BROADCOM®

Data Sheet

ASMB-MTB0-0B3A2

PLCC4 Tricolor Black Surface LED

Overview

These families of SMT LED are in PLCC-4 package. A wide viewing angle of 115° together with the built in reflector drives up the intensity of light output making these LEDs suitable for use in interior electronics signs. The black top surface of the LED provides better contrast enhancement, especially in full color display.

These LEDs are compatible with reflow soldering process. For easy pick & place, the LEDs are shipped in tape and reel. Every reel is shipped from a single intensity and color bin except red color for better uniformity.

Features

- Standard PLCC-4 package (Plastic Leaded Chip Carrier)
- LED package with diffused silicone encapsulation
- High brightness using AlInGaP and InGaN dice technologies
- Typical viewing angle at 115º
- Compatible with reflow soldering process
- JEDEC MSL 3

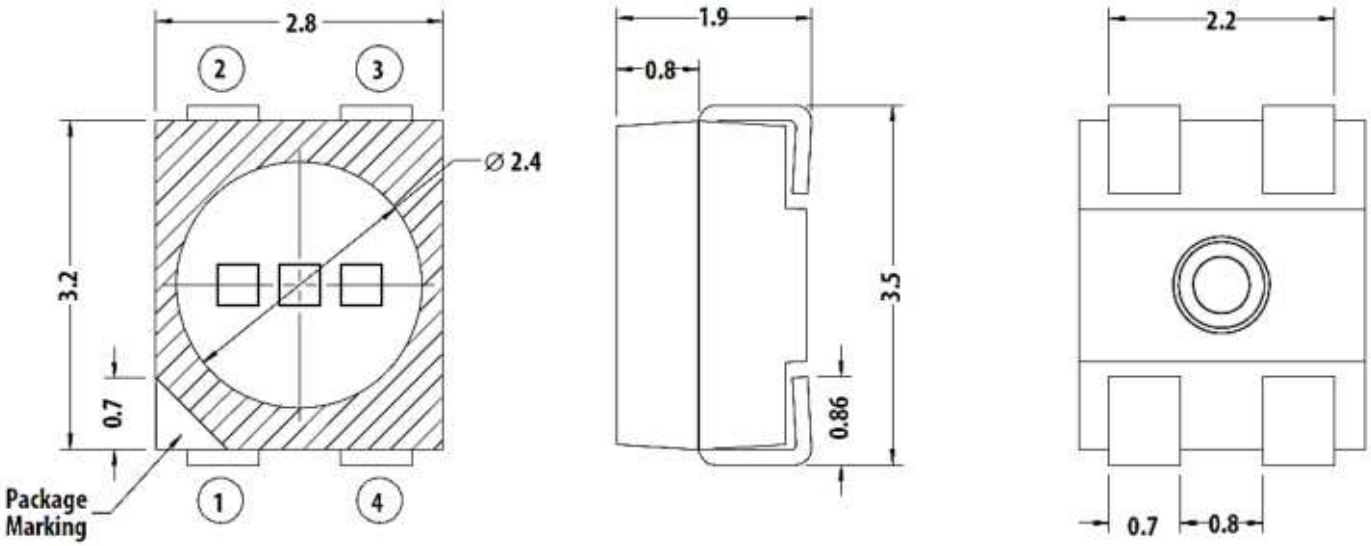
Applications

- Indoor full color display

CAUTION!

This LED is ESD sensitive. Please observe appropriate precautions during handling and processing. Refer to application note AN-1142 for additional detail.

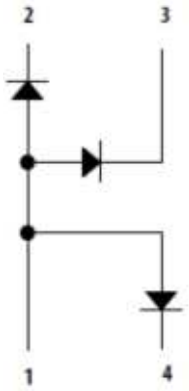
Figure 1: Package Drawing



Pin	Configuration
1	Common Anode
2	Blue Cathode
3	Green Cathode
4	Red Cathode

NOTE:

1. All dimensions in millimeters (mm).
2. Tolerance is ±0.20mm unless otherwise specified.
3. Encapsulation = silicone.
4. Terminal finish = silver plating.



Absolute Maximum Ratings

Parameters	Red	Green	Blue	Unit
DC Forward Current [a]	25	25	25	mA
Peak Forward Current [b]	100	100	100	mA
Power Dissipation	65	90	90	mW
Reverse Voltage	Not recommended for reverse bias operation			
LED Junction Temperature	110			°C
Operating Temperature Range	-40 to +100			°C
Storage Temperature Range	-40 to +100			°C

a. Derate linearly as shown in Figure 8 and Figure 9.

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

Optical Characteristics (T_J = 25°C, I_F = 20mA)

Color	Luminous Intensity, I_V (mcd) [a]			Dominant Wavelength, λ_d (nm) [b]			Peak Wavelength, λ_p (nm)	Viewing Angle, $2\theta_{½}$ (°) [c]
	Min.	Typ.	Max.	Min.	Typ.	Max.	Typ.	Typ.
Red	450	-	900	619	625	629	634	115
Green	1800	-	3550	525	530	535	522	115
Blue	355	-	715	465	470	473	465	115

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

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

c. $\theta_{½}$ is the off-axis angle where the luminous intensity if half of the peak intensity.

Electrical Characteristics (T_J = 25°C = 20mA)

Color	Forward Voltage V_F (V) [a]			Reverse Voltage, V_R (V) at I_R = 10µA [b]	Thermal Resistance, $R_{\theta J\text{-}S}$ (°C/W) [c]	
					1 Chip On	3 Chips On
	Min.	Typ.	Max.	Max.	Typ.	Typ.
Red	1.8	2.1	2.6	-	609	653
Green	2.8	3.1	3.6	4.0	320	430
Blue	2.8	3.1	3.6	4.0	320	430

a. Forward voltage tolerance is ±0.1V.

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

c. Thermal resistance from LED junction to solder point.

Part Numbering System

A S M B – M T x_1 0 – 0 x_2 x_3 x_4 x_5

Code	Description	Option		
x_1	Package Type	B	Black Surface	
x_2	Minimum Intensity Bin	B	Red = Bin U1	Red : Bin U1, U2, V1
			Green = Bin X1	Green : Bin X1, X2, Y1
			Blue = Bin T2	Blue : Bin T2, U1, U2
x_3	Number of Intensity Bins	3	3 Intensity Bins from minimum	
x_4	Color Bin Option	A	Red = Full Distribution	
			Green = Bin A, B, D	
			Blue = Bin A, B, C	
x_5	Test Option	2	Test Current = 20mA	

Bin Information

Intensity Bin Limits (CAT)

Bin ID	Luminous Intensity, I_V (mcd)	
	Min.	Max.
Red		
U1	450	560
U2	560	715
V1	715	900
Green		
X1	1800	2240
X2	2240	2850
Y1	2850	3550
Blue		
T2	355	450
U1	450	560
U2	560	715

Tolerance = ±12%

Color Bin Limits (BIN) – Red

Bin ID	Dominant Wavelength, λ_d (nm)		Chromaticity Coordinates	
	Min.	Max.	x	y
–	619	629	0.6894	0.3104
			0.6752	0.3113
			0.6916	0.2950
			0.7066	0.2934

Tolerance = ±1.0nm

Color Bin Limits (BIN) – Green

Bin ID	Dominant Wavelength, λ_d (nm)		Chromaticity Coordinates	
	Min.	Max.	x	y
A	525	531	0.1142	0.8262
			0.1624	0.7178
			0.2001	0.6983
			0.1625	0.8012
B	528	534	0.1387	0.8148
			0.1815	0.7089
			0.2179	0.6870
			0.1854	0.7867
D	531	535	0.1625	0.8012
			0.2001	0.6983
			0.2238	0.6830
			0.1929	0.7816

Tolerance = ±1.0nm

Color Bin Limits (BIN) – Blue

Bin ID	Dominant Wavelength, λ_d (nm)		Chromaticity Coordinates	
	Min.	Max.	x	y
A	465	467	0.1355	0.0399
			0.1751	0.0986
			0.1680	0.1094
			0.1267	0.0534
B	467	472	0.1314	0.0459
			0.1718	0.1034
			0.1638	0.1167
			0.1215	0.0626
C	469	473	0.1267	0.0534
			0.1680	0.1094
			0.1593	0.1255
			0.1158	0.0736

Tolerance = ±1.0nm

Figure 2: Spectral Power Distribution

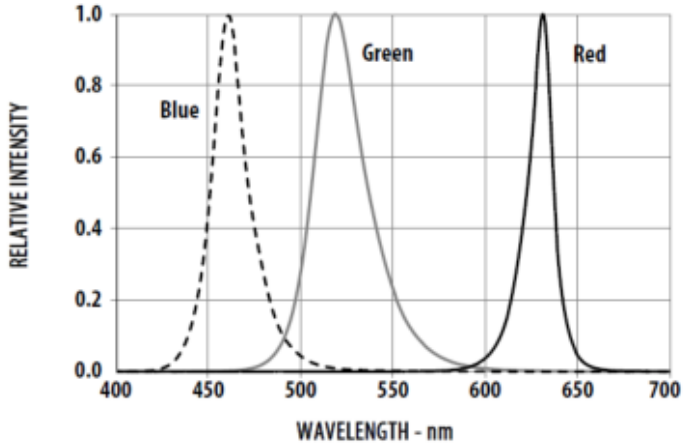


Figure 3: Forward Current vs. Forward Voltage

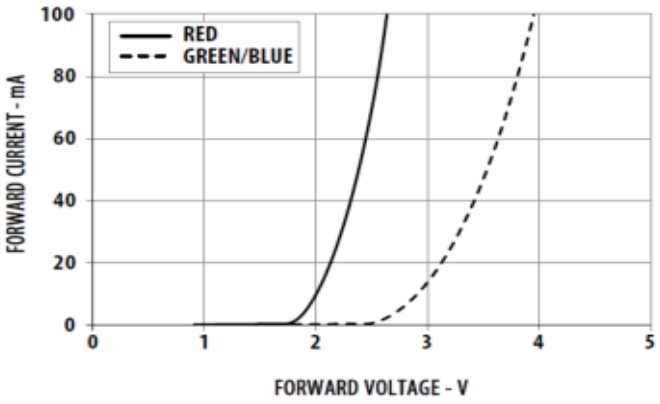


Figure 4: Relative Luminous Intensity vs. Mono Pulse Current

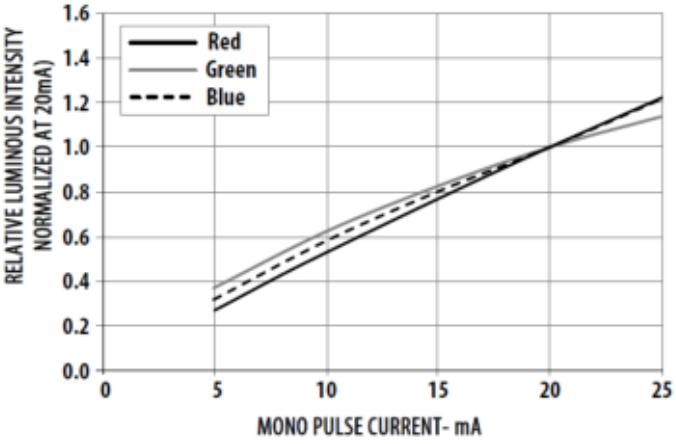


Figure 5: Dominant Wavelength Shift vs Mono Pulse Current

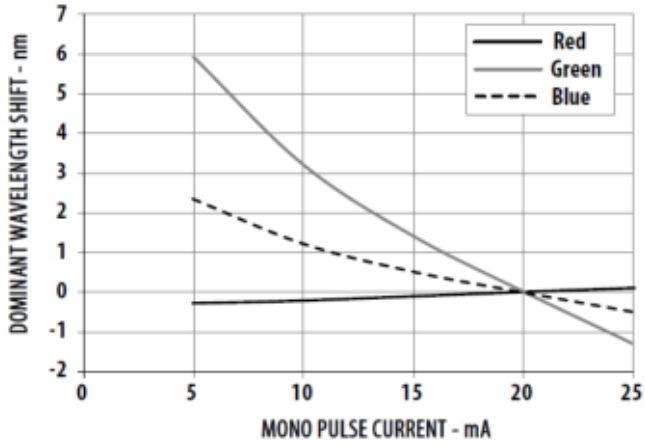


Figure 6: Relative Light Output vs. Junction Temperature

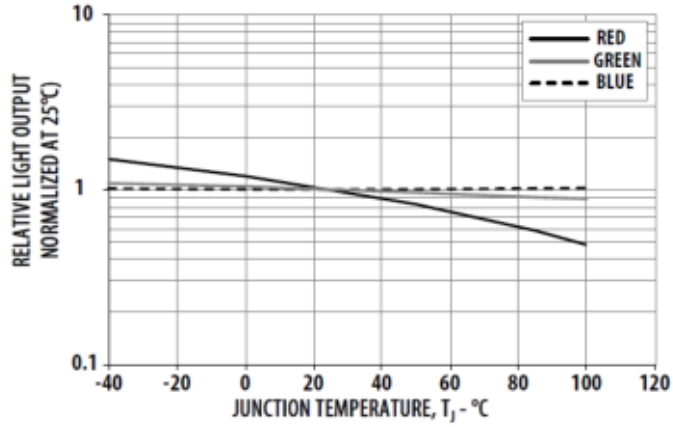


Figure 7: Forward Voltage Shift vs. Junction Temperature

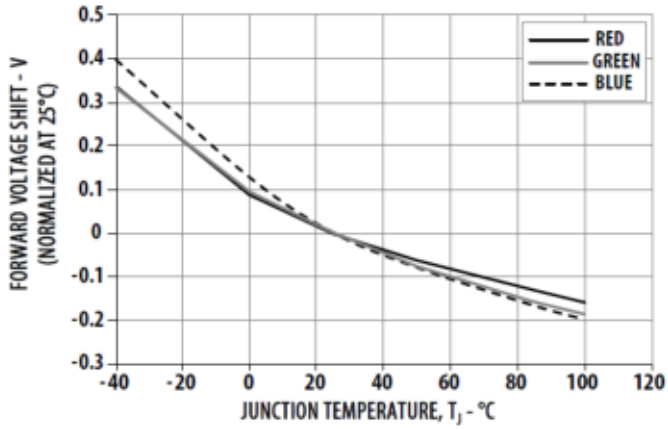


Figure 8: Maximum Forward Current vs. Temperature for Red (1 chip on)

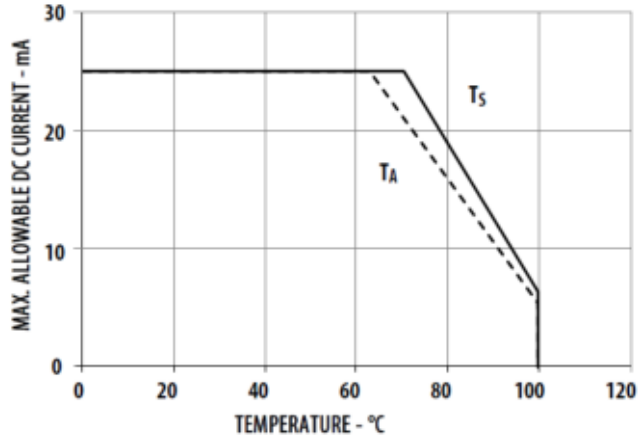


Figure 8a: Maximum Forward Current vs. Solder Temperature for Red (3 chips on)

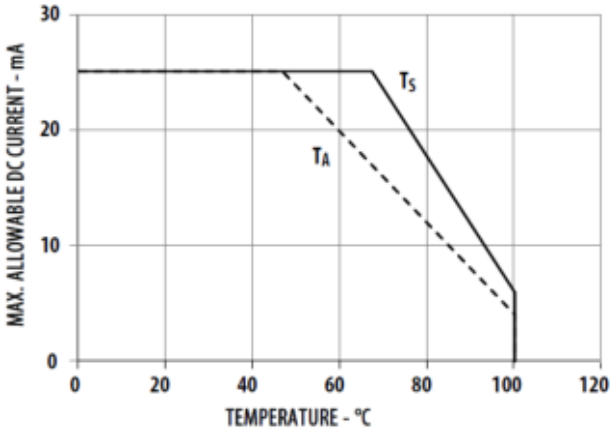


Figure 9: Maximum Forward Current vs. Temperature for Green & Blue (1 chip on)

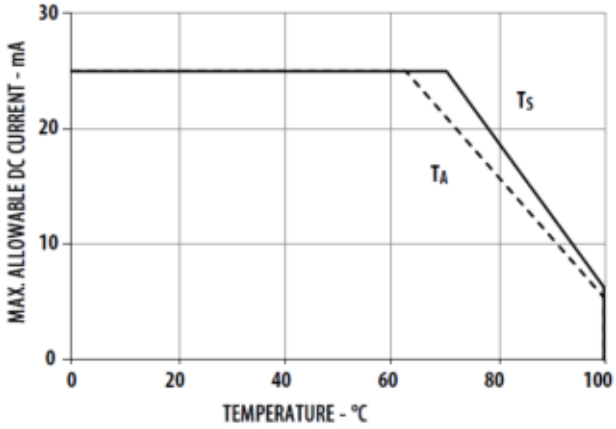
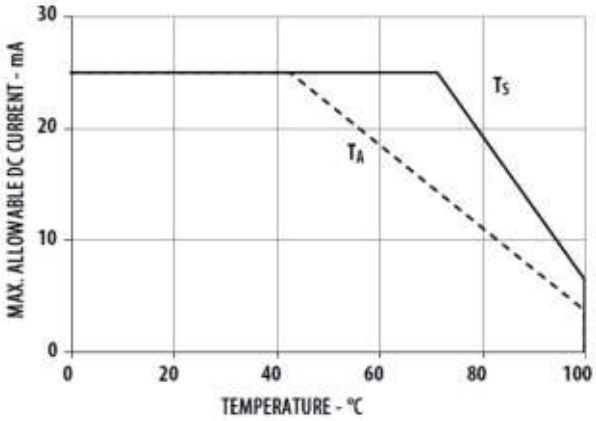


Figure 9a: Maximum Forward Current vs. Solder Temperature for Green & Blue (3 chips on)



NOTE: Maximum forward current graphs based on ambient temperature (T_A) above are with reference to the thermal resistance $R_{\theta J-A}$ in the following table. Do refer to Precautionary Note for more details.

Condition	Thermal Resistance from LED Junction to Ambient, $R_{\theta J-A}$ (°C/W)		
	Red	Green	Blue
1 chip	725	454	454
3 chips on	970	747	747

Figure 10: Radiation Pattern for x-axis

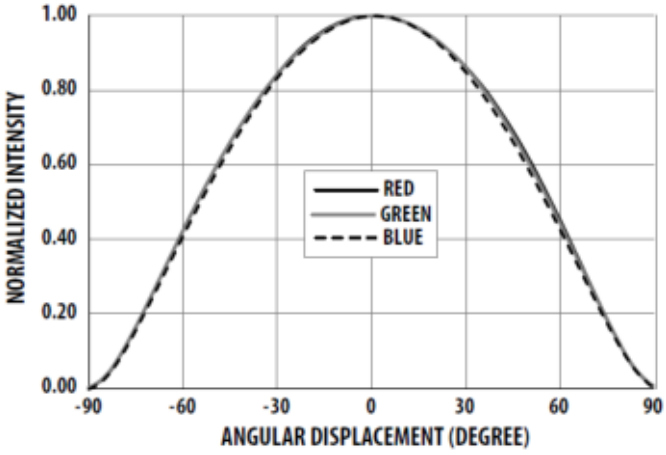


Figure 11: Radiation Pattern for y-axis

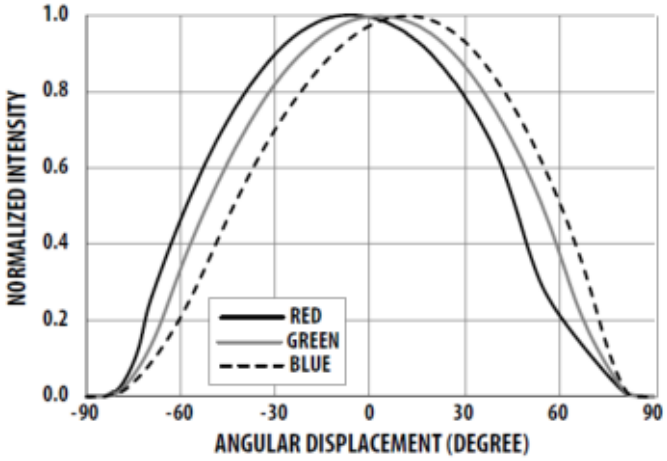


Figure 11a: Illustration of package axis for radiation pattern

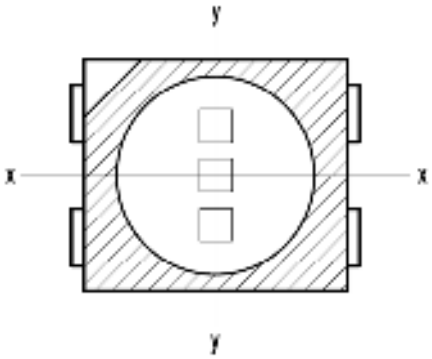
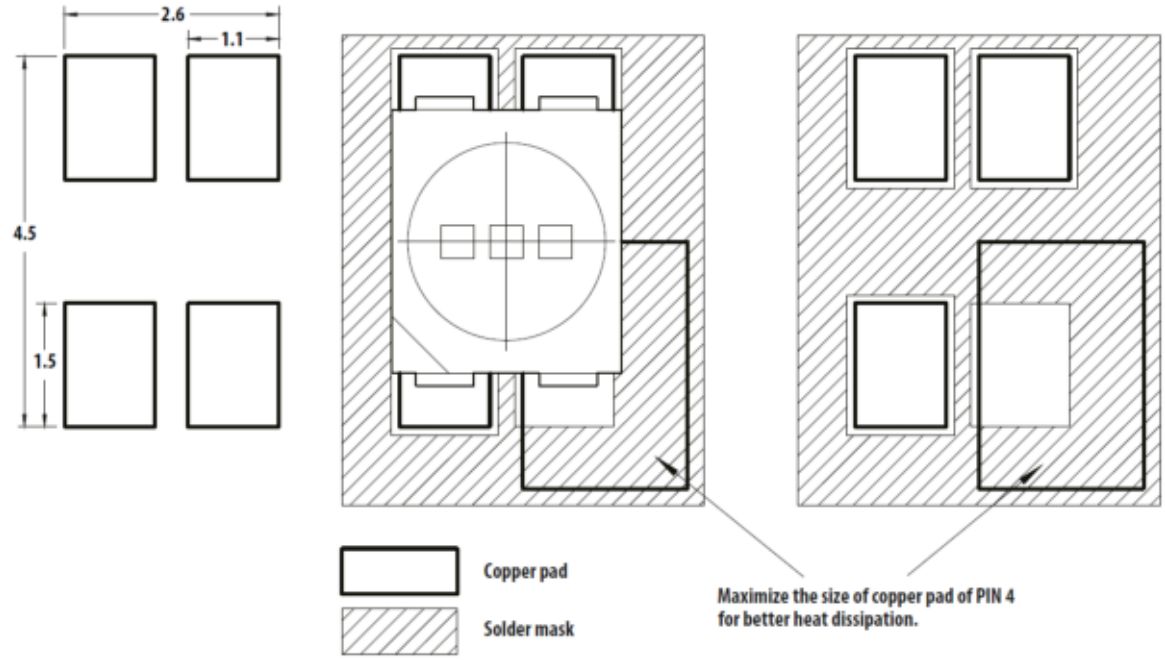
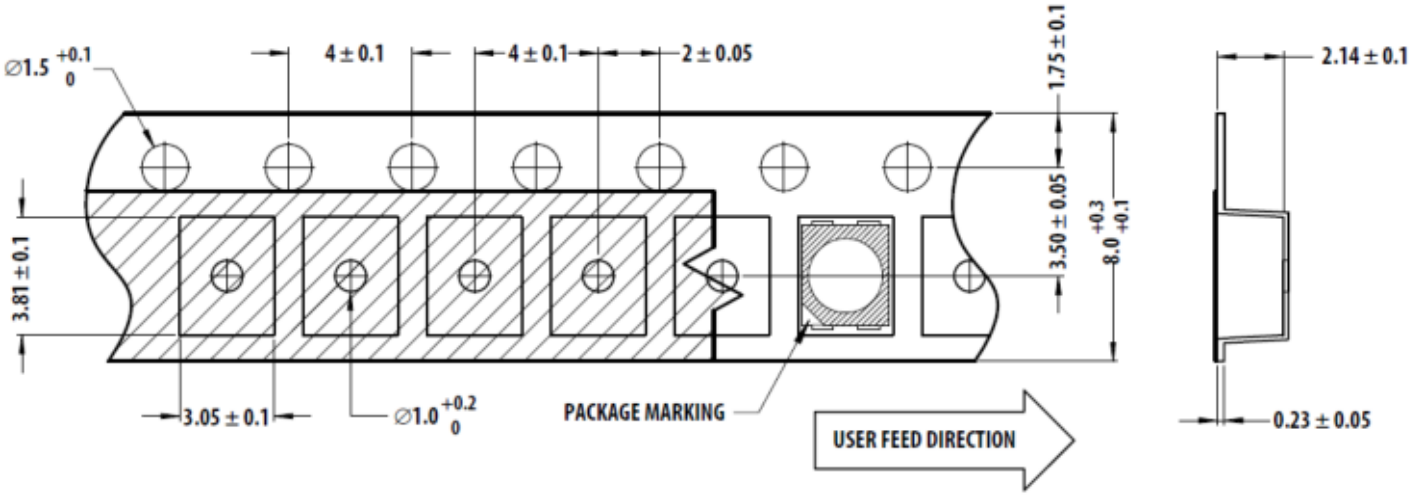


Figure 12: Recommended Soldering Pad Pattern



NOTE: All dimensions are in millimeters (mm).

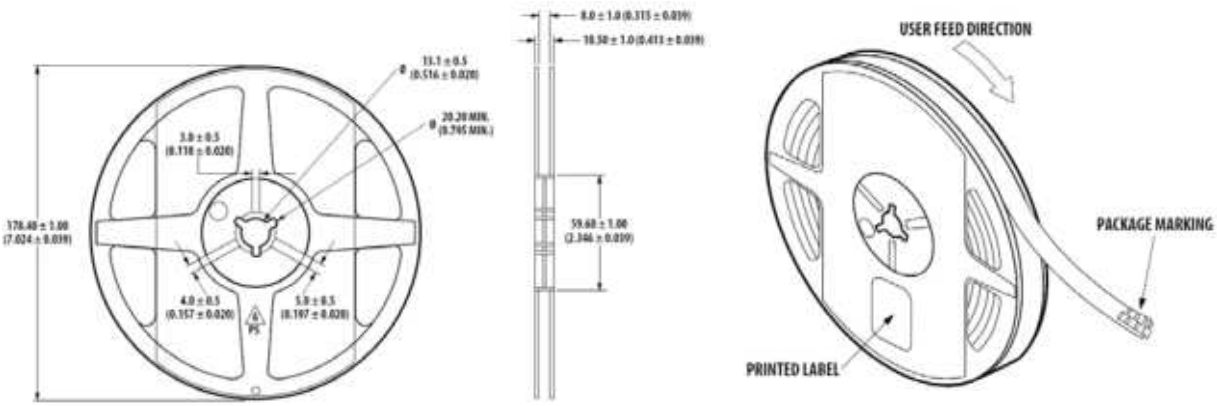
Figure 13: Carrier Tape Dimensions



NOTE:

1. All dimensions in millimeters (mm).
2. Tolerance is ±0.20mm unless otherwise specified.

Figure 13: Reel Dimensions and Reel Orientation



NOTE: All dimensions are in millimeters (mm).

Precautionary Notes

Soldering

- Do not perform reflow soldering more than twice. Observe necessary precautions of handling moisture-sensitive device as stated in the following section.
- Do not apply any pressure or force on the LED during reflow and after reflow when the LED is still hot.
- Use reflow soldering to solder the LED. Use hand soldering only for rework if unavoidable, but it must be strictly controlled to following conditions:
  - Soldering iron tip temperature = 315°C max.
  - Soldering duration = 3sec max.
  - Number of cycles = 1 only
  - Power of soldering iron = 50W max.
- Do not touch the LED package body with the soldering iron except for the soldering terminals, as it may cause damage to the LED.
- Confirm beforehand whether the functionality and performance of the LED is affected by soldering with hand soldering.

Figure 14: Recommended Lead-Free Reflow Soldering Profile

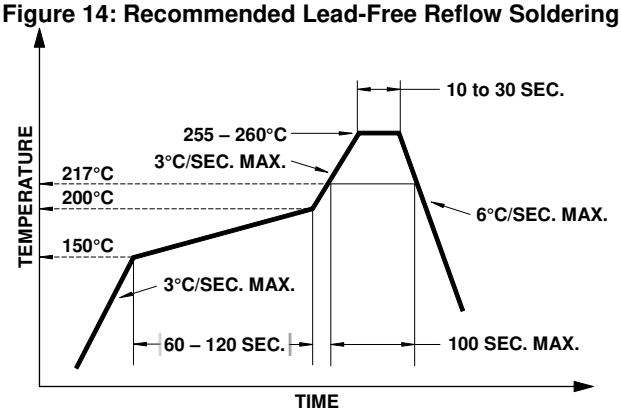
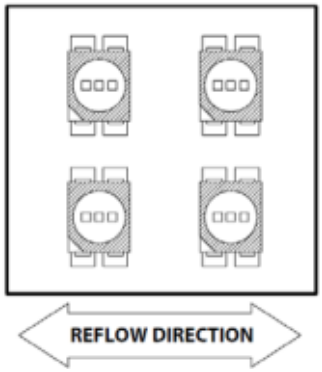


Figure 15: Recommended Board Reflow Direction



Handling Precautions

The encapsulation material of the LED is made of silicone for better product reliability. Compared to epoxy encapsulant, which is hard and brittle, silicone is softer and flexible. Observe special handling precautions during assembly of silicone encapsulated LED products. Failure to comply might lead to damage and premature failure of the LED. Refer to Broadcom Application Note AN5288, *Silicone Encapsulation for LED: Advantages and Handling Precautions,* for additional information.

- 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.
- Surface of silicone material attracts dust 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 too much pressure on the silicone. Ultrasonic cleaning is not recommended.
- For automated pick and place, Broadcom has tested a nozzle size with OD 1.5mm to work with this LED. However, due to the possibility of variations in other parameters such as pick and place machine maker/model, and other settings of the machine, verify that the selected nozzle will not cause damage to the LED.

Handling of Moisture-Sensitive Devices

This product has a Moisture Sensitive Level 3 rating per JEDEC J-STD-020. Refer to Broadcom Application Note AN5305*, Handling of Moisture Sensitive Surface Mount Devices* for additional details and a review of proper handling procedures.

- 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). If unavoidable, MBB must be properly resealed with fresh desiccant and HIC. The exposed duration must be taken in as floor life.
- Control after opening the MBB:
  - Read the HIC immediately upon opening of MBB.
  - Keep the LEDs at <30°/60%RH at all times, and complete all high temperature-related processes, including soldering, curing or rework within 168 hours.
- Control for unfinished reel:

  Store unused LEDs in a sealed MBB with desiccant or 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 desiccator at <5% RH to ensure that all LEDs have not exceeded their floor life of 168 hours.
- Baking is required if:
  - The HIC indicator indicates a change in color for 10% and 5%, as stated on the HIC.
  - The LEDs are exposed to conditions of >30°C/60% RH at any time.
  - The LED's floor life exceeded 168 hours.

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

  Baking can only be done once.
- Storage:

  The soldering terminals of these Broadcom LEDs are silver plated. If the LEDs are exposed in ambient environment for too long, the silver plating might be oxidized, thus affecting 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 the data sheet. Constant current driving is recommended to ensure consistent performance.
- Circuit design must cater to the whole range of forward voltage (V_F) of the LEDs to ensure the intended drive current can always be achieved.
- The LED exhibits slightly different characteristics at different drive currents, which may result in a larger variation of performance (meaning: intensity, wavelength, and forward voltage). Set the application current as close as possible to the test current to minimize these variations.
- Do not use the LED in the vicinity of material with sulfur content or in environments of high gaseous sulfur compounds and corrosive elements. Examples of material that might contain sulfur are rubber gaskets, room- temperature vulcanizing (RTV) silicone rubber, rubber gloves, and so on. Prolonged exposure to such environments may affect the optical characteristics and product life.
- White LEDs must not be exposed to acidic environments and must not be used in the vicinity of any compound that may have acidic outgas, such as, but not limited to, acrylate adhesive. These environments have an adverse effect on LED performance.
- Avoid rapid change in ambient temperature, especially in high-humidity environments, because they cause condensation on the LED.
- If the LED is intended to be used in harsh or outdoor environment, protect the LED against damages caused by rain water, water, dust, oil, corrosive gases, external mechanical stresses, and so on.

Thermal Management

The optical, electrical, and reliability characteristics of the LED are affected by temperature. Keep the junction temperature (T_J) of the LED 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 follows:

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

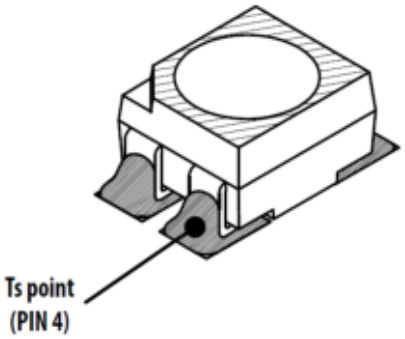
where:

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

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

I_F = forward current (A)

V_{Fmax} = maximum forward voltage (V)



T_S can be easily measured by mounting a thermocouple on the soldering joint as shown in preceding figure, while $R_{\theta J\text{-}S}$ is provided in the data sheet. Verify the T_S of the LED in the final product to ensure that the LEDs are operating within all maximum ratings stated in the data sheet.

Eye Safety Precautions

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

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