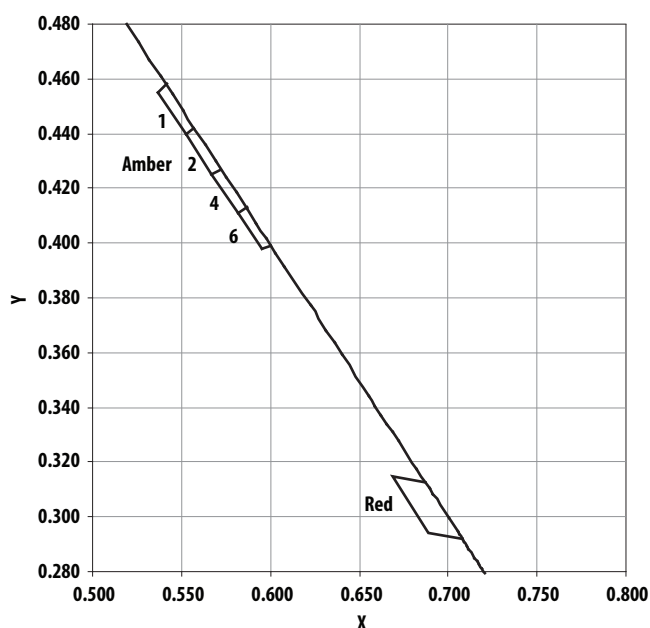


Figure 3: Relative Intensity vs Wavelength

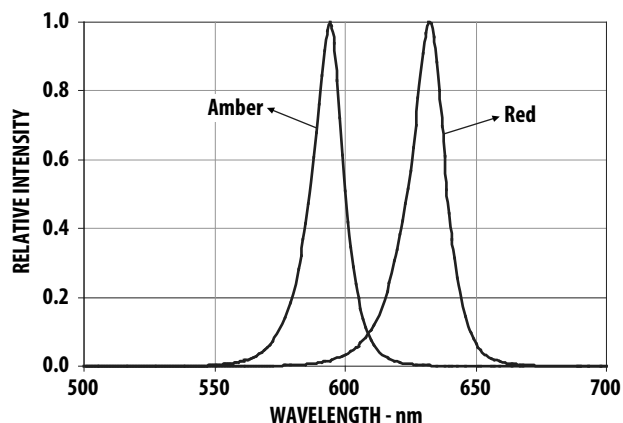


Figure 4: Forward Current vs Forward Voltage

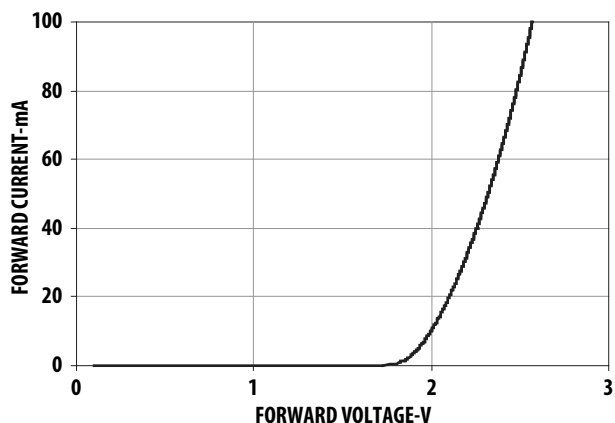


Figure 5: Relative Intensity vs Forward Current

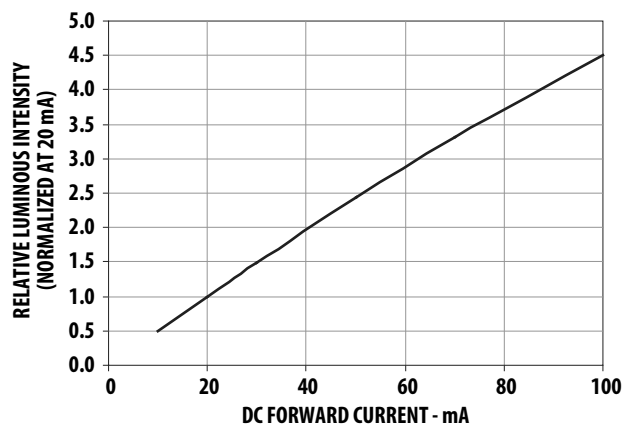


Figure 6: Maximum Forward Current vs Ambient Temperature

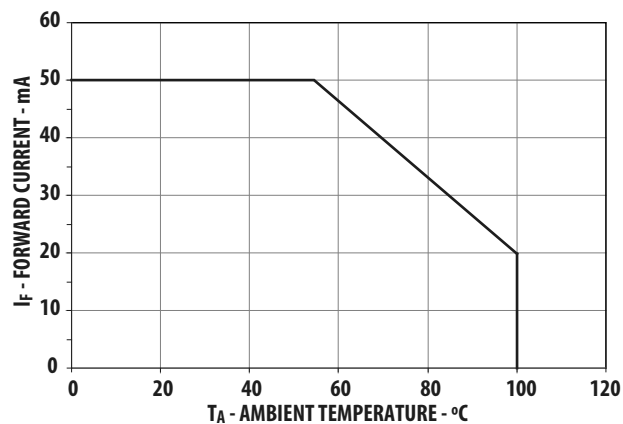


Figure 7: Representative Radiation Pattern for 15° Viewing Angle Lamp

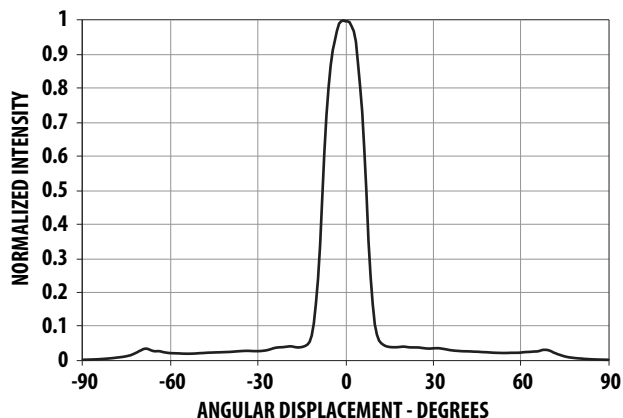


Figure 8: Representative Radiation Pattern for 23° Viewing Angle Lamp

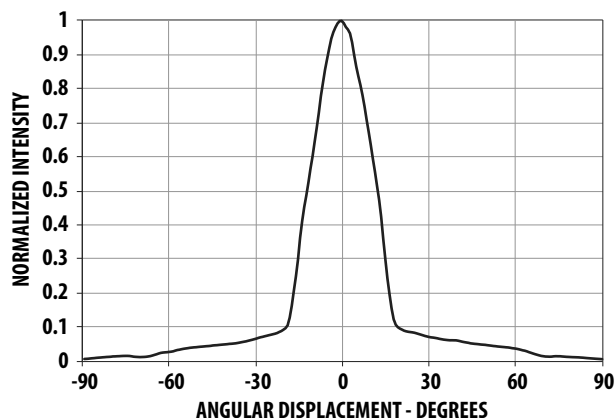


Figure 9: Representative Radiation Pattern for 30° Viewing Angle Lamp

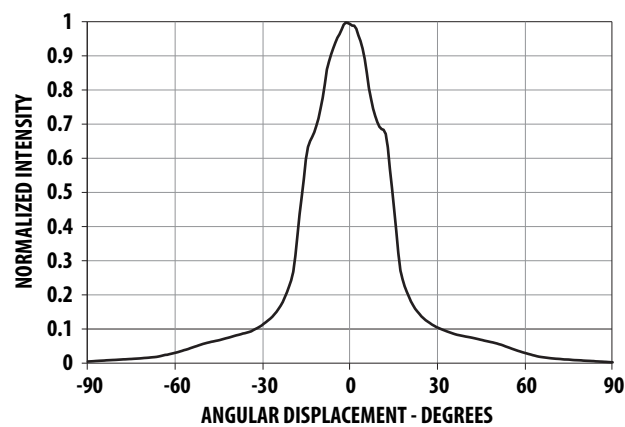


Figure 10: Relative Light Output vs Junction Temperature

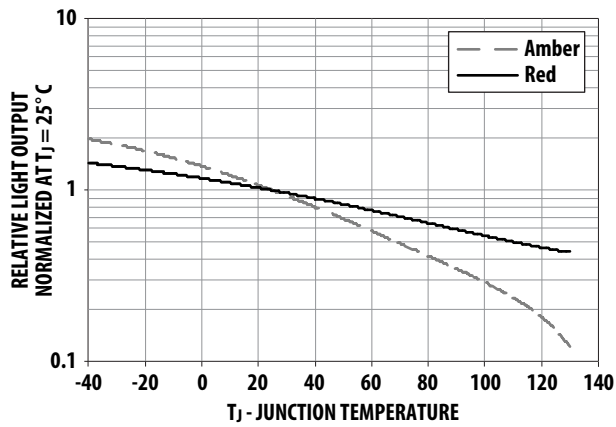
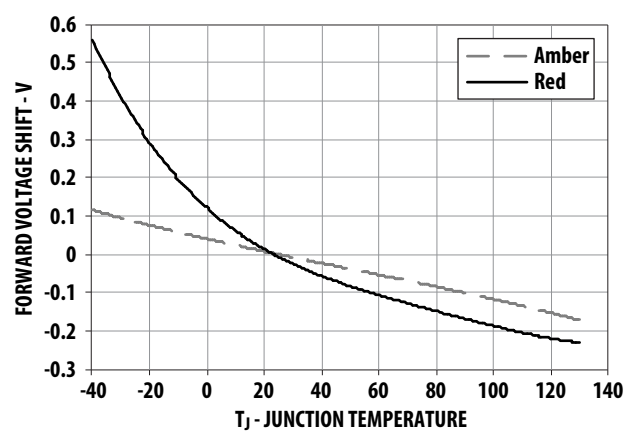


Figure 11: Forward Voltage Shift vs Junction Temperature



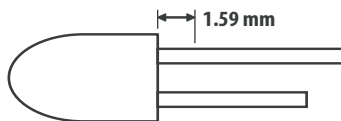
## Precautionary Notes

### Lead Forming

- The leads of an LED lamp can be preformed or cut to length prior to insertion and soldering on PC board.
- For better control, use proper tool to precisely form and cut the leads to applicable length rather than doing it manually.
- If manual lead cutting is necessary, cut the leads after the soldering process. The solder connection forms a mechanical ground, which prevents mechanical stress due to lead cutting from traveling into LED package. This is highly recommended for hand solder operation, as the excess lead length also acts as small heat sink.

### Soldering and Handling

- Care must be taken during PCB assembly and soldering process to prevent damage to the LED component.
- The LED component can be effectively hand soldered to PCB. However, it is only recommended under unavoidable circumstances such as rework. The closest manual soldering distance of the soldering heat source (soldering iron's tip) to the body is 1.59 mm. Soldering the LED using soldering iron tip closer than 1.59 mm might damage the LED.



- ESD precaution must be properly applied on the soldering station and personnel to prevent ESD damage to the LED component that is ESD sensitive. Refer to Broadcom application note AN 1142 for details. The soldering iron used should have grounded tip to ensure electrostatic charge is properly grounded.
- Recommended soldering condition:

|                     | Wave Soldering <sup>a,b</sup> | Manual Solder Dipping |
|---------------------|-------------------------------|-----------------------|
| Preheat Temperature | 105°C Max.                    | —                     |
| Preheat Time        | 60 sec Max                    | —                     |
| Peak Temperature    | 260°C Max.                    | 260°C Max.            |
| Dwell Time          | 5 sec Max.                    | 5 sec Max             |

a. These conditions refer to the measurement with thermocouple mounted at the bottom of PCB.

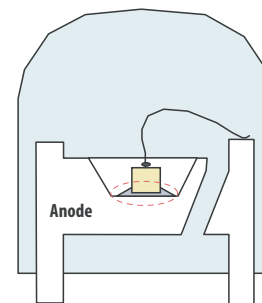
b. Use only bottom preheaters to reduce thermal stress experienced by LED.

- Wave soldering parameters must be set and maintained according to the recommended temperature and dwell time. The customer is advised to perform a daily check on the soldering profile to ensure that it is always conforming to recommended soldering conditions.

#### NOTE:

- A PCB with different size and design (component density) will have different heat mass (heat capacity). This might cause a change in temperature experienced by the board if same wave soldering setting is used. So, it is recommended to recalibrate the soldering profile again before loading a new type of PCB.
- The Broadcom high brightness LEDs are using high-efficiency LED die with single-wire bond as shown in Figure 12. The customer is advised to take extra precaution during wave soldering to ensure that the maximum wave temperature does not exceed 260°C and the solder contact time does not exceeding 5 sec. Overstressing the LED during soldering process might cause premature failure to the LED due to delamination.

Figure 12: LED Configuration



**NOTE:** Electrical connection between bottom surface of LED die and the lead frame is achieved through conductive paste.

- Any alignment fixture that is being applied during wave soldering should be loosely fitted and should not apply weight or force on the LED. Non-metal material is recommended as it will absorb less heat during wave soldering process.

**NOTE:** In order to further assist the customer in designing jig accurately to fit the Broadcom product, a 3D model of the product is available upon request.

- At elevated temperature, the LED is more susceptible to mechanical stress. Therefore, the PCB must be allowed to cool down to room temperature prior to handling, which includes removal of alignment fixture or pallet.
- If the PCB board contains both through-hole (TH) LED and other surface mount components, it is recommended that surface mount components be soldered on the top side of the PCB. If surface mount needs to be on the bottom side, these components should be soldered using reflow soldering prior to insertion the TH LED.

- The following table shows the recommended PC board plated through holes (PTH) size for LED component leads:

| LED Component Lead Size               | Diagonal                 | Plated Through Hole Diameter             |
|---------------------------------------|--------------------------|------------------------------------------|
| 0.45 x 0.45 mm<br>(0.018x 0.018 inch) | 0.636 mm<br>(0.025 inch) | 0.98 to 1.08 mm<br>(0.039 to 0.043 inch) |
| 0.50 x 0.50 mm<br>(0.020x 0.020 inch) | 0.707 mm<br>(0.028 inch) | 1.05 to 1.15 mm<br>(0.041 to 0.045 inch) |

- Oversizing the PTH can lead to twisted LED after clinching. On the other hand, undersizing the PTH can cause difficulty inserting the TH LED.

Refer to the Broadcom application note AN5334 for more information about soldering and handling of high brightness TH LED lamps.

Figure 13: Example of Wave Soldering Temperature Profile for TH LED

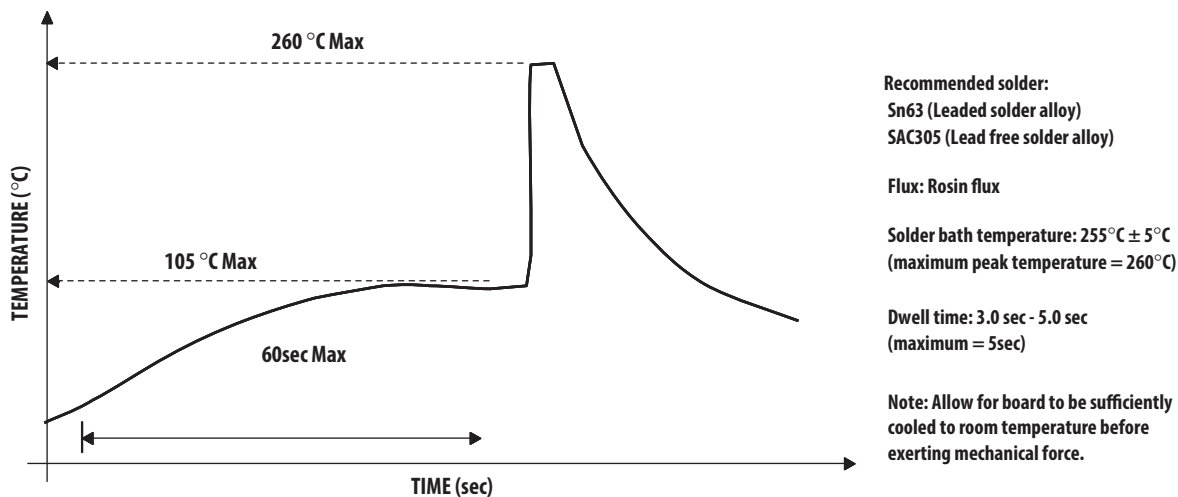
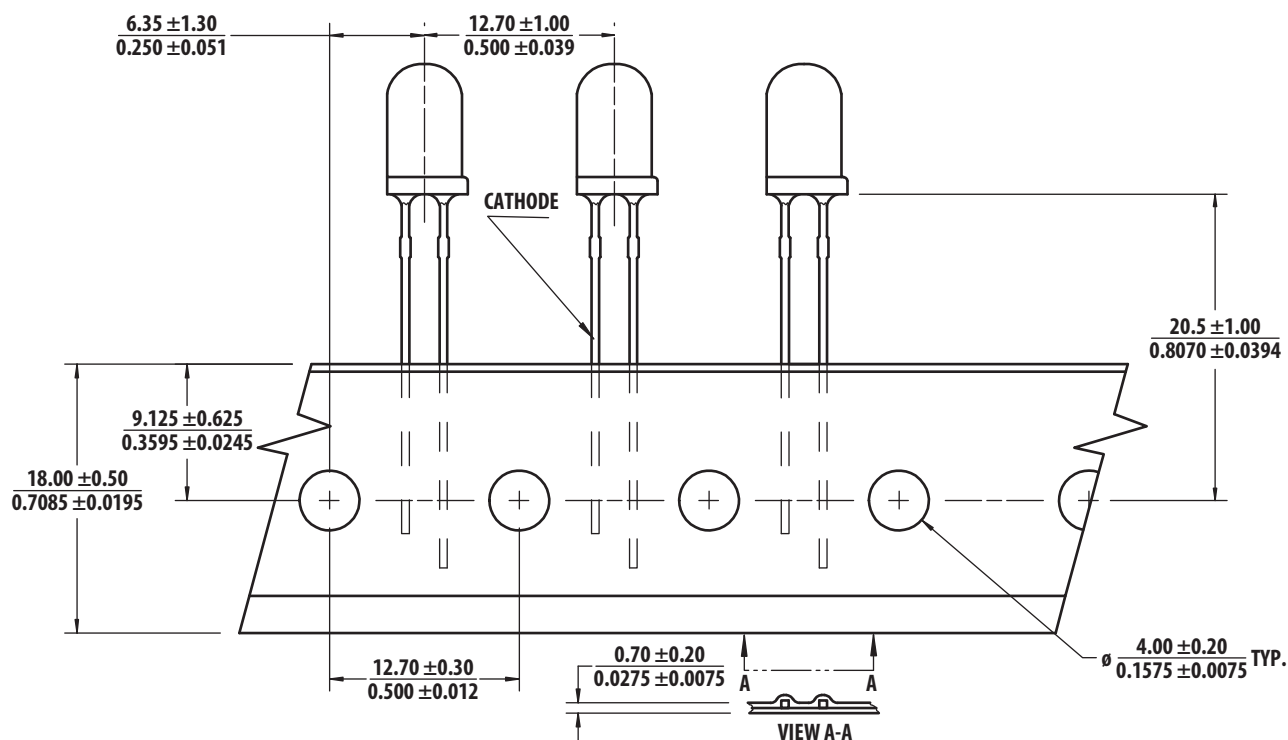
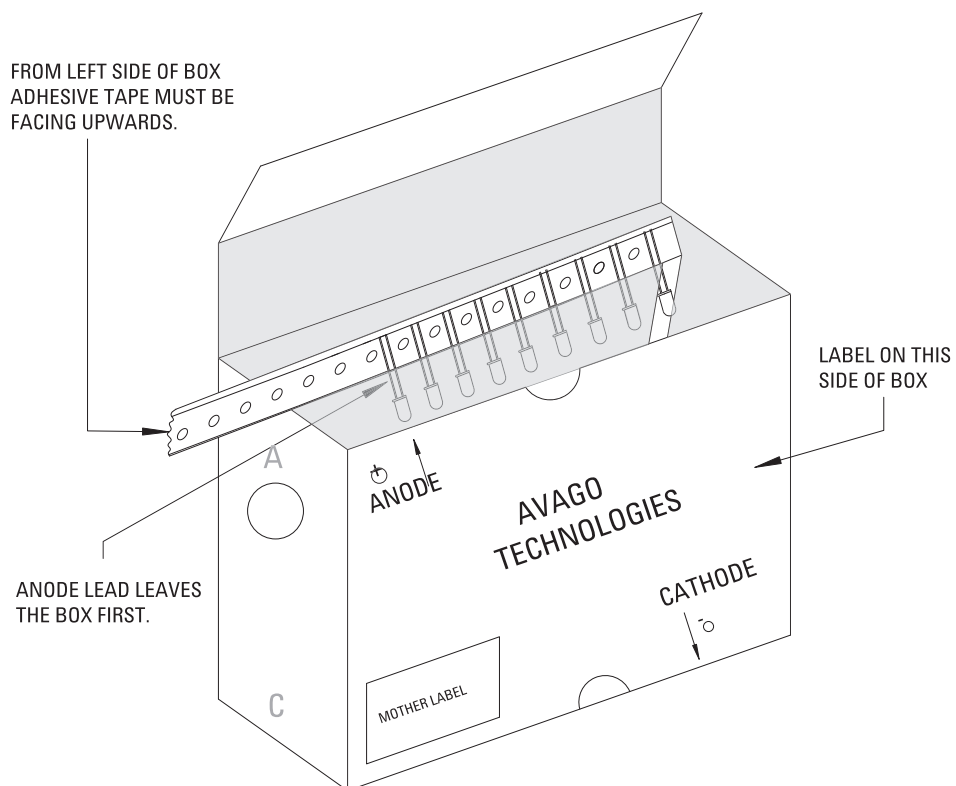


Figure 14: Ammo Packs Drawing



**NOTE:** The ammo-packs drawing is applicable for packaging option -DD and -ZZ and regardless standoff or non-standoff.

**Figure 15: Packaging Box for Ammo Packs**

**NOTE:** The dimension for ammo pack is applicable for the device with standoff and without standoff.

## Packaging Labels

Figure 16: (i) Mother Label (Available on packaging box of ammo pack and shipping box)

|                                                                                   |                                                                                   |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
|  |                                                                                   |
| (1P) Item: <b>Part Number</b>                                                     | STANDARD LABEL LS0002                                                             |
|  | RoHS Compliant                                                                    |
| (1T) Lot: <b>Lot Number</b>                                                       | e3 max temp 260C                                                                  |
|  | (Q) QTY: <b>Quantity</b>                                                          |
| LPN:                                                                              |  |
|  | CAT: <b>Intensity Bin</b>                                                         |
| (9D)MFG Date: <b>Manufacturing Date</b>                                           |  |
|  | BIN: <b>Refer to below information</b>                                            |
| <hr/>                                                                             |                                                                                   |
| (P) Customer Item:                                                                |                                                                                   |
|  |                                                                                   |
| (V) Vendor ID:                                                                    | (9D) Date Code: <b>Date Code</b>                                                  |
|  |  |
| <hr/>                                                                             |                                                                                   |
| DeptID:                                                                           | Made In: <b>Country of Origin</b>                                                 |
|  |  |

Figure 17: (ii) Baby Label (Only available on bulk packaging)

|                                                                                     |                                                                                     |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |                                                                                     |
| <b>Lamps Baby Label</b>                                                             |                                                                                     |
| RoHS Compliant                                                                      |                                                                                     |
| e3 max temp 260C                                                                    |                                                                                     |
| (1P) PART #: <b>Part Number</b>                                                     |                                                                                     |
|  |                                                                                     |
| (1T) LOT #: <b>Lot Number</b>                                                       |                                                                                     |
|  |                                                                                     |
| (9D)MFG DATE: <b>Manufacturing Date</b>                                             | QUANTITY: <b>Packing Quantity</b>                                                   |
|  |  |
| C/O: <b>Country of Origin</b>                                                       |                                                                                     |
| <hr/>                                                                               |                                                                                     |
| Customer P/N:                                                                       | CAT: <b>Intensity Bin</b>                                                           |
|  |  |
| Supplier Code:                                                                      | BIN: <b>Refer to below information</b>                                              |
|  |  |
|                                                                                     | DATECODE: <b>Date Code</b>                                                          |
|                                                                                     |  |

## Acronyms and Definitions

### **BIN:**

- (i) Color bin only or  $V_F$  bin only

Applicable for part number with color bins but without  $V_F$  bin OR part number with  $V_F$  bins and no color bin.

OR

- (ii) Color bin incorporated with  $V_F$  Bin

Applicable for part number that have both color bin and  $V_F$  bin.

### **Example:**

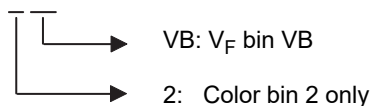
- (i) Color bin only or  $V_F$  bin only

BIN: 2 (represent color bin 2 only)

BIN: VB (represent  $V_F$  bin VB only)

- (ii) Color bin incorporate with  $V_F$  Bin

BIN: 2 VB



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