

## **ASCB-NTC2-0A307**

### **1413 Tricolor PLCC-4 LED**

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#### **Description**

The Broadcom® ASCB-NTC2 series are the latest high-brightness tricolor LEDs targeting small pixel pitch displays. They come in a 1.4 mm × 1.3 mm PLCC-4 package. Their full black body appearance with diffused epoxy enhance display contrast and provide a suitable solution for high-resolution video display. With the short lead design, potting process is more convenient and easier.

To facilitate easy pick-and-place assembly, the LEDs are packed in tape and reel form. Each reel is shipped in single intensity and color bin to ensure uniformity.

#### **Features**

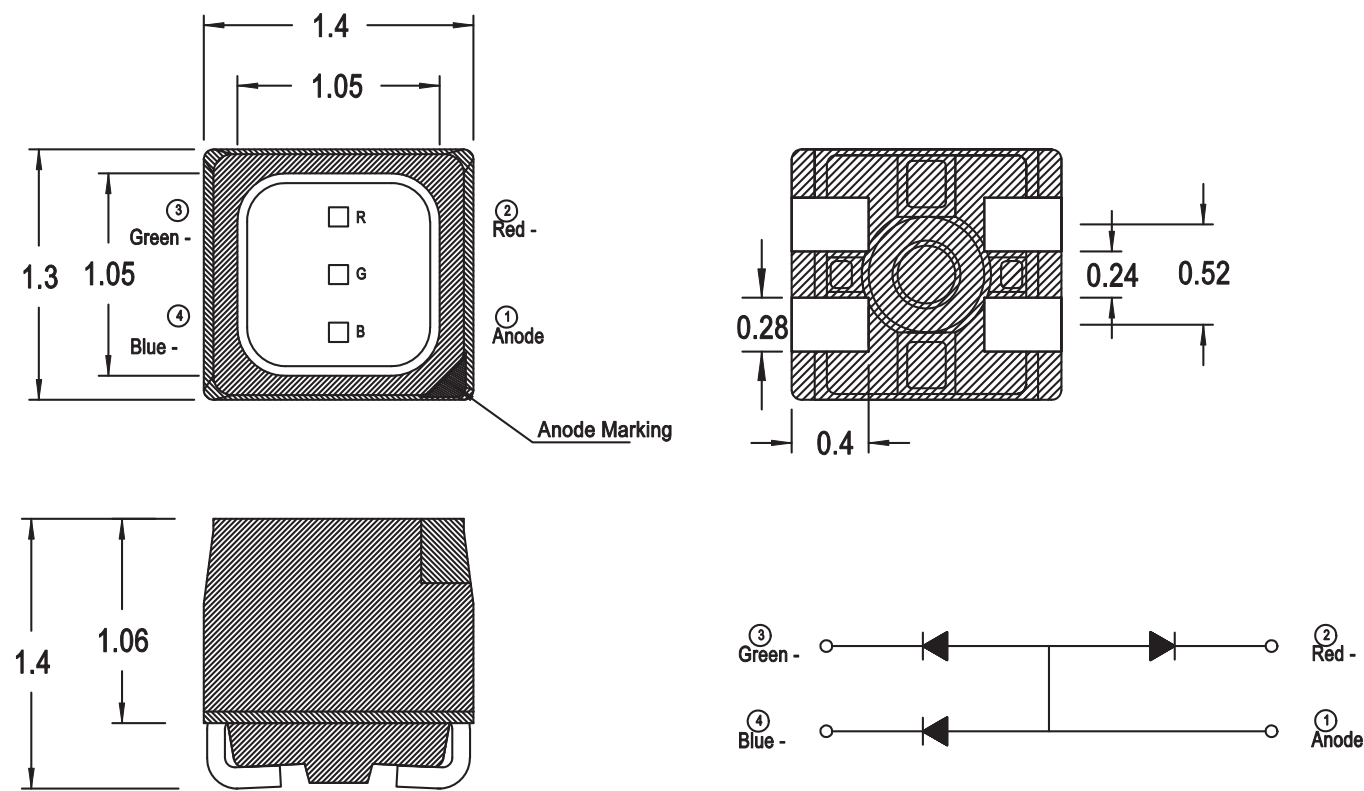
- PLCC-4 package with full black body
- Suitable for small pitch sign
- Short leads for better potting process

#### **Applications**

- Full color display

**CAUTION!** This LED is ESD sensitive. Observe appropriate precautions during handling and processing. Refer to application note AN-1142 for additional details.

Figure 1: Package Drawing



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

- NOTE:**
- 1. All dimensions in millimeters (mm).
  - 2. Tolerance is  $\pm 0.20$  mm unless otherwise specified.
  - 3. Terminal finish = silver plating.

## Absolute Maximum Ratings

Parameters	Red	Green	Blue	Units
DC Forward Current <sup>a</sup>	25	20	15	mA
Peak Forward Current <sup>b</sup>	100	100	100	mA
Power Dissipation	60	66	46.2	mW
Reverse Voltage	Not recommended for reverse bias operation			
LED Junction Temperature	100			°C
Operating Temperature Range	–40 to +85			°C
Storage Temperature Range	–40 to +100			°C

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

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

## Optical Characteristics (T<sub>J</sub> = 25°C)

Color	Luminous Intensity, I <sub>V</sub> (mcd) <sup>a</sup>			Dominant Wavelength, λ <sub>d</sub> (nm) <sup>b</sup>			Peak Wavelength, λ <sub>p</sub> (nm)	Viewing Angle, 2θ <sub>½</sub> (°) <sup>c</sup>	Test Current (mA)
	Min.	Typ.	Max.	Min.	Typ.	Max.	Typ.	Typ.	
Red	155	180	225	618	621	628	629	105	10
Green	365	440	530	518	524	530	519	105	10
Blue	45	55	66	465	471	476	468	105	5

a. The luminous intensity, I<sub>V</sub> 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<sub>d</sub>, is derived from the CIE Chromaticity Diagram and represents the perceived color of the device.

c. θ<sub>½</sub> is the off-axis angle where the luminous intensity is half of the peak intensity.

## Electrical Characteristics (T<sub>J</sub> = 25°C)

Color	Forward Voltage V <sub>F</sub> (V) <sup>a</sup>			Reverse Voltage, V <sub>R</sub> (V) at I <sub>R</sub> = 10 μA <sup>b</sup>	Thermal Resistance, R <sub>θJ-S</sub> (°C/W) <sup>c</sup>
					3 Chips On
	Min.	Typ.	Max.	Min.	Typ.
Red	1.70	2.00	2.40	4.0	500
Green	2.50	2.90	3.30	4.0	500
Blue	2.50	2.70	3.30	4.0	900

a. Forward voltage tolerance is ±0.1V. V<sub>F</sub> is tested at test current.

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 C B - N T x<sub>1</sub> 2 - 0 x<sub>2</sub> x<sub>3</sub> x<sub>4</sub> x<sub>5</sub>

Code	Description	Option		
x <sub>1</sub>	Package Type	C	Full Black Body	
x <sub>2</sub>	Minimum Intensity Bin	A	Red = Bin R1, R2, R3	Red: Bin R1, R2, R3
			Green = Bin G1, G2, G3	Green: Bin G1, G2, G3
			Blue = Bin B1, B2, B3	Blue: Bin B1, B2, B3
x <sub>3</sub>	Number of Intensity Bins	3	3 Intensity Bins from minimum	
x <sub>4</sub>	Color Bin Option	0	Red = Bin A, B, C, D, E, F	
			Green = Bin J, K, L, M, N, P, Q, R, S, T	
			Blue = Bin A, B, C, D, E, F, G, H, J	
x <sub>5</sub>	Test Option	7	Test Current: Red 10 mA, Green 10 mA, Blue 5 mA	

## Bin Information

### Intensity Bin Limits (CAT)

Bin ID	Luminous Intensity, I <sub>V</sub> (mcd)	
	Min.	Max.
<b>Red</b>		
R1	155	170
R2	170	205
R3	205	225
<b>Green</b>		
G1	365	400
G2	400	480
G3	480	530
<b>Blue</b>		
B1	45	50
B2	50	60
B3	60	66

Example of bin information on reel and packaging label:

CAT: R2 G1 B2    –    Red intensity bin R2  
                              –    Green intensity bin G1  
                              –    Blue intensity bin B2  
 BIN: A M E        –    Red color bin A  
                              –    Green color bin M  
                              –    Blue color bin E

Tolerance = ± 12%.

## Color Bin Limits (BIN) – Red

Bin ID	Dominant Wavelength, $\lambda_d$ (nm)		Chromaticity Coordinates	
	Min.	Max.	x	y
A	618	623	0.6873	0.3126
			0.6696	0.3136
			0.6790	0.3042
			0.6972	0.3027
B	619	624	0.6894	0.3104
			0.6716	0.3116
			0.6807	0.3026
			0.6989	0.3010
C	620	625	0.6915	0.3083
			0.6736	0.3096
			0.6822	0.3010
			0.7006	0.2993
D	621	626	0.6935	0.3064
			0.6755	0.3077
			0.6837	0.2995
			0.7022	0.2977
E	622	627	0.6954	0.3045
			0.6773	0.3059
			0.6852	0.2981
			0.7037	0.2962
F	623	628	0.6972	0.3027
			0.6790	0.3042
			0.6866	0.2967
			0.7052	0.2948

Tolerance =  $\pm 1.0$  nm.

## Color Bin Limits (BIN) – Green

Bin ID	Dominant Wavelength, $\lambda_d$ (nm)		Chromaticity Coordinates	
	Min.	Max.	x	y
J	518	521	0.0593	0.08294
			0.1415	0.6806
			0.1574	0.6839
			0.0821	0.8341
K	519	522	0.0667	0.8323
			0.1467	0.6826
			0.1629	0.6833
			0.0900	0.8333
L	520	523	0.0743	0.8338
			0.1520	0.6837
			0.1686	0.6821
			0.0979	0.8316
M	521	524	0.0821	0.8341
			0.1574	0.6839
			0.1742	0.6804
			0.1060	0.8292
N	522	525	0.0899	0.8333
			0.1629	0.6833
			0.1799	0.6783
			0.1142	0.8262

Tolerance =  $\pm 1.0$  nm.

Bin ID	Dominant Wavelength, $\lambda_d$ (nm)		Chromaticity Coordinates	
	Min.	Max.	x	y
P	523	526	0.0979	0.8316
			0.1686	0.6821
			0.1856	0.6759
			0.1223	0.8228
Q	524	527	0.1060	0.8292
			0.1742	0.6804
			0.1914	0.6732
			0.1305	0.8189
R	525	528	0.1142	0.8262
			0.1799	0.6783
			0.1971	0.6703
			0.1387	0.8148
S	526	529	0.1223	0.8228
			0.1856	0.6759
			0.2027	0.6673
			0.1468	0.8104
T	527	530	0.1305	0.8189
			0.1914	0.6732
			0.2083	0.6641
			0.1547	0.8059

Tolerance =  $\pm 1.0$  nm.

## Color Bin Limits (BIN) – Blue

Bin ID	Dominant Wavelength, $\lambda_d$ (nm)		Chromaticity Coordinates	
	Min.	Max.	x	y
A	465	468	0.1355	0.0399
			0.1454	0.0546
			0.1373	0.0608
			0.1291	0.0494
B	466	469	0.1335	0.0427
			0.1415	0.0543
			0.1349	0.0646
			0.1267	0.0534
C	467	470	0.1314	0.0459
			0.1394	0.0574
			0.1325	0.0688
			0.1241	0.0578
D	468	471	0.1291	0.0495
			0.1373	0.0608
			0.1299	0.0734
			0.1215	0.0626
E	469	472	0.1267	0.0534
			0.1349	0.0646
			0.1273	0.0784
			0.1187	0.0678

Tolerance =  $\pm 1.0$  nm.

Bin ID	Dominant Wavelength, $\lambda_d$ (nm)		Chromaticity Coordinates	
	Min.	Max.	x	y
F	470	473	0.1241	0.0578
			0.1325	0.0688
			0.1245	0.0840
			0.1158	0.0736
G	471	474	0.1215	0.0626
			0.1299	0.0734
			0.1216	0.0900
			0.1128	0.0799
H	472	475	0.1187	0.0678
			0.1273	0.0784
			0.1185	0.0967
			0.1096	0.0868
J	473	476	0.1158	0.0736
			0.1245	0.0840
			0.1153	0.1040
			0.1063	0.0945

Tolerance =  $\pm 1.0$  nm.

Figure 2: Spectral Power Distribution

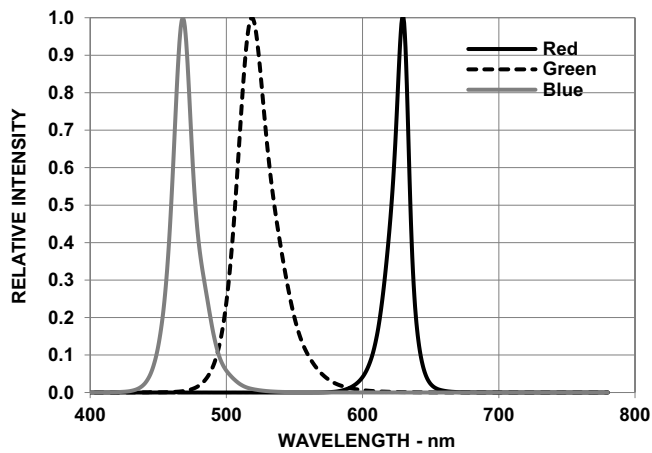


Figure 3: Forward Current vs. Forward Voltage

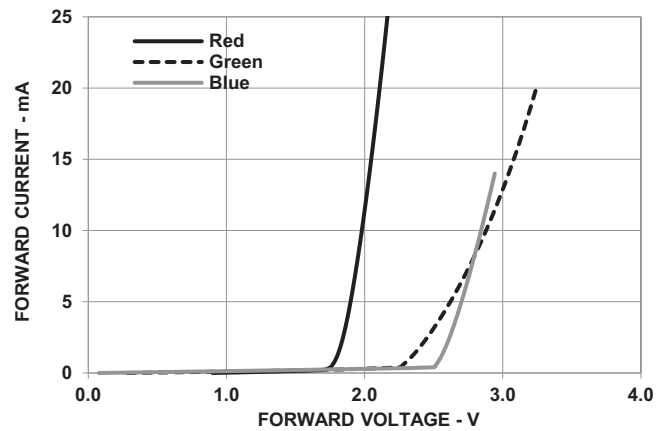


Figure 4: Relative Luminous Intensity vs. Mono Pulse Current

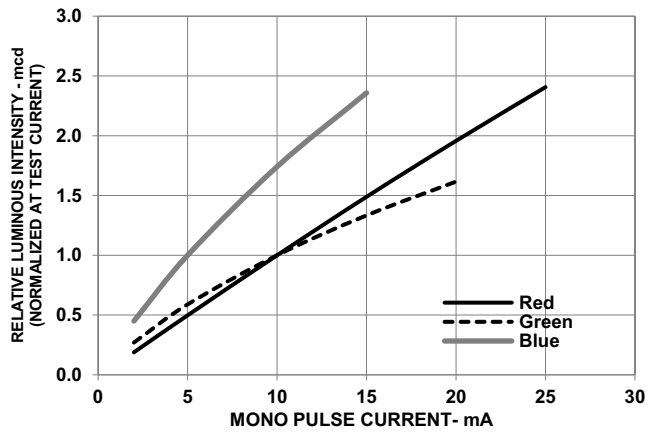


Figure 5: Dominant Wavelength Shift vs. Mono Pulse Current

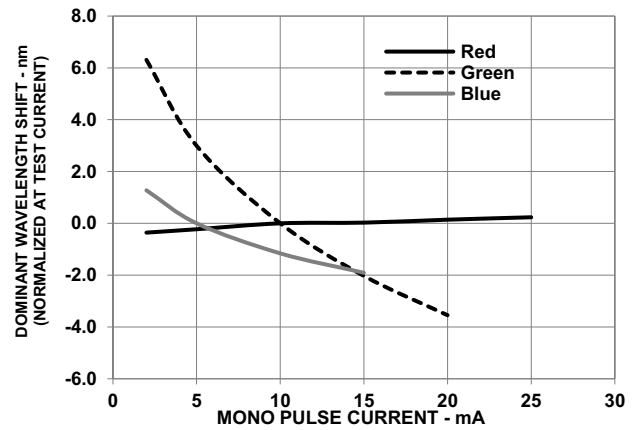


Figure 6: Relative Light Output vs. Junction Temperature

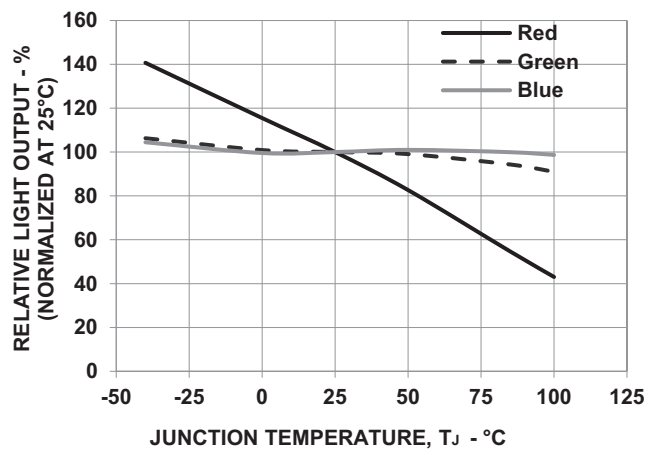


Figure 7: Forward Voltage Shift vs. Junction Temperature

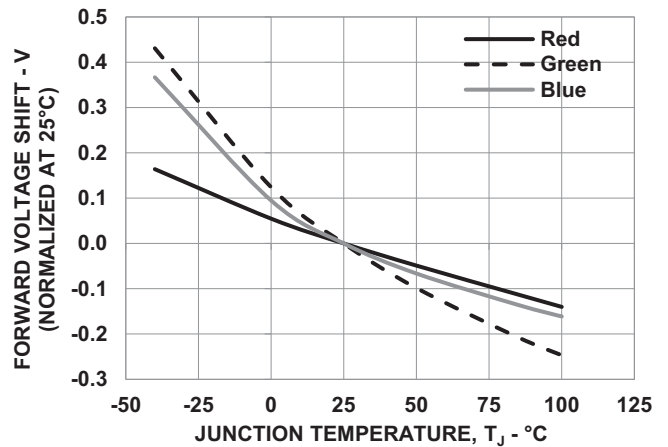




Figure 8: Maximum Forward Current vs. Temperature for Red, Green, and Blue (3 Chips On)

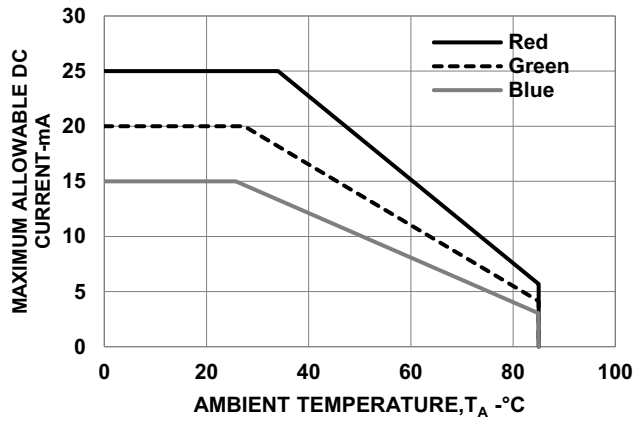
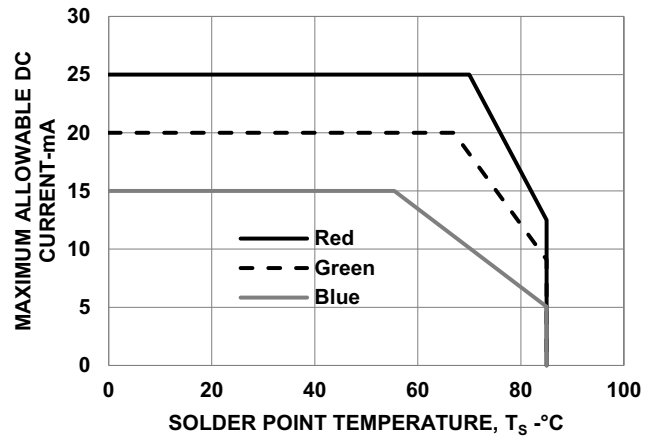


Figure 9: Maximum Forward Current vs. Solder Temperature for Red, Green, and Blue (3 Chips On)



**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. See [Precautionary Notes](#) for more details.

Condition	Thermal Resistance from LED Junction to Ambient, $R_{\theta J-A}$ (°C/W)		
	Red	Green	Blue
3 chips on	1100	1100	1500

Figure 10: Radiation Pattern for X-Axis

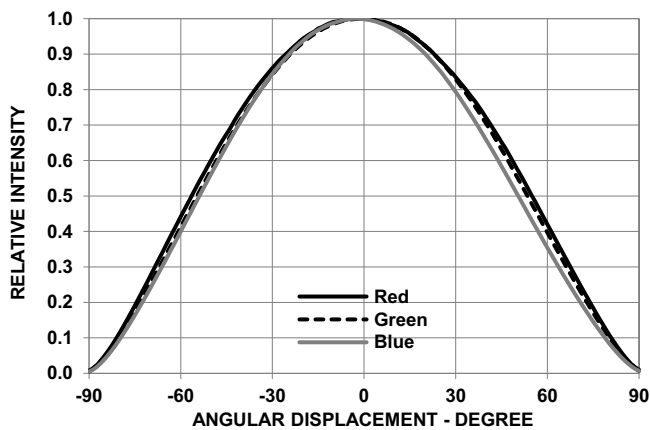


Figure 11: Radiation Pattern for Y-Axis

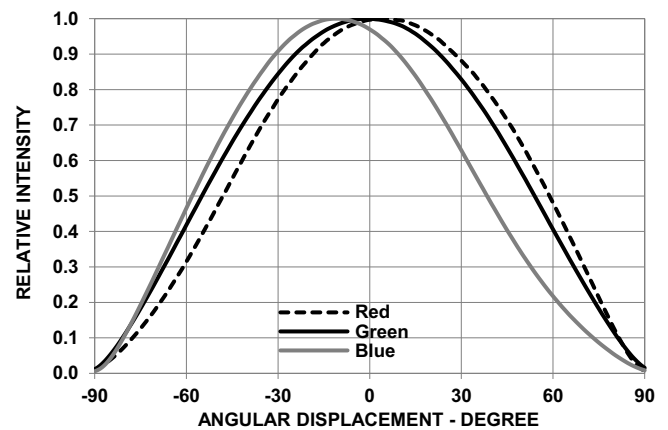
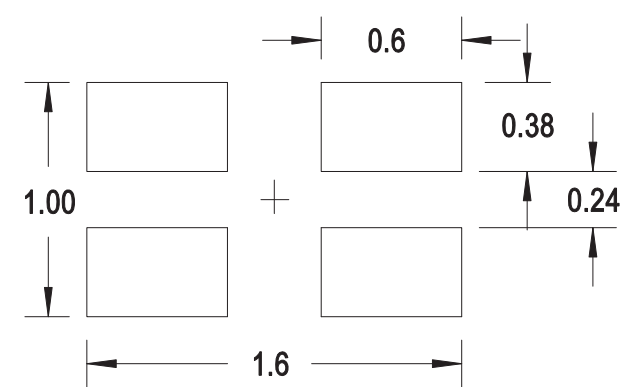
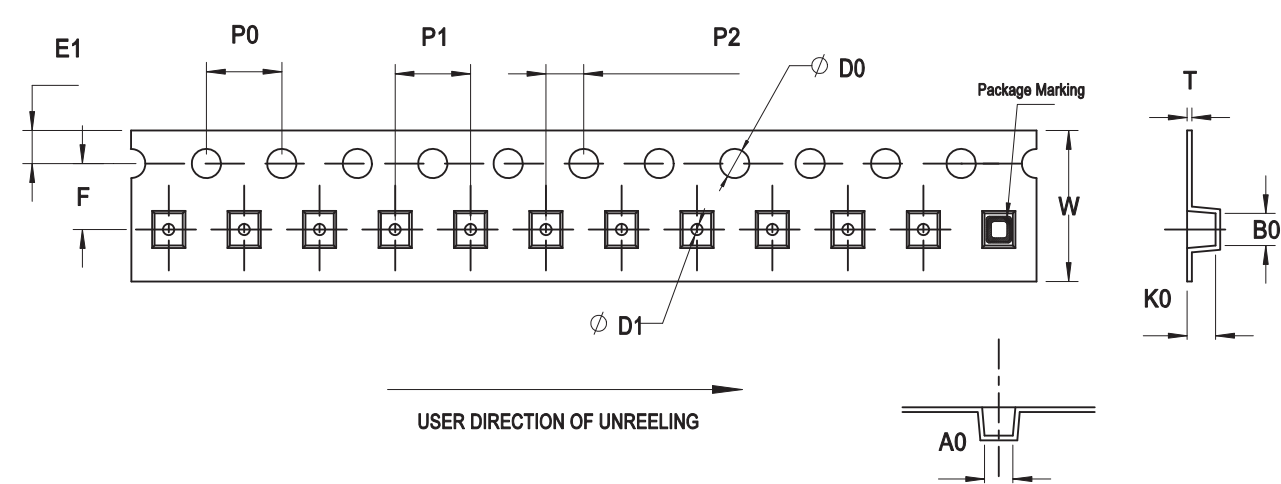


Figure 12: Recommended Soldering Pad Pattern



**NOTE:** All dimensions are in millimeters (mm).

Figure 13: Carrier Tape Drawing

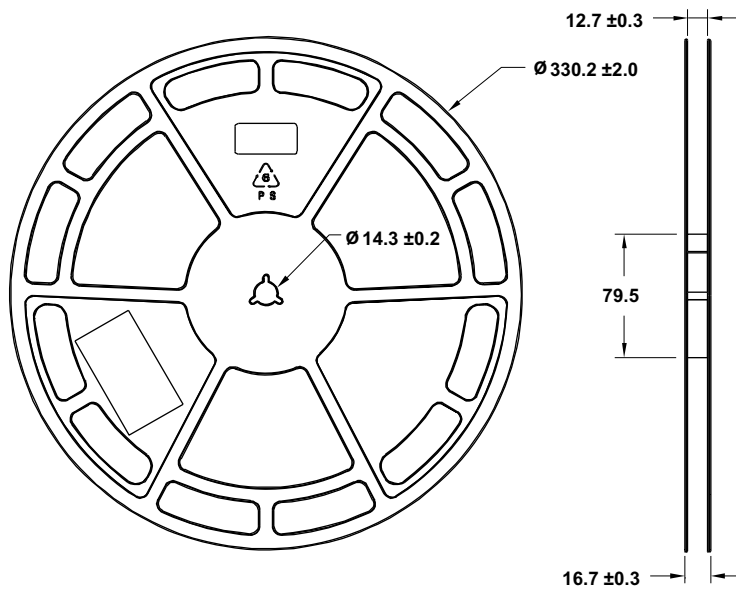


F	E1	P0	P1	P2	D0	D1	W	A0	K0
3.5 ± 0.1	1.75 ± 0.1	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.1	1.55 +0.1/-0	0.6 ± 0.1	8.0 ± 0.2	1.4 ± 0.1	1.55 ± 0.1
B0	T								
1.5 5 ± 0.1	0.25 ± 0.05								

**NOTE:**

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

Figure 14: Reel Drawing



**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 devices 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 maximum.
  - Soldering duration = 3 seconds maximum.
  - Number of cycles = 1 only
  - Power of soldering iron = 50W maximum.
- Do not touch the LED package body with the soldering iron except for the soldering terminals, because 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 15: Recommended Lead-Free Reflow Soldering Profile

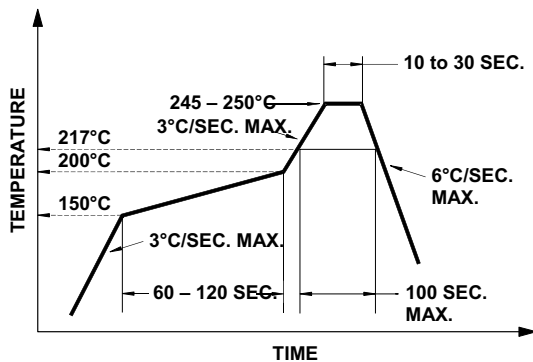
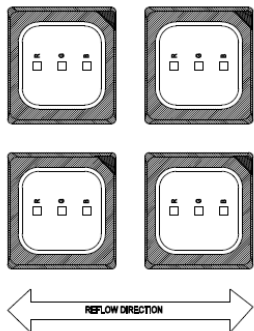


Figure 16: Recommended Board Reflow Direction



### Handling Precautions

Observe special handling precautions during assembly of epoxy encapsulated LED products. Failure to comply might lead to damage and premature failure of the LED.

- Do not stack assembled PCBs together. Use an appropriate rack to hold the PCBs.
- For automated pick and place, Broadcom has tested a nozzle size with OD 1.0 mm 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 5a 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, 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, the 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 the MBB.
- Keep the LEDs at <30°/60% RH at all times, and complete all high temperature-related processes, including soldering, curing, or rework within 24 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 24 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 conditions of >30°C/60% RH at any time.
- The LED's floor life exceeded 24 hours.

The recommended baking condition is: 65°C ± 5°C for 24 hours.

Baking can only be done 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, 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 (such as intensity, wavelength, and forward voltage). Set the application current as close as possible to the test current 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.
- As actual application might not be exactly similar to the test conditions, verify that the LED will not be damaged by prolonged exposure in the intended environment.
- Avoid rapid change in ambient temperatures, especially in high-humidity environments, because they cause condensation on the LED.

- If the LED is intended to be used in a harsh or an 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:

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

where:

$T_A$  = Ambient temperature (°C)

$R_{\theta J-A}$  = 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  $R_{\theta J-A}$ . Actual  $T_A$  is sometimes subjective and hard to determine.  $R_{\theta J-A}$  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:

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

where:

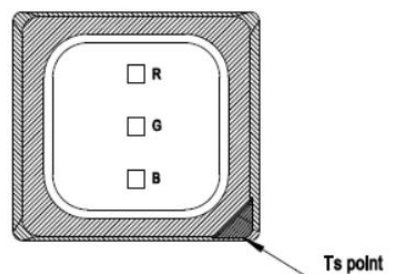
$T_S$  = LED solder point temperature as shown in the following figure (°C)

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

$I_F$  = Forward current (A)

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

**Figure 17: Solder Point Temperature on PCB**



$T_S$  can be easily measured by mounting a thermocouple on the soldering joint as shown in preceding figure, while  $R_{\theta J-S}$  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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