

# HLMP-1600

T-1<sup>3</sup>/<sub>4</sub> (5 mm), T-1 (3 mm), 5 Volt, 12 Volt,  
Integrated Resistor LED Lamps



## Data Sheet

**HLMP-1600, HLMP-1601, HLMP-1620, HLMP-1621  
HLMP-1640, HLMP-1641, HLMP-3600, HLMP-3601  
HLMP-3650, HLMP-3651, HLMP-3680, HLMP-3681**



### Description

The 5 volt and 12 volt series lamps contain an integral current limiting resistor in series with the LED. This allows the lamp to be driven from a 5 volt/12 volt source without an external current limiter. The red LEDs are made from GaAsP on a GaAs substrate. The High Efficiency Red and Yellow devices use GaAsP on a GaP substrate.

The green devices use GaP on a GaP substrate. The diffused lamps provide a wide off-axis viewing angle.

The T-1<sup>3</sup>/<sub>4</sub> lamps are provided with sturdy leads suitable for wire wrap applications. The T-1<sup>3</sup>/<sub>4</sub> lamps may be front panel mounted by using the HLMP-0103 clip and ring.

### Features

- **Integral current limiting resistor**
- **TTL compatible**  
Requires no external current Limiter with 5 volt/12 volt supply
- **Cost effective**  
Saves space and resistor cost
- **Wide viewing angle**
- **Available in all colors**  
Red, High Efficiency Red, Yellow, and High Performance Green in T-1 and T-1<sup>3</sup>/<sub>4</sub> packages

### Package Dimensions

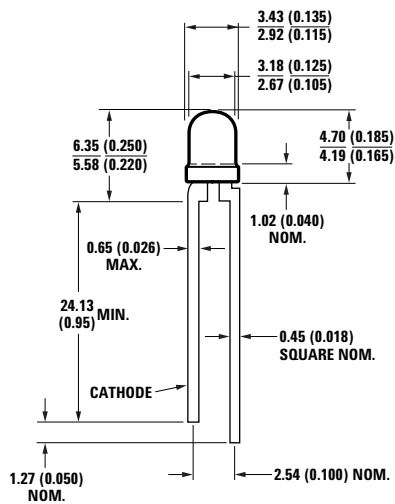


Figure A. T-1 package.

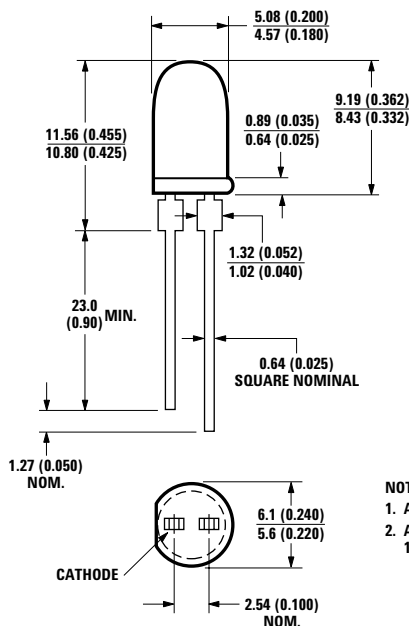


Figure B. T-1<sup>3</sup>/<sub>4</sub> package.

- NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS (INCHES).
  2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1 mm (0.040") DOWN THE LEADS.

## Selection Guide

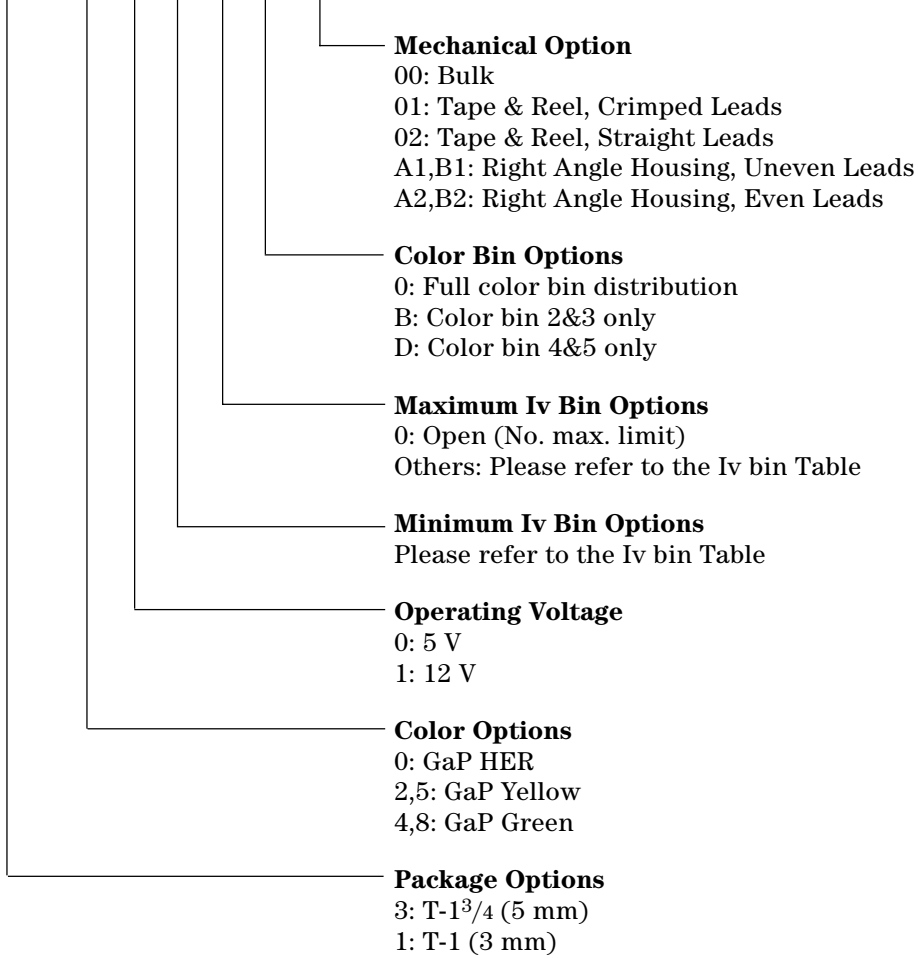
| Color                   | Package Description     | Package Outline | $2\theta_{1/2}^{[1]}$ | Operating Voltage (V) | Part Number<br>HLMP- | Luminous Intensity<br>I <sub>v</sub> (mcd) |      |
|-------------------------|-------------------------|-----------------|-----------------------|-----------------------|----------------------|--|------|
|                         |                         |                 |                       |                       |                      | Min.                                       | Max. |
| Red                     | T-1 Tinted Diffused     | A               | 60                    | 5                     | 1600                 | 2.1  | -    |
|                         |                         |                 |                       |                       | 1600-D00xx           | 2.1  | -    |
|                         |                         |                 | 60                    | 12                    | 1601                 | 2.1  | -    |
|                         |                         |                 |                       |                       | 1601-D00xx           | 2.1  | -    |
|                         | T-1 3/4 Tinted Diffused | B               | 60                    | 5                     | 1601-GH0xx           | 8.6  | 27.6 |
|                         |                         |                 |                       |                       | 3600                 | 2.1  | -    |
|                         |                         |                 | 60                    | 12                    | 3600-D00xx           | 2.1  | -    |
|                         |                         |                 |                       |                       | 3601                 | 2.1  | -    |
| Yellow                  | T-1 Tinted Diffused     | A               | 60                    | 5                     | 3601-D00xx           | 2.1  | -    |
|                         |                         |                 |                       |                       | 1620                 | 2.2  | -    |
|                         |                         |                 | 60                    | 12                    | 1620-C00xx           | 2.2  | -    |
|                         |                         |                 |                       |                       | 1620-C0Bxx           | 2.2  | -    |
|                         | T-1 3/4 Tinted Diffused | B               | 60                    | 5                     | 1620-EFBxx           | 3.4  | 10.8 |
|                         |                         |                 |                       |                       | 1621                 | 2.2  | -    |
|                         |                         |                 | 60                    | 12                    | 1621-C00xx           | 2.2  | -    |
|                         |                         |                 |                       |                       | 3650                 | 2.2  | -    |
| Green                   | T-1 Tinted Diffused     | A               | 60                    | 5                     | 3650-C00xx           | 2.2  | -    |
|                         |                         |                 |                       |                       | 3651                 | 2.2  | -    |
|                         |                         |                 | 60                    | 12                    | 3651-C00xx           | 2.2  | -    |
|                         |                         |                 |                       |                       | 1640                 | 1.6  | -    |
|                         | T-1 3/4 Tinted Diffused | B               | 60                    | 5                     | 1640-B00xx           | 1.6  | -    |
|                         |                         |                 |                       |                       | 1640-B0Dxx           | 1.6  | -    |
|                         |                         |                 | 60                    | 12                    | 1640-DE0xx           | 4.2  | 13.4 |
|                         |                         |                 |                       |                       | 1641                 | 1.6  | -    |
| T-1 3/4 Tinted Diffused | B                       | 60              | 5                     | 1641-B00xx            | 1.6                  | -  |      |
|                         |                         |                 |                       | 3680                  | 1.6                  | -  |      |
|                         |                         | 60              | 12                    | 3680-B00xx            | 1.6                  | -  |      |
|                         |                         |                 |                       | 3681                  | 1.6                  | -  |      |
|                         |                         |                 |                       |                       | 3681-B00xx           | 1.6  | -    |

**Note:**

1.  $\theta_{1/2}$  is the off-axis angle at which the luminous intensity is 1/2 the axial luminous intensity.

## Part Numbering System

HLMX-X 6 X X X X X XX



## Absolute Maximum Ratings at T<sub>A</sub> = 25°C

|  | Red/HER/Yellow<br>5 Volt Lamps | Red/HER/Yellow<br>12 Volt Lamps | Green<br>5 Volt Lamps    | Green<br>12 Volt Lamps  |
|--|--------------------------------|---------------------------------|--------------------------|-------------------------|
| DC Forward Voltage (T <sub>A</sub> = 25°C) | 7.5 Volts <sup>[2]</sup>       | 15 Volts <sup>[3]</sup>         | 7.5 Volts <sup>[2]</sup> | 15 Volts <sup>[3]</sup> |
| Reverse Voltage (I <sub>R</sub> = 100 μA)  | 5 Volts                        | 5 Volts                         | 5 Volts                  | 5 Volts                 |
| Operating Temperature Range                | -40°C to 85°C                  | -40°C to 85°C                   | -20°C to 85°C            | -20°C to 85°C           |
| Storage Temperature Range                  | -55°C to 100°C                 | -55°C to 100°C                  | -55°C to 100°C           | -55°C to 100°C          |

### Notes:

2. Derate from T<sub>A</sub> = 50°C at 0.071 V/°C, see Figure 3.

3. Derate from T<sub>A</sub> = 50°C at 0.086 V/°C, see Figure 4.

## Electrical/Optical Characteristics at $T_A = 25^\circ\text{C}$

| Symbol                | Description                     | High Efficiency Red |      |      | Yellow |      |      | Green |      |      | Unit                      | Test Condition                    |
|-----------------------|---------------------------------|---------------------|------|------|--------|------|------|-------|------|------|---------------------------|-----------------------------------|
|                       |                                 | Min.                | Typ. | Max. | Min.   | Typ. | Max. | Min.  | Typ. | Max. |                           |                                   |
| $\lambda_P$           | Peak Wavelength                 |                     | 635  |      |        | 583  |      |       | 565  |      | nm                        |                                   |
| $\lambda_d$           | Dominant Wavelength             |                     | 626  |      |        | 585  |      |       | 569  |      | nm                        | Note 4                            |
| $\Delta\lambda^{1/2}$ | Spectral Line Halfwidth         |                     | 40   |      |        | 36   |      |       | 28   |      | nm                        |                                   |
| $R\theta_{J-PIN}$     | Thermal Resistance              |                     | 290  |      |        | 290  |      |       | 290  |      | $^\circ\text{C}/\text{W}$ | Junction to Cathode Lead (Note 6) |
| $R\theta_{J-PIN}$     | Thermal Resistance              |                     | 210  |      |        | 210  |      |       | 210  |      | $^\circ\text{C}/\text{W}$ | Junction to Cathode Lead (Note 7) |
| $I_F$                 | Forward Current<br>12 V Devices |                     | 13   | 20   |        | 13   | 20   |       | 13   | 20   | mA                        | $V_F = 12\text{ V}$               |
| $I_F$                 | Forward Current<br>5 V Devices  |                     | 10   | 15   |        | 10   | 15   |       | 10   | 15   | mA                        | $V_F = 5\text{ V}$                |
| $\eta_V$              | Luminous Efficacy               |                     | 145  |      |        | 500  |      |       | 595  |      | lumen/Watt                | Note 2                            |
| $V_R$                 | Reverse Breakdown Voltage       | 5.0                 |      |      | 5.0    |      |      | 5.0   |      |      | V                         | $I_R = 100\ \mu\text{A}$          |

### Notes:

- The dominant wavelength,  $\lambda_d$ , is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
- Radiant intensity,  $I_e$ , in watts/steradian, may be found from the equation  $I_e = I_V/\eta_V$ , where  $I_V$  is the luminous intensity in candelas and  $\eta_V$  is the luminous efficacy in lumens/Watt.
- For Figure A package type.
- For Figure B package type.

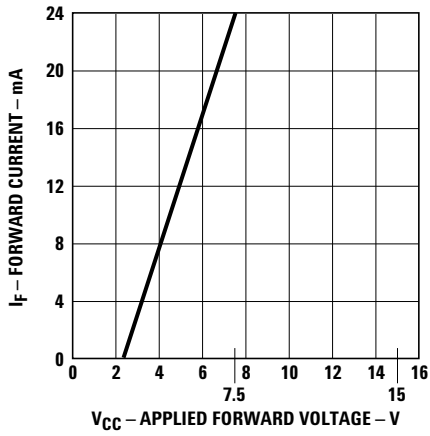


Figure 1. Forward current vs. applied forward voltage. 5 volt devices.

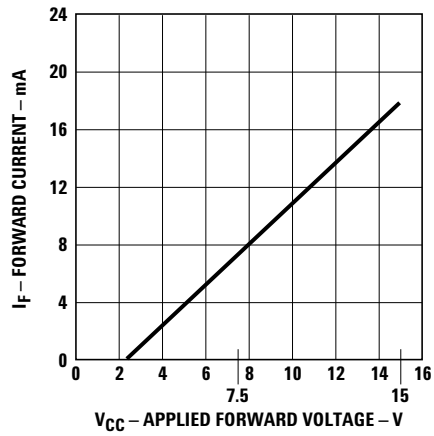


Figure 2. Forward current vs. applied forward voltage. 12 volt devices.

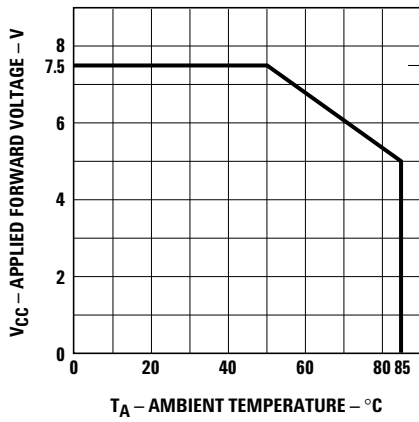


Figure 3. Maximum allowed applied forward voltage vs. ambient temperature  $R_{\theta JA} = 175^\circ\text{C}/\text{W}$ . 5 volt devices.

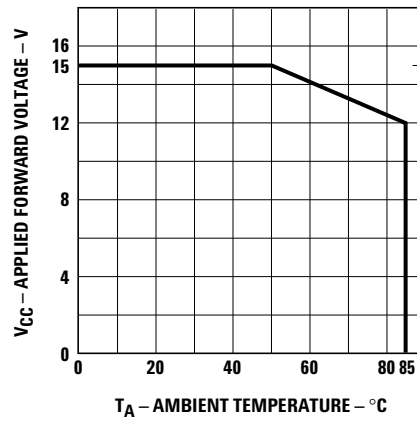


Figure 4. Maximum allowed applied forward voltage vs. ambient temperature  $R_{\theta JA} = 175^\circ\text{C}/\text{W}$ . 12 volt devices.

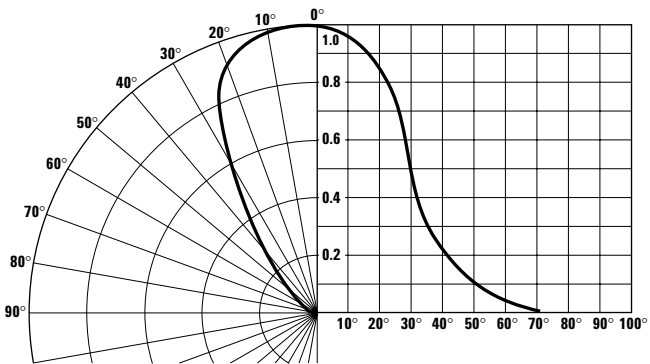


Figure 5. Relative luminous intensity vs. angular displacement for T-1 package.

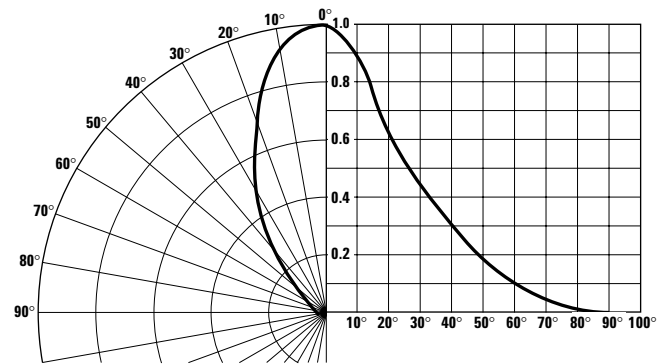


Figure 6. Relative luminous intensity vs. angular displacement for T-1<sup>3/4</sup> package.

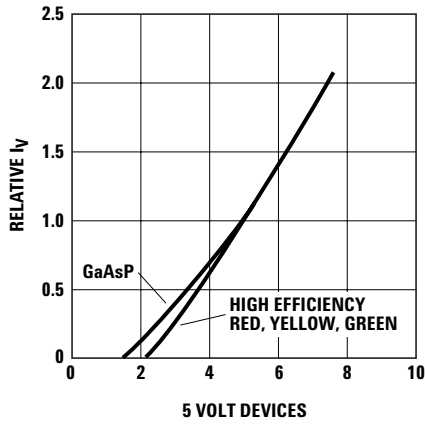


Figure 7. Relative luminous intensity vs. applied forward voltage. 5 volt devices.

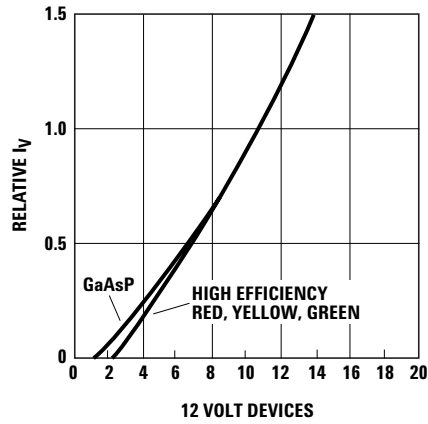


Figure 8. Relative luminous intensity vs. applied forward voltage. 12 volt devices.

**Intensity Bin Limit**

| Color | Bin     | Intensity Range (mcd) |         |
|-------|---------|-----------------------|---------|
|       |         | Min.                  | Max.    |
| Red   | D       | 2.4                   | 3.8     |
|       | E       | 3.8                   | 6.1     |
|       | F       | 6.1                   | 9.7     |
|       | G       | 9.7                   | 15.5    |
|       | H       | 15.5                  | 24.8    |
|       | I       | 24.8                  | 39.6    |
|       | J       | 39.6                  | 63.4    |
|       | K       | 63.4                  | 101.5   |
|       | L       | 101.5                 | 162.4   |
|       | M       | 162.4                 | 234.6   |
|       | N       | 234.6                 | 340.0   |
|       | O       | 340.0                 | 540.0   |
|       | P       | 540.0                 | 850.0   |
|       | Q       | 850.0                 | 1200.0  |
|       | R       | 1200.0                | 1700.0  |
|       | S       | 1700.0                | 2400.0  |
|       | T       | 2400.0                | 3400.0  |
|       | U       | 3400.0                | 4900.0  |
|       | V       | 4900.0                | 7100.0  |
|       | W       | 7100.0                | 10200.0 |
| X     | 10200.0 | 14800.0               |         |
| Y     | 14800.0 | 21400.0               |         |
| Z     | 21400.0 | 30900.0               |         |

**(Cont'd)**

| Color  | Bin     | Intensity Range (mcd) |         |
|--------|---------|-----------------------|---------|
|        |         | Min.                  | Max.    |
| Yellow | C       | 2.5                   | 4.0     |
|        | D       | 4.0                   | 6.5     |
|        | E       | 6.5                   | 10.3    |
|        | F       | 10.3                  | 16.6    |
|        | G       | 16.6                  | 26.5    |
|        | H       | 26.5                  | 42.3    |
|        | I       | 42.3                  | 67.7    |
|        | J       | 67.7                  | 108.2   |
|        | K       | 108.2                 | 173.2   |
|        | L       | 173.2                 | 250.0   |
|        | M       | 250.0                 | 360.0   |
|        | N       | 360.0                 | 510.0   |
|        | O       | 510.0                 | 800.0   |
|        | P       | 800.0                 | 1250.0  |
|        | Q       | 1250.0                | 1800.0  |
|        | R       | 1800.0                | 2900.0  |
|        | S       | 2900.0                | 4700.0  |
|        | T       | 4700.0                | 7200.0  |
|        | U       | 7200.0                | 11700.0 |
|        | V       | 11700.0               | 18000.0 |
| W      | 18000.0 | 27000.0               |         |

**(Cont'd)**

| Color | Bin     | Intensity Range (mcd) |         |
|-------|---------|-----------------------|---------|
|       |         | Min.                  | Max.    |
| Green | B       | 1.8                   | 2.9     |
|       | C       | 2.9                   | 4.7     |
|       | D       | 4.7                   | 7.6     |
|       | E       | 7.6                   | 12.0    |
|       | F       | 12.0                  | 19.1    |
|       | G       | 19.1                  | 30.7    |
|       | H       | 30.7                  | 49.1    |
|       | I       | 49.1                  | 78.5    |
|       | J       | 78.5                  | 125.7   |
|       | K       | 125.7                 | 201.1   |
|       | L       | 201.1                 | 289.0   |
|       | M       | 289.0                 | 417.0   |
|       | N       | 417.0                 | 680.0   |
|       | O       | 680.0                 | 1100.0  |
|       | P       | 1100.0                | 1800.0  |
|       | Q       | 1800.0                | 2700.0  |
|       | R       | 2700.0                | 4300.0  |
|       | S       | 4300.0                | 6800.0  |
|       | T       | 6800.0                | 10800.0 |
|       | U       | 10800.0               | 16000.0 |
| V     | 16000.0 | 25000.0               |         |
| W     | 25000.0 | 40000.0               |         |

Maximum tolerance for each bin limit is ±18%.

## Color Categories

| Color  | Cat # | Lambda (nm) |       |
|--------|-------|-------------|-------|
|        |       | Min.        | Max.  |
| Green  | 6     | 561.5       | 564.5 |
|        | 5     | 564.5       | 567.5 |
|        | 4     | 567.5       | 570.5 |
|        | 3     | 570.5       | 573.5 |
|        | 2     | 573.5       | 576.5 |
|        | 1     | 582.0       | 584.5 |
| Yellow | 3     | 584.5       | 587.0 |
|        | 2     | 587.0       | 589.5 |
|        | 4     | 589.5       | 592.0 |
|        | 5     | 592.0       | 593.0 |

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

## Mechanical Option Matrix

| Mechanical Option Code | Definition  |
|------------------------|---|
| 00                     | Bulk Packaging, minimum increment 500 pcs/bag   |
| 01                     | Tape & Reel, crimped leads, minimum increment 1300 pcs/bag                                |
| 02                     | Tape & Reel, straight leads, minimum increment 1300 pcs/bag                               |
| A1                     | T-1, Right Angle Housing, uneven leads, minimum increment 500 pcs/bag                     |
| A2                     | T-1, Right Angle Housing, even leads, minimum increment 500 pcs/bag                       |
| B1                     | T-1 <sup>3</sup> / <sub>4</sub> Angle Housing, uneven lead, minimum increment 500 pcs/bag |
| B2                     | T-1 <sup>3</sup> / <sub>4</sub> Angle Housing, even leads, minimum increment 500 pcs/bag  |

**Note:** All categories are established for classification of products. Products may not be available in all categories. Please contact your local Avago representative for further clarification/information.

## Precautions

### Lead Forming

- The leads of an LED lamp may be preformed or cut to length prior to insertion and soldering into PC board.
- If lead forming is required before soldering, care must be taken to avoid any excessive mechanical stress induced to LED package. Otherwise, cut the leads of LED to length after soldering process at room temperature. The solder joint formed will absorb the mechanical stress of the lead cutting from traveling to the LED chip die attach and wirebond.
- It is recommended that tooling made to precisely form and cut the leads to length rather than rely upon hand operation.

### Soldering Conditions

- Care must be taken during PCB assembly and soldering process to prevent damage to LED component.
- The closest LED is allowed to solder on board is 1.59 mm below the body (encapsulant epoxy) for those parts without standoff.
- Recommended soldering conditions:

|                      | Wave Soldering | Manual Solder Dipping |
|----------------------|----------------|-----------------------|
| Pre-heat Temperature | 105 °C Max.    | –                     |
| Pre-heat Time        | 30 sec Max.    | –                     |
| Peak Temperature     | 250 °C Max.    | 260 °C Max.           |
| Dwell Time           | 3 sec Max.     | 5 sec Max.            |

- Wave soldering parameter must be set and maintained according to recommended temperature and dwell time in the solder wave. Customer is advised to periodically check on the soldering profile to ensure the soldering profile used is always conforming to recommended soldering condition.
- If necessary, use fixture to hold the LED component in proper orientation with respect to the PCB during soldering process.
- Proper handling is imperative to avoid excessive thermal stresses to LED components when heated. Therefore, the soldered PCB must be allowed to cool to room temperature, 25°C, before handling.
- Special attention must be given to board fabrication, solder masking, surface plating and lead holes size and component orientation to assure solderability.
- Recommended PC board plated through hole sizes for LED component leads:

| LED Component Lead Size                  | Diagonal                 | Plated Through Hole Diameter               |
|--|--------------------------|--|
| 0.457 x 0.457 mm<br>(0.018 x 0.018 inch) | 0.646 mm<br>(0.025 inch) | 0.976 to 1.078 mm<br>(0.038 to 0.042 inch) |
| 0.508 x 0.508 mm<br>(0.020 x 0.020 inch) | 0.718 mm<br>(0.028 inch) | 1.049 to 1.150 mm<br>(0.041 to 0.045 inch) |

**Note:** Refer to application note AN1027 for more information on soldering LED components.

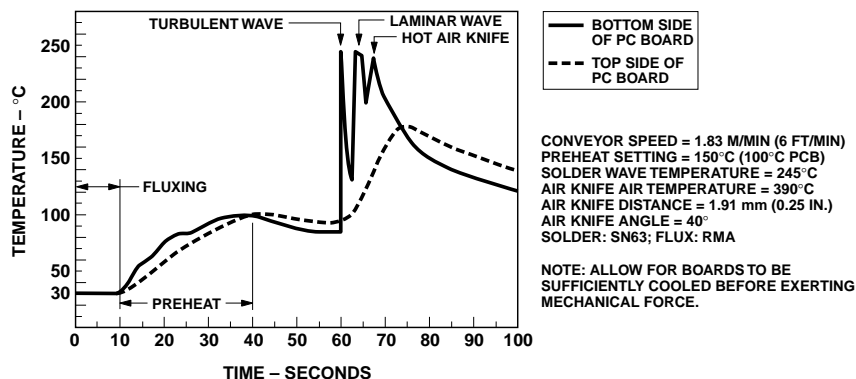


Figure 9. Recommended wave soldering profile.



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