Data Sheet

# ASMT-YTD2-0BB02

## High-Brightness Tricolor PLCC-6 White-Surface LED

## Description

This family of Broadcom® SMT LEDs is packaged in the form of PLCC-6 with a separate heat path for each LED die, enabling it to be driven at higher current.

Individually addressable pinouts give higher flexibility in circuitry design. With a closely matched radiation pattern along the package's X-axis, these LEDs are suitable for indoor full-color display applications.

For easy pick-and-place, the LEDs are shipped in tape and reel. Every reel is shipped from a single intensity and color bin for better uniformity.

These LEDs are compatible with reflow soldering processes.

**CAUTION!** LEDs are Class 1C ESD sensitive. Observe appropriate precautions during handling and processing. Refer to Broadcom Application Note 1142 for additional details.

## Features

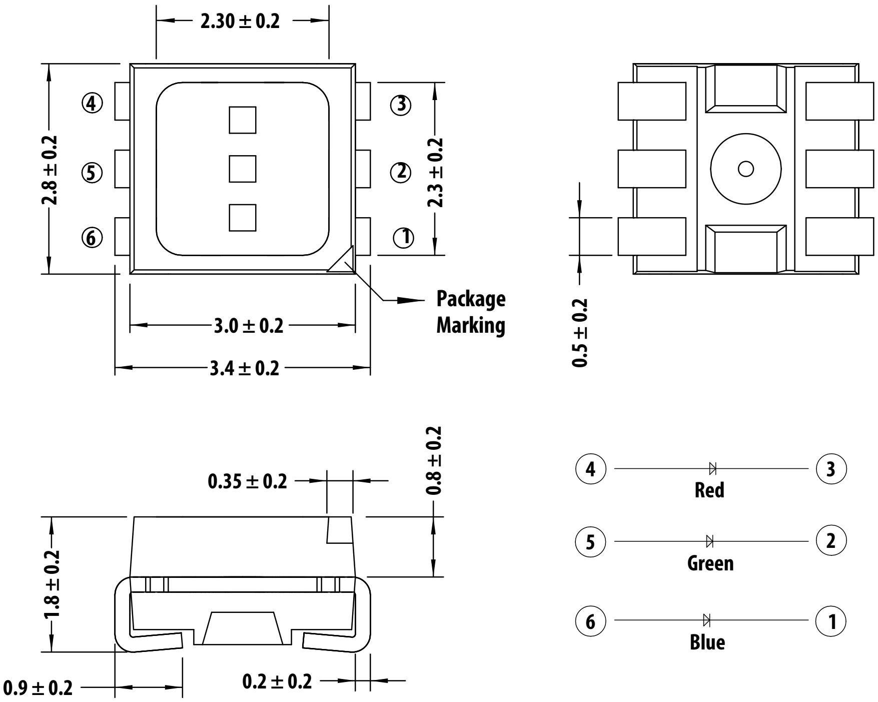
- Standard PLCC-6 package (plastic leaded chip carrier) with individual addressable pinouts for higher flexibility of driving configuration
- High-reliability LED package with silicone encapsulation
- High brightness using AlInGaP and InGaN dice technologies
- Typical viewing angle of 120°
- Compatible with reflow soldering processes
- JEDEC MSL 2a
- Water-resistance (IPX6*) per IEC 60529:2001

  * The test is conducted on a component level by mounting the components on the PCB with proper potting to protect the leads. It is strongly recommended that customers perform necessary tests on the components for their final application.

## Applications

- Full-color sign displays
- Gaming machines

# Package Dimensions




# Lead Configuration

| | |
|---|---|
| 1 | Cathode (Blue) |
| 2 | Cathode (Green) |
| 3 | Cathode (Red) |
| 4 | Anode (Red) |
| 5 | Anode (Green) |
| 6 | Anode (Blue) |

**NOTE:**

1. All dimensions are in millimeters (mm).
2. Unless otherwise specified, the tolerance is ± 0.20 mm.
3. Encapsulation = silicone.
4. Terminal finish = silver plating.

# Absolute Maximum Ratings ($T_J$ = 25°C)

| Parameter | Red | Green and Blue | Units |
|---|---|---|---|
| DC forward current[a] | 50 | 30 | mA |
| Peak forward current [b] | 100 | 100 | mA |
| Power dissipation | 125 | 114 | mW |
| Reverse voltage[c] | 4 | | V |
| Junction temperature | 125 | | °C |
| Operating temperature range | –40 to + 110 | | °C |
| Storage temperature range | –40 to +120 | | °C |

a. Derate linearly as shown in Figure 7 to Figure 10.

b. Duty factor = 10%, frequency = 1 kHz.

c. Driving the LED in a reverse bias condition is suitable for the short term only.

# Optical Characteristics ($T_J$ = 25°C)

| Color | Luminous Intensity, $I_V$ (mcd) at $I_F$ = 20 mA[a] | | | Dominant Wavelength, $\lambda d$ (nm) at $I_F$ = 20 mA[b] | | | Peak Wavelength, $\lambda_P$ (nm) at $I_F$ = 20 mA | Viewing Angle, $2\theta½$ (°)[c] | Luminous Efficacy, $\eta_V$ (lm/W)[d] | Luminous Efficiency, $\eta_e$ (lm/W) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. | Typ. | Typ. | Typ. | Typ. |
| Red | 560 | 745 | 1125 | 618 | 622 | 628 | 629 | 120 | 210 | 43 |
| Green | 1800 | 2280 | 3550 | 525 | 530 | 537 | 521 | 120 | 535 | 75 |
| Blue | 355 | 520 | 715 | 465 | 470 | 477 | 464 | 120 | 84 | 15 |

a. The luminous intensity $I_V$, is measured at the mechanical axis of the LED package at a single current pulse condition. The actual peak of the spatial radiation pattern may not be aligned with the axis.

b. The dominant wavelength is derived from the CIE Chromaticity Diagram and represents the perceived color of the device.

c. $\theta½$ is the off-axis angle where the luminous intensity is ½ the peak intensity.

d. Radiant intensity, Ie, in watts/steradian, can be calculated from the equation $Ie = I_V / \eta_V$, where $I_V$ is the luminous intensity in candelas and $\eta_V$ is the luminous efficacy in lumens/watt.

# Electrical Characteristics ($T_J$ = 25°C)

| Color | Forward Voltage, $V_F$ (V) at $I_F$ = 20 mA[a] | | | Reverse Voltage, $V_R$ at $I_R$ = 100 µA[b] | Reverse Voltage, $V_R$ at $I_R$ = 10 µA[b] | Thermal Resistance, $R\theta_{J-S}$ (°C/W) | |
|---|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Min. | 1 Chip On | 3 Chips On |
| Red | 1.8 | 2.0 | 2.5 | 4.0 | — | 280 | 280 |
| Green | 2.4 | 2.7 | 3.4 | — | 4.0 | 180 | 230 |
| Blue | 2.4 | 2.7 | 3.4 | — | 4.0 | 180 | 230 |

a. Tolerance = ±0.1V.

b. Indicates the product final test condition. Long-term reverse bias is not recommended.

# Part Numbering System

| A | S | M | T | - | Y | T | D | 2 | - | 0 | B | B | 0 | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $x_1$ | | | | $x_2$ | $x_3$ | $x_4$ | $x_5$ |

| Code | Description | Option | | | | |
|---|---|---|---|---|---|---|
| $x_1$ | Package type | D | White surface | | | |
| $x_2$ | Minimum intensity bin | B | Red: | Bin U2 | Red | Bin U2, V1, V2 |
| | | | Green: | Bin X1 | Green | Bin X1, X2, Y1 |
| | | | Blue: | Bin T2 | Blue | Bin T2, U1, U2 |
| $x_3$ | Number of intensity bins | B | Three intensity bins from minimum | | | |
| $x_4$ | Color bin combination | 0 | Red: | Full distribution | | |
| | | | Green: | Bin A, B, C | | |
| | | | Blue: | Bin A, B, C, D, E | | |
| $x_5$ | Test option | 2 | Test current = 20 mA | | | |

# Bin Information

## Intensity Bins (CAT)

| Bin ID | Luminous Intensity (mcd) | |
|---|---|---|
| | Min. | Max. |
| T1 | 285 | 355 |
| T2 | 355 | 450 |
| U1 | 450 | 560 |
| U2 | 560 | 715 |
| V1 | 715 | 900 |
| V2 | 900 | 1125 |
| W1 | 1125 | 1400 |
| W2 | 1400 | 1800 |
| X1 | 1800 | 2240 |
| X2 | 2240 | 2850 |
| Y1 | 2850 | 3550 |

Tolerance: ±12%

## Color Bins (BIN) – Green

| Bin ID | Dominant Wavelength (nm) | | Chromaticity Coordinate (for Reference) | |
|---|---|---|---|---|
| | Min. | Max. | Cx | Cy |
| A | 525.0 | 531.0 | 0.1142 | 0.8262 |
| | | | 0.1799 | 0.6783 |
| | | | 0.2138 | 0.6609 |
| | | | 0.1625 | 0.8012 |
| B | 528.0 | 534.0 | 0.1387 | 0.8148 |
| | | | 0.1971 | 0.6703 |
| | | | 0.2298 | 0.6507 |
| | | | 0.1854 | 0.7867 |
| C | 531.0 | 537.0 | 0.1625 | 0.8012 |
| | | | 0.2138 | 0.6609 |
| | | | 0.2454 | 0.6397 |
| | | | 0.2077 | 0.7711 |

Tolerance: ±1 nm

## Color Bins (BIN) – Red

| Bin ID | Dominant Wavelength (nm) | | Chromaticity Coordinate (for Reference) | |
|---|---|---|---|---|
| | Min. | Max. | Cx | Cy |
| — | 618.0 | 628.0 | 0.6873 | 0.3126 |
| | | | 0.6696 | 0.3136 |
| | | | 0.6866 | 0.2967 |
| | | | 0.7052 | 0.2948 |

Tolerance: ±1 nm

## Color Bins (BIN) – Blue

| Bin ID | Dominant Wavelength (nm) | | Chromaticity Coordinate (for Reference) | |
|---|---|---|---|---|
| | Min. | Max. | Cx | Cy |
| A | 465.0 | 469.0 | 0.1355 | 0.0399 |
| | | | 0.1751 | 0.0986 |
| | | | 0.1680 | 0.1094 |
| | | | 0.1267 | 0.0534 |
| B | 467.0 | 471.0 | 0.1314 | 0.0459 |
| | | | 0.1718 | 0.1034 |
| | | | 0.1638 | 0.1167 |
| | | | 0.1215 | 0.0626 |
| C | 469.0 | 473.0 | 0.1267 | 0.0534 |
| | | | 0.1680 | 0.1094 |
| | | | 0.1593 | 0.1255 |
| | | | 0.1158 | 0.0736 |
| D | 471.0 | 475.0 | 0.1215 | 0.0626 |
| | | | 0.1638 | 0.1167 |
| | | | 0.1543 | 0.1361 |
| | | | 0.1096 | 0.0868 |
| E | 473.0 | 477.0 | 0.1158 | 0.0736 |
| | | | 0.1593 | 0.1255 |
| | | | 0.1489 | 0.1490 |
| | | | 0.1028 | 0.1029 |

Tolerance: ±1 nm

# Characteristics

**Figure 1: Relative Spectral Emission**

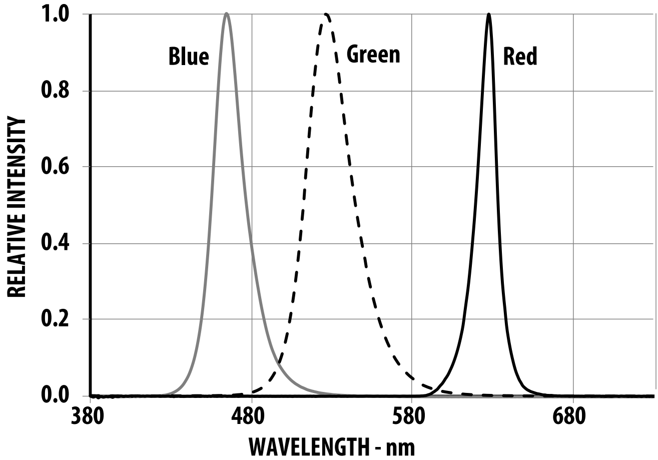



**Figure 2: Forward Current vs. Forward Voltage**

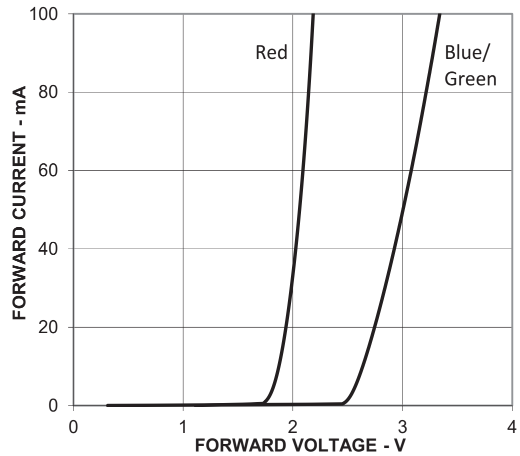



**Figure 3: Relative Luminous Intensity vs. Forward Current**

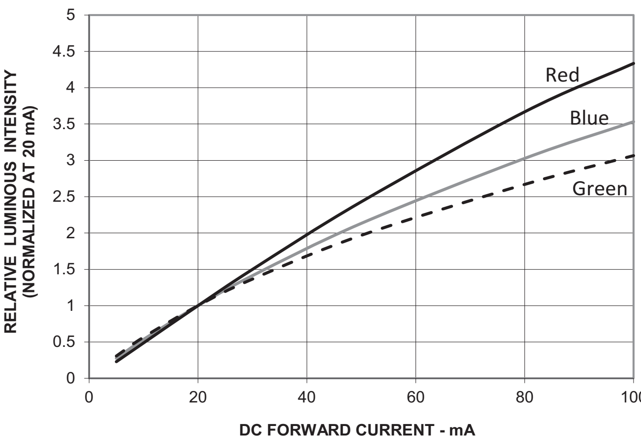



**Figure 4: Dominant Wavelength Shift vs. Forward Current**

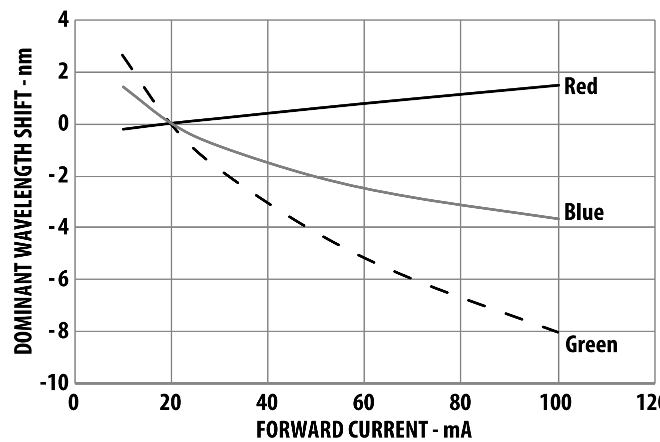



**Figure 5: Relative Luminous Intensity vs. Junction Temperature**

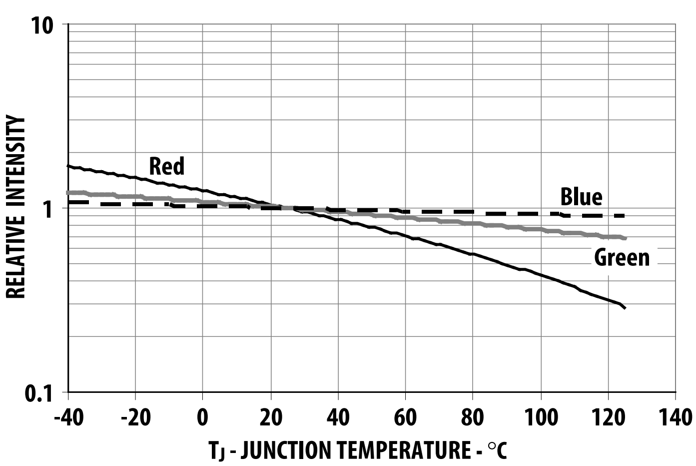



**Figure 6: Forward Voltage Shift vs. Junction Temperature**

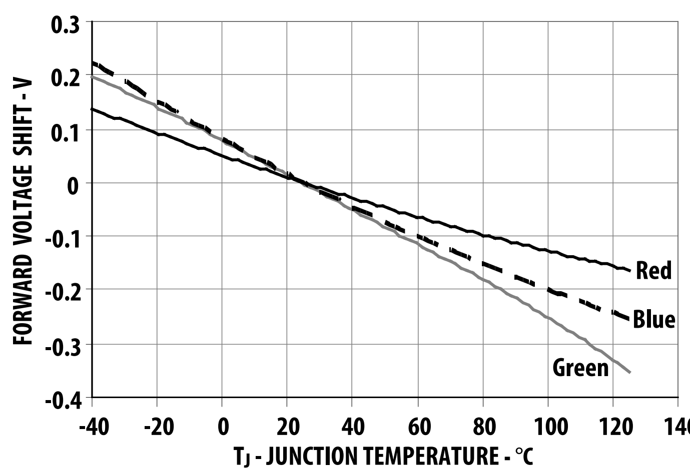


**Figure 7: Maximum Forward Current vs. Temperature for Red (1 Chip On)**

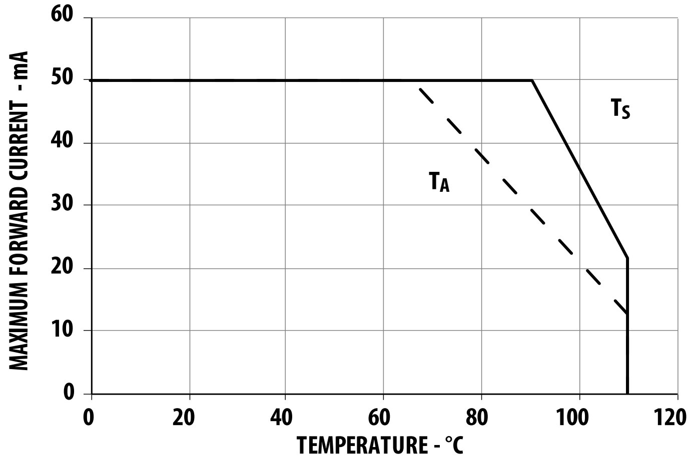



**Figure 8: Maximum Forward Current vs. Temperature for Red (3 Chips On)**

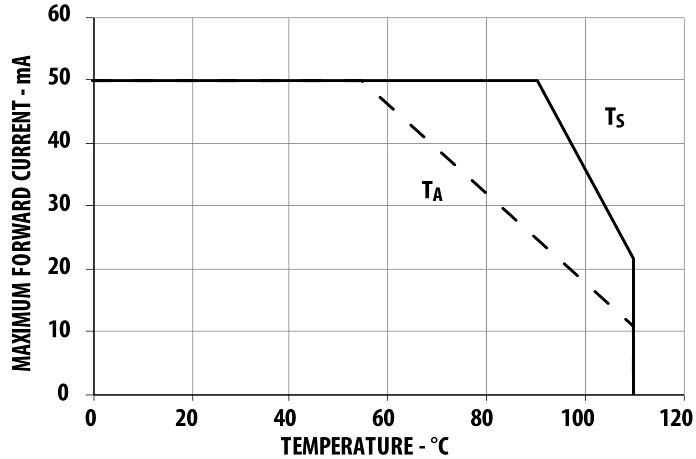



**Figure 9: Maximum Forward Current vs. Temperature for Green and Blue (1 Chip On)**

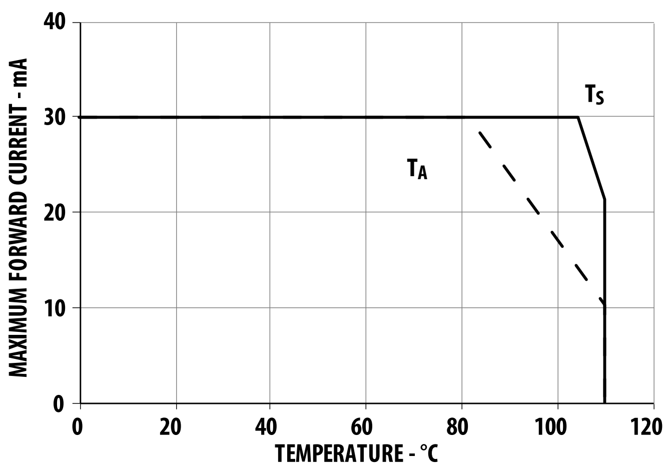
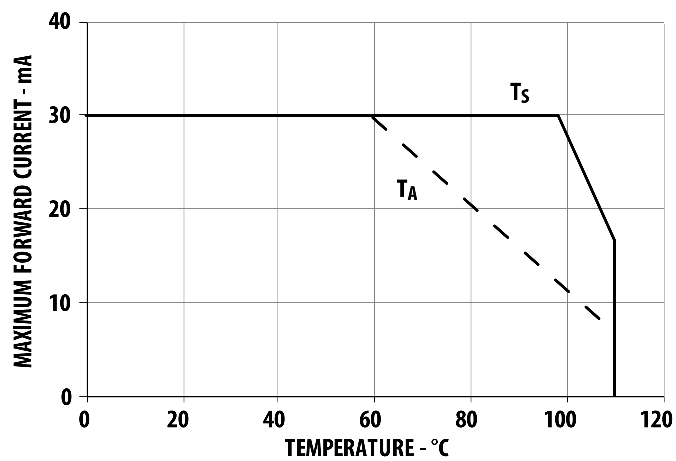



**Figure 10: Maximum Forward Current vs. Temperature for Green and Blue (3 Chips On)**




**NOTE:** Maximum forward current graphs based on ambient temperature ($T_A$) are with reference to thermal resistance ($R\theta_{J-A}$) as follows. For more details, see Thermal Management.

| Condition | Thermal Resistance from LED Junction to Ambient, $R\theta_{J-A}$ (°C/W) | |
|---|---|---|
| | Red | Green and Blue |
| 1 chip on | 473 | 373 |
| 3 chips on | 563 | 563 |

**Figure 11: Radiation Pattern Along X-Axis of the Package**

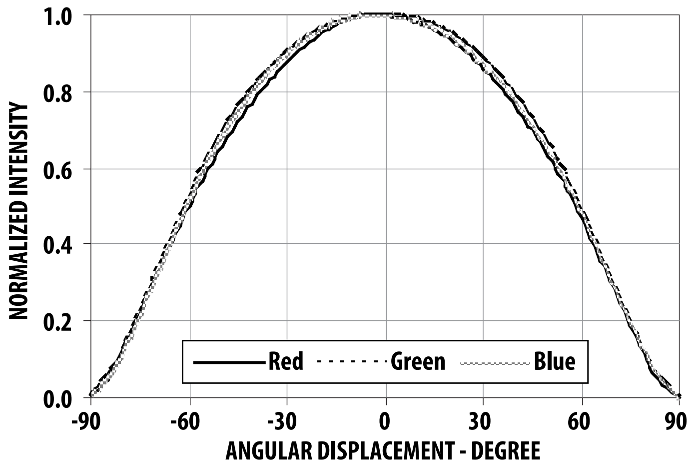



**Figure 12: Radiation Pattern Along Y-Axis of the Package**

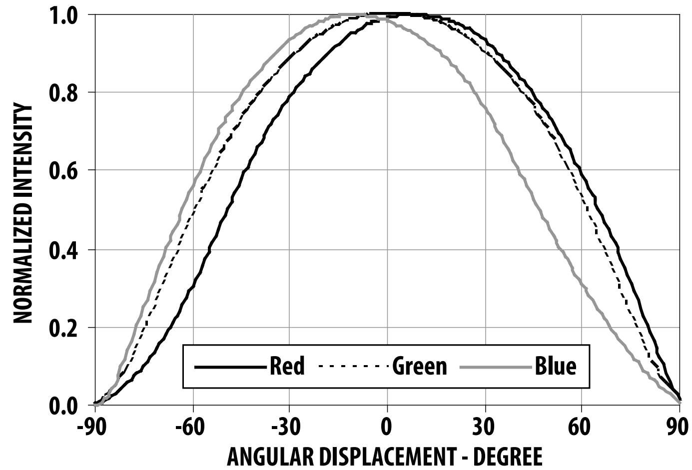



**Figure 13: Illustration of Package Axis for Radiation Pattern**

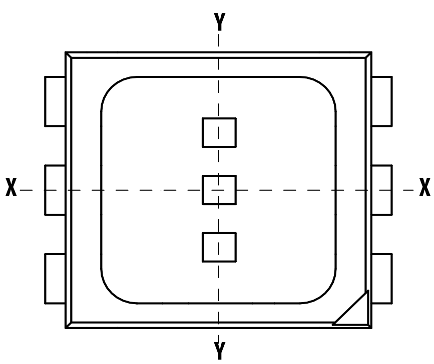


**Figure 14: Recommended Soldering Land Pattern**

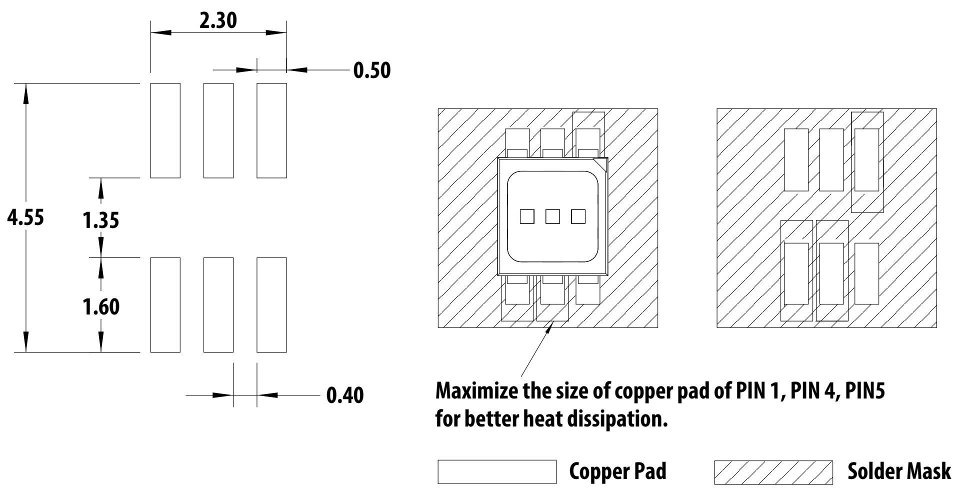



**Figure 15: Carrier Tape Dimensions**

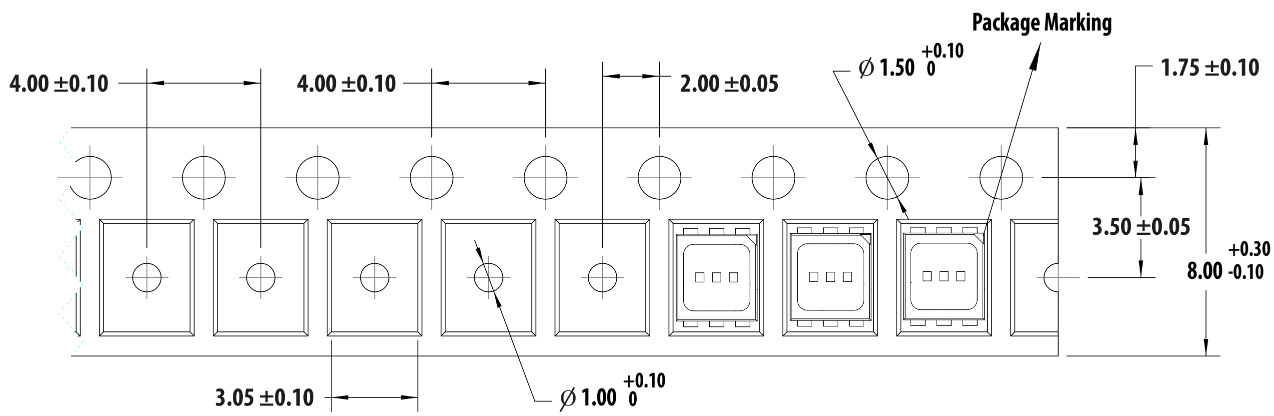



**Figure 16: Reeling Orientation**

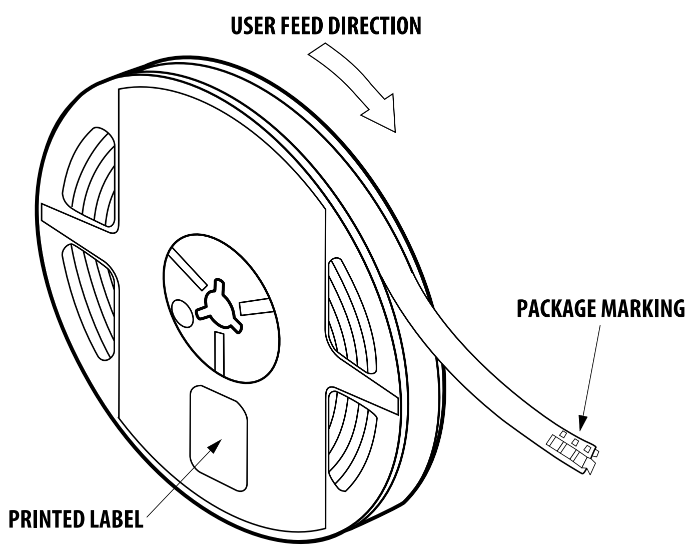
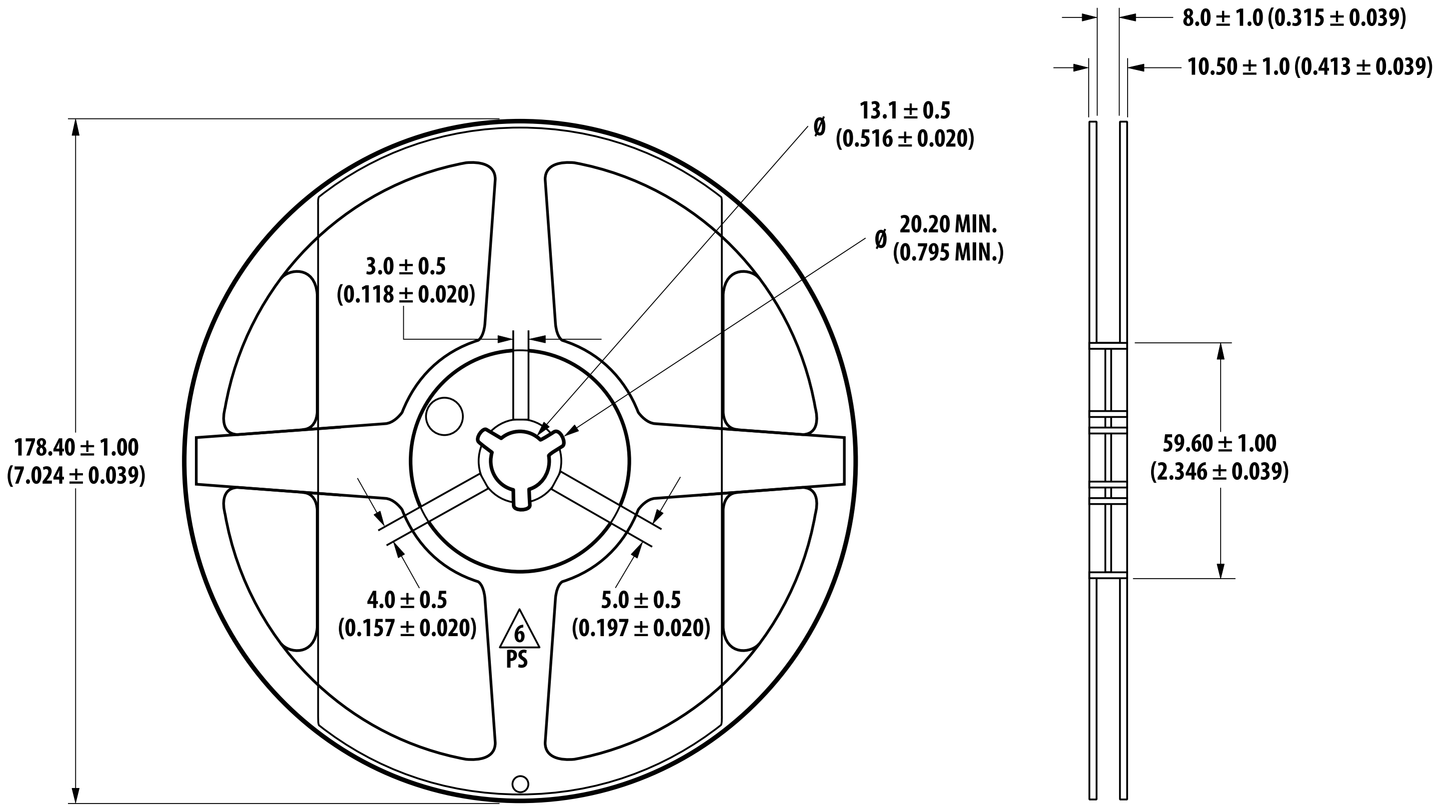


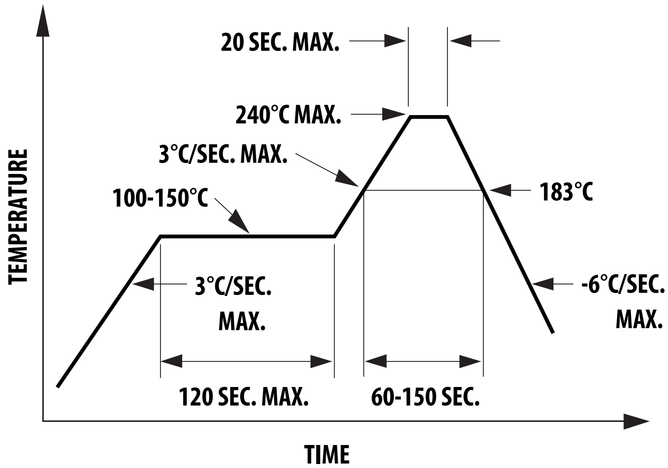
**Figure 17: Reel Dimensions**



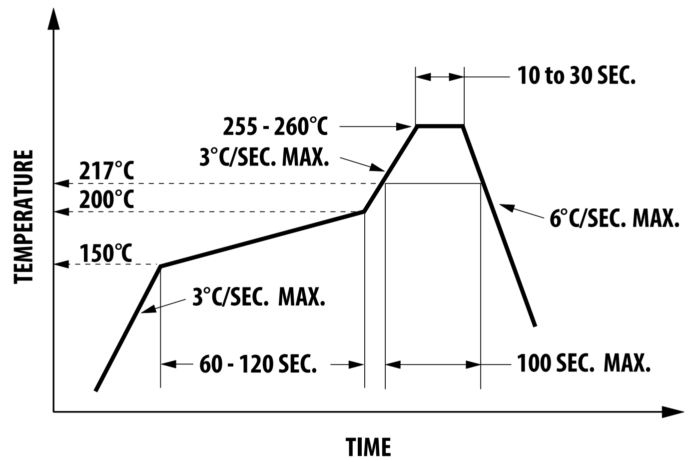
# Soldering

## Recommended Reflow Soldering Conditions

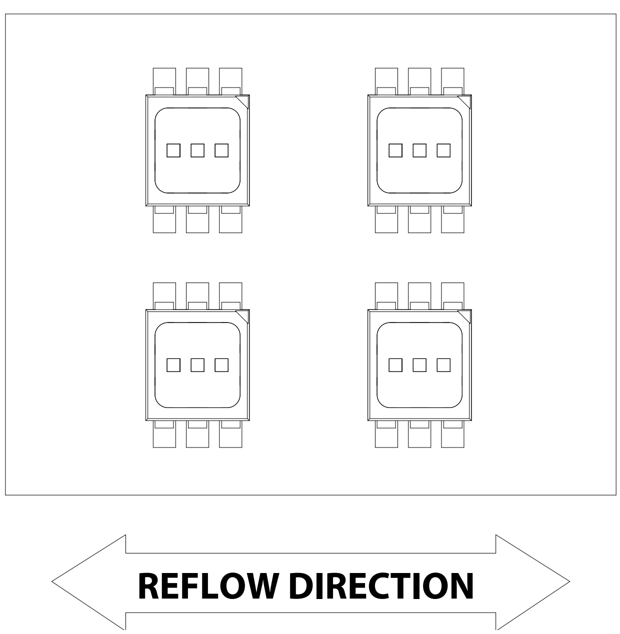
### (i) Leaded Reflow Soldering




### (ii) Lead-Free Reflow Soldering




1. Reflow soldering must not be done more than twice. Observe necessary precautions for handling moisture-sensitive devices as stated in Handling Moisture-Sensitive Devices.
2. The recommended board reflow direction is shown in the following figure.



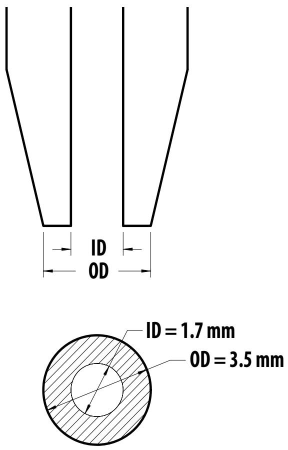

3. Do not apply any pressure or force on the LED during reflow and after reflow when the LED is still hot.
4. Use reflow soldering to solder the LED. Use hand soldering for rework if this is unavoidable, but it must be strictly controlled to the following conditions:
   – Soldering iron tip temperature = 320°C maximum
   – Soldering duration = 3 seconds maximum
   – Number of cycles = 1 only
   – Power of soldering iron = 50W maximum
5. Do not touch the LED body with a hot soldering iron except the soldering terminals because it may cause damage to the LED.
6. For de-soldering, use a double flat tip.
7. Confirm beforehand whether hand soldering will affect the functionality and performance of the LED.

# Precautionary Notes

## Handling Precautions

The encapsulation material of the LED is made of silicone for better product reliability. Compared to epoxy encapsulant that is hard and brittle, silicone is softer and flexible. Observe special handling precautions during the assembly of silicone-encapsulated LED products. Failure to comply might lead to damage and premature failure of the LED. For more information, refer to Application Note 5288, S*ilicone Encapsulation for LED: Advantages and Handling Precautions*.

- Do not poke sharp objects into the silicone encapsulant. Sharp objects, such as tweezers or syringes, might apply excessive force or even pierce through the silicone and induce failures to the LED die or wire bond.
- Do not touch the silicone encapsulant. Uncontrolled force acting on the silicone encapsulant might result in excessive stress on the wire bond. Hold the LED only by the body.
- Do not stack assembled PCBs together. Use an appropriate rack to hold the PCBs.
- The surface of silicone material attracts dusk and dirt easier than epoxy due to its surface tackiness. To remove foreign particles on the surface of silicone, use a cotton bud with isopropyl alcohol (IPA). During cleaning, rub the surface gently without putting much pressure on the silicone. Ultrasonic cleaning is not recommended.
- For automated pick-and-place, Broadcom has tested the following nozzle size to work well with this LED. However, due to the possibility of variations in other parameters, such as the pick-and-place machine maker/model and other machine settings, verify that the selected nozzle will not cause damage to the LED.




## Handling Moisture-Sensitive Devices

This product has a Moisture Sensitive Level 2a rating per JEDEC J-STD-020. For additional details and a review of proper handling procedures, refer to Broadcom Application Note 5305, *Handling Moisture-Sensitive Surface-Mount LEDs*.

**Before use:**

- An unopened moisture barrier bag (MBB) can be stored at < 40°C/90% RH for 12 months. If the actual shelf life has exceeded 12 months and the humidity indicator card (HIC) indicates that baking is not required, then it is safe to reflow the LEDs per the original MSL rating.
- Do not open the MBB prior to assembly (for example, for IQC).

**Control after opening the MBB:**

- Read the HIC immediately upon opening the MBB.
- Keep the LEDs at < 30°C/60% RH at all times, and all high-temperature-related processes, including soldering, curing, or rework, must be completed within 672 hours.

**Control for unfinished reels:**

Store unused LEDs in a sealed MBB with desiccant or in a desiccator at < 5% RH.

**Control of assembled boards:**

If the PCB soldered with the LEDs is to be subjected to other high-temperature processes, store the PCB in a sealed MBB with desiccant or in a desiccator at < 5% RH to ensure that all LEDs have not exceeded their floor life of 672 hours.

**Baking is required if the following conditions exist:**

- The HIC indicator indicates a change in color for 10% and 5%, as stated on the HIC.
- The LEDs are exposed to a condition of > 30°C/ 60% RH at any time.
- The LED floor life exceeded 672 hours.

The recommended baking condition is: 60°C ±5ºC for 20 hours.

Baking should be done only once.

**Storage:**

The soldering terminals of these Broadcom LEDs are silver-plated. If the LEDs are exposed in an ambient environment for too long, the silver plating might be oxidized and thus affect its solderability performance. As such, keep unused LEDs in a sealed MBB with desiccant or in a desiccator at <5% RH.

# Application Precautions

- The drive current of the LED must not exceed the maximum allowable limit across temperature as stated in this data sheet. Constant current driving is recommended to ensure consistent performance.
- LEDs exhibit slightly different characteristics at different drive currents, which might result in a larger variation in their performance (that is, intensity, wavelength, and forward voltage). Set the application current as close as possible to the test current in order to minimize these variations.
- The LED is not intended for reverse bias. Use other appropriate components for such purposes. When driving the LED in matrix form, ensure that the reverse bias voltage does not exceed the allowable limit of the LED.
- Do not use the LED in the vicinity of material with sulfur content, in an environment of high gaseous sulfur compound and corrosive elements. Examples of material that may contain sulfur are rubber gaskets, RTV (room temperature vulcanizing) silicone rubber, rubber gloves, and so on. Prolonged exposure to such environments may affect the optical characteristics and product life.
- Avoid rapid changes in ambient temperature especially in high-humidity environments as this will cause condensation on the LED.
- Although the LED is rated as IPx6 according to IEC60529, *Degrees of Protection Provided by Enclosures*, the test condition may not represent actual exposure during application. If the LED is intended to be used in an outdoor or harsh environment, protect the LED against damages caused by rainwater, dust, oil, corrosive gases, external mechanical stress, and so on.

# Thermal Management

Optical, electrical, and reliability characteristics of the LED are affected by temperature. The junction temperature ($T_J$) of the LED must be kept below the allowable limit at all times. $T_J$ can be calculated as follows:

$$T_J = T_A + R_{\theta J\text{-}A} \times I_F \times V_{Fmax}$$

where:

$T_A$ = Ambient temperature (°C)

$R_{\theta J\text{-}A}$ = Thermal resistance from LED junction to ambient (°C/W)

$I_F$ = Forward current (A)

$V_{Fmax}$ = Maximum forward voltage (V)

The complication of using this formula lies in $T_A$ and $R_{\theta J\text{-}A}$. Actual $T_A$ is sometimes subjective and hard to determine. $R_{\theta J\text{-}A}$ varies from system to system depending on design and is usually not known.

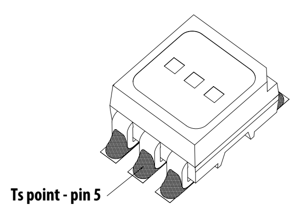
Another way of calculating $T_J$ is by using the solder point temperature ($T_S$) as shown below:

$$T_J = T_S + R_{\theta J\text{-}S} \times I_F \times V_{Fmax}$$

where:

$T_S$ = LED solder point temperature as shown in the following illustration (°C)

$R_{\theta J\text{-}S}$ = Thermal resistance from the junction to the solder point (°C/W)




$T_S$ can be measured easily by mounting a thermocouple on the soldering joint as shown in preceding illustration, whereas $R_{\theta J\text{-}S}$ is provided in this data sheet. The user is advised to verify the $T_S$ of the LED in the final product to ensure that the LEDs are operated within all maximum ratings stated in this data sheet.

# Eye Safety Precautions

LEDs may pose optical hazards when in operation. Do not look directly at operating LEDs as it may be harmful to the eyes. For safety reasons, use appropriate shielding or personal protective equipment.

## Disclaimer

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