Data Sheet

ASMB-KTF0-0A306

2220 Tricolor PLCC-4 LED

Overview

The Broadcom® KTF0 is a series of tricolor LEDs in a PLCC-4 package. The package is (2.2 x 2.0) mm, and it is designed specifically for a small pitch display. The black outer appearance helps to improve the contrast of display.

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

Features

- PLCC-4 package with black outer appearance
- Short leads for better potting process
- Compatible with reflow soldering process
- MSL5a

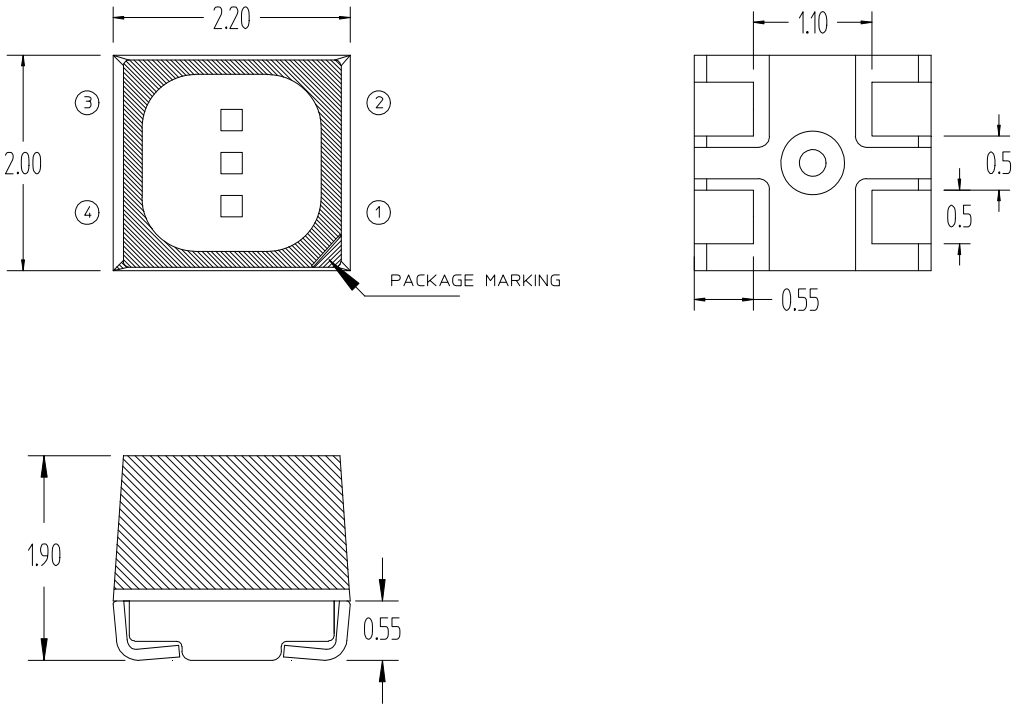
Applications

- 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	
Pin 1	Anode
Pin 2	Red Cathode
Pin 3	Green Cathode
Pin 4	Blue Cathode

NOTE:

1. Tolerance is ±0.20 mm unless otherwise specified.
2. Encapsulation = epoxy.
3. Terminal finish = silver plating.

Absolute Maximum Ratings

Parameters	Red	Green	Blue	Units
DC Forward Current[a]	20	20	20	mA
Peak Forward Current[b]	100	100	100	mA
Power Dissipation	48	66	66	mW
Reverse Voltage	Not recommended for reverse bias			
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.

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

Optical Characteristics (T_J = 25°C)

Color	Luminous Intensity I_V, (mcd)[a]			Dominant Wavelength, λ_d (nm)[b]			Peak Wavelength λ_p (nm)	Viewing Angle $2\theta_{1/2}$, (°)[c]	Test Current (mA)
	Min.	Typ.	Max.	Min.	Typ.	Max.	Typ.	Typ.	
Red	330	490	725	618	620	628	628	110	15
Green	770	1100	1690	521	524	529	518		15
Blue	145	215	315	465	471	474	467		10

a. The luminous intensity is measured at the mechanical axis of LED package, and it is tested with mono 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. $\theta_{1/2}$ is the off-axis angle where the luminous intensity is ½ the peak intensity.

Electrical Characteristics (T_J = 25°C)

Color	Forward Voltage V_F (V)[a]			Reverse Voltage V_R at 10 μA[b]	Thermal Resistance $R_{\theta J\text{-}P}$ (°C/W)
					Three Chips On
	Min.	Typ.	Max.	Min.	Typ.
Red	1.80	2.00	2.40	4.0	500
Green	2.60	2.95	3.30	4.0	400
Blue	2.60	2.85	3.30	4.0	500

a. Tolerance = ±0.1V. Test current, Red 15 mA, Green 15 mA, Blue 10 mA.

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

Part Numbering System

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

Code	Description	Option		
x_1	Package Type	F	Diffused encapsulation	
x_2	Minimum Intensity Bin	A	Red: bin S1 Green: bin V1 Blue: bin P1	Red: bin S1, T1, U1 Green: bin V1, W1, X1 Blue: bin P1, Q1, R1
x_3	Number of Intensity Bins	3	3 intensity bins from minimum	
x_4	Color Bin Combination	0	Red: full distribution Green: bin A, B, C, D Blue: bin A, B, C, D, E, F	
x_5	Test Current	6	Red: 15 mA Green: 15 mA Blue: 10 mA	

Bin Information

Luminous Intensity Bin Limits (CAT)

Bin ID	Luminous Intensity, I_V (mcd)	
	Min.	Max.
Red		
S1	330	430
T1	430	560
U1	560	725
Green		
V1	770	1000
W1	1000	1300
X1	1300	1690
Blue		
P1	145	190
Q1	190	245
R1	245	315

Tolerance = ±12%

Color Bin Limits (BIN) - Red

Bin ID	Dominant Wavelength, λ_d (nm)		Chromaticity Coordinates (for reference)	
	Min.	Max.	x	y
—	618.0	628.0	0.6873	0.3126
			0.6837	0.3128
			0.7014	0.2952
			0.7052	0.2948

Tolerance = ±1 nm

Color Bin Limits (BIN) - Green

Bin ID	Dominant Wavelength, λ_d (nm)		Chromaticity Coordinates (for reference)	
	Min.	Max.	x	y
A	521	526	0.0821	0.8341
			0.1348	0.7289
			0.1666	0.7200
			0.1223	0.8228
B	522	527	0.0899	0.8333
			0.1410	0.7283
			0.1731	0.7169
			0.1305	0.8189
C	523	528	0.0979	0.8316
			0.1474	0.7270
			0.1796	0.7137
			0.1387	0.8148
D	524	529	0.1060	0.8292
			0.1538	0.7250
			0.1859	0.7102
			0.1468	0.8104

Tolerance = ±1 nm

Color Bin Limits (BIN) - Blue

Bin ID	Dominant Wavelength, λ_d (nm)		Chromaticity Coordinates (for reference)	
	Min.	Max.	x	y
A	465	469	0.1355	0.0399
			0.1434	0.0516
			0.1349	0.0646
			0.1267	0.0534
B	466	470	0.1335	0.0427
			0.1415	0.0543
			0.1325	0.0688
			0.1241	0.0578
C	467	471	0.1314	0.0459
			0.1394	0.0574
			0.1299	0.0734
			0.1215	0.0626
D	468	472	0.1291	0.0495
			0.1373	0.0608
			0.1273	0.0784
			0.1187	0.0678
E	469	473	0.1267	0.0534
			0.1349	0.0646
			0.1245	0.0840
			0.1158	0.0736
F	470	474	0.1241	0.0578
			0.1325	0.0688
			0.1216	0.0900
			0.1128	0.0799

Tolerance = ±1 nm

Example of bin information on reel and packaging label:

CAT : S1 V1 P1	–	Red intensity bin S1
	–	Green intensity bin V1
	–	Blue intensity bin P1
BIN : A B	–	Green color bin A
		Blue color bin B

Figure 2: Spectral Power Distribution

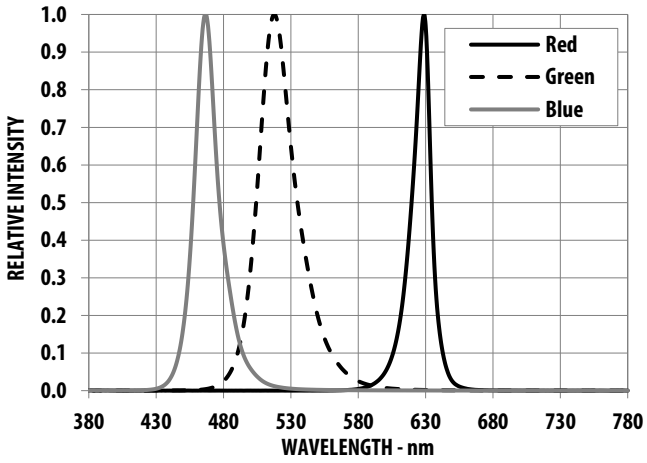


Figure 3: Forward Current vs. Forward Voltage

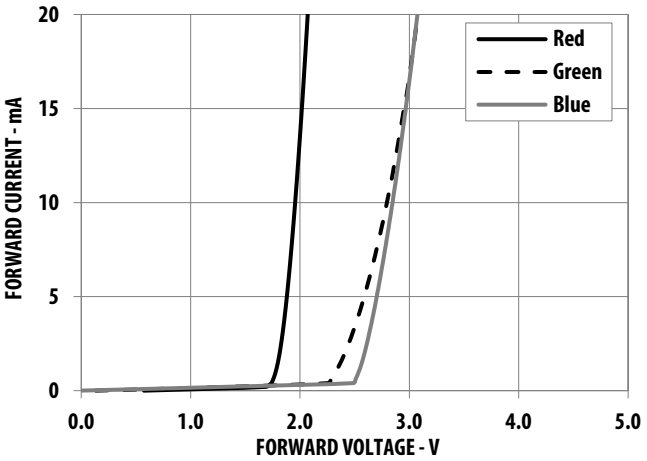


Figure 4: Relative Luminous Intensity vs. Mono Pulse Current

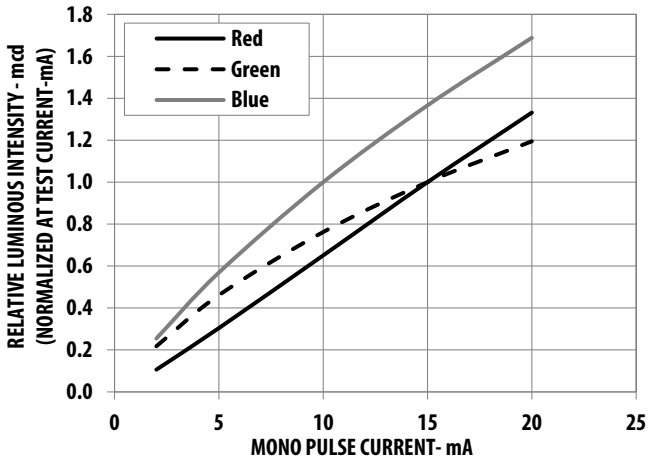


Figure 5: Dominant Wavelength Shift vs. Mono Pulse Current

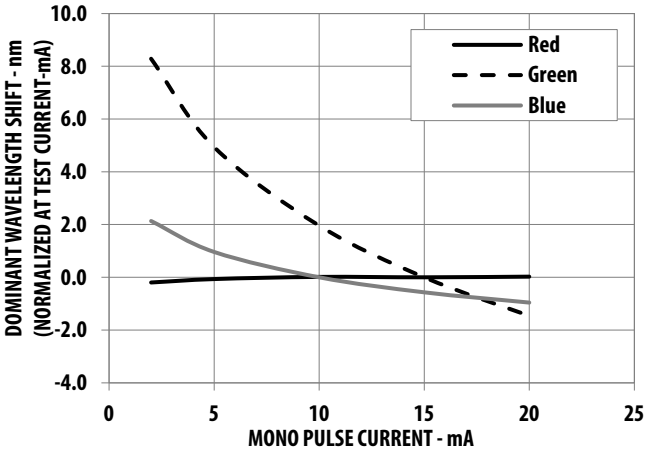


Figure 6: Relative Light Output vs. Junction Temperature

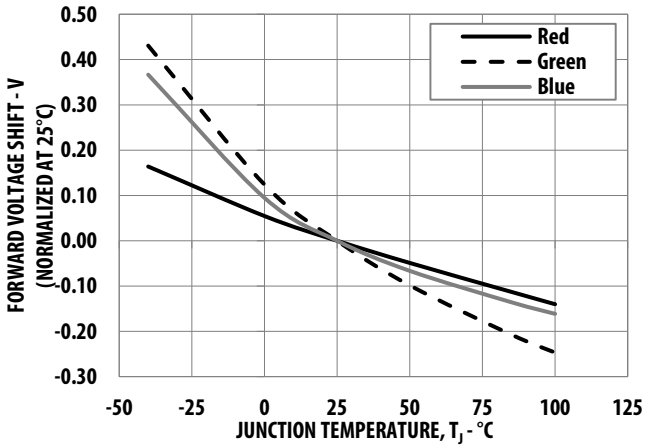


Figure 7: Forward Voltage Shift vs. Junction Temperature

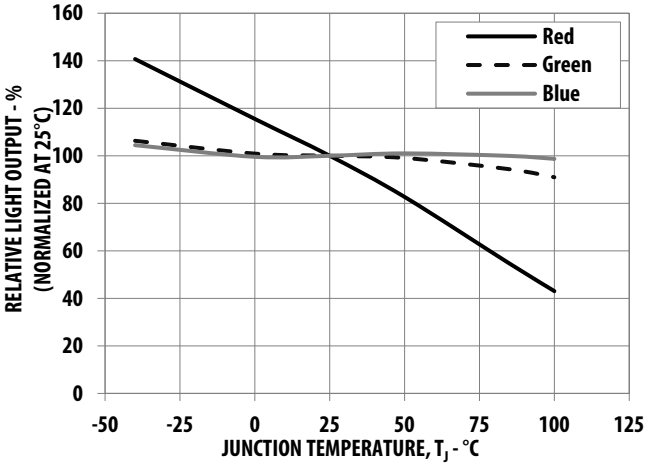


Figure 8: Maximum Forward Current vs. Temperature for Red, Green, and Blue (3 chips on)

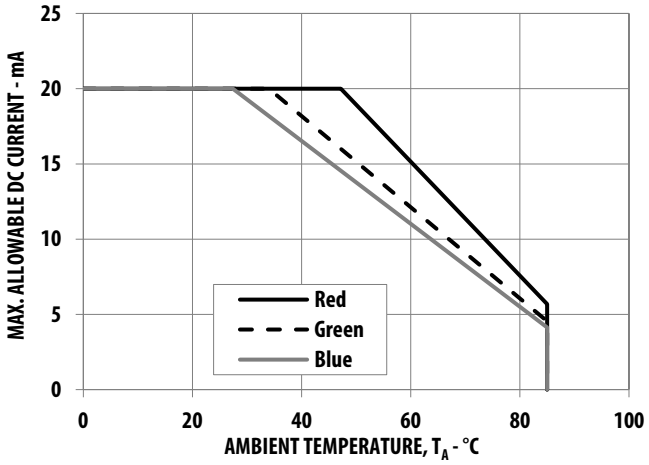
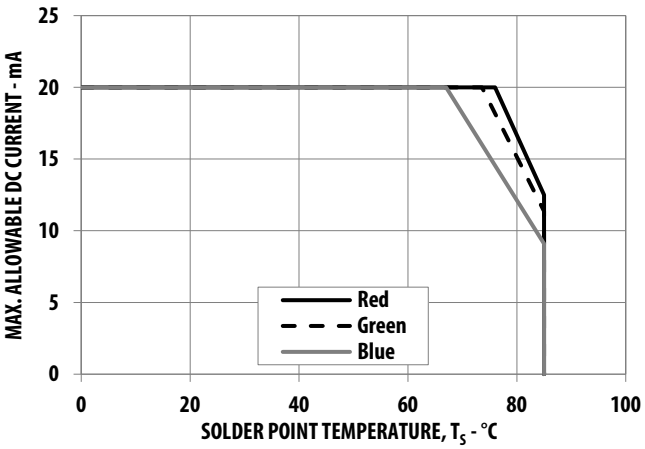


Figure 9: Maximum Forward Current vs. Solder Temperature for Red, Green, and Blue (3 chips on)



NOTE:

The maximum forward current graphs based on ambient temperature (T_A) in Figure 8 and Figure 9 are with reference to the thermal resistance $R_{\theta J-A}$ in the following table. Refer to Precautionary Note for more details.

Condition	Thermal Resistance from LED Junction to Ambient, $R_{\theta J-A}$ (°C/W)	
	Red and Blue	Green
3 chips on	1100	1000

Figure 10: Radiation Pattern for x-axis

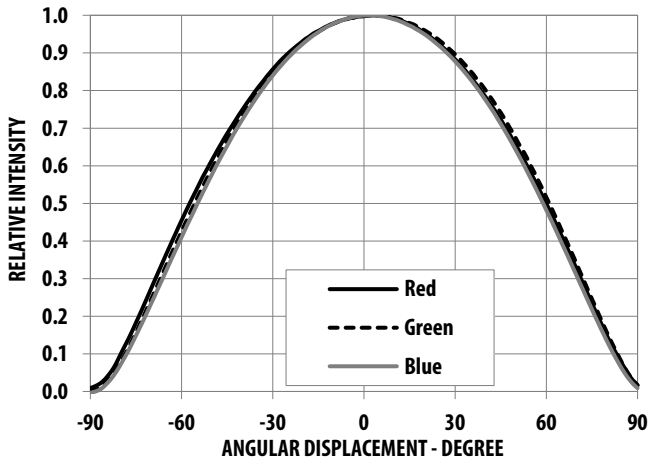


Figure 11: Radiation Pattern for y-axis

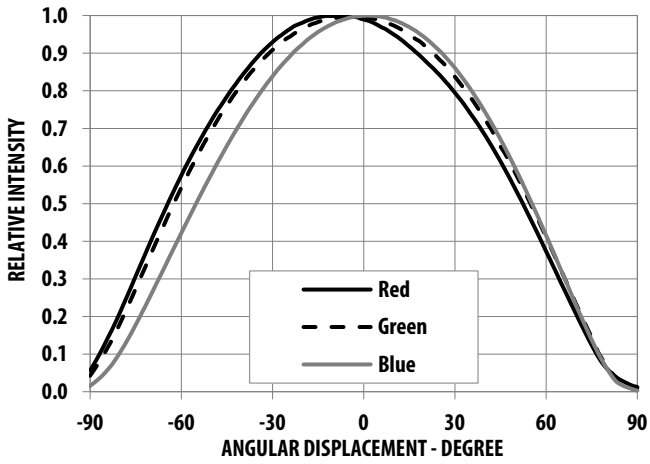


Figure 12: Package Axis for Radiation Pattern

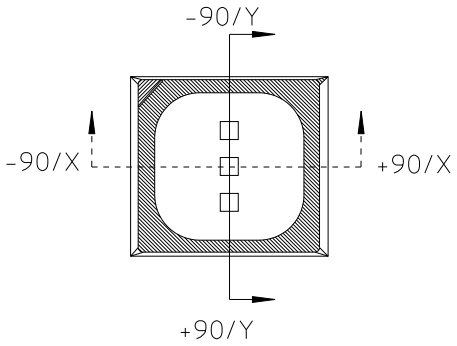
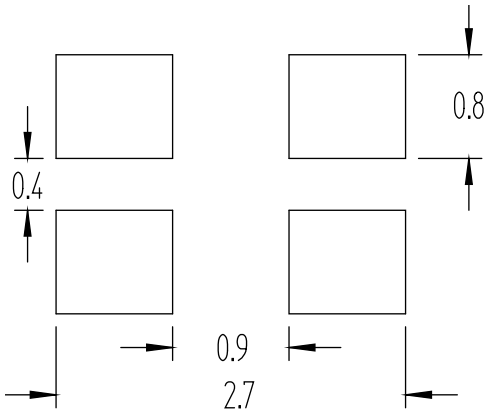
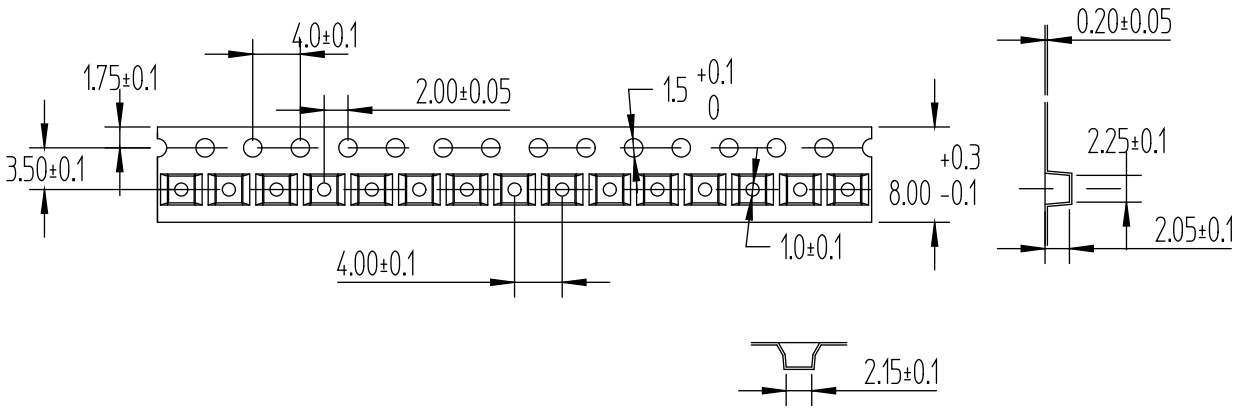


Figure 13: Recommended Soldering Pad Pattern



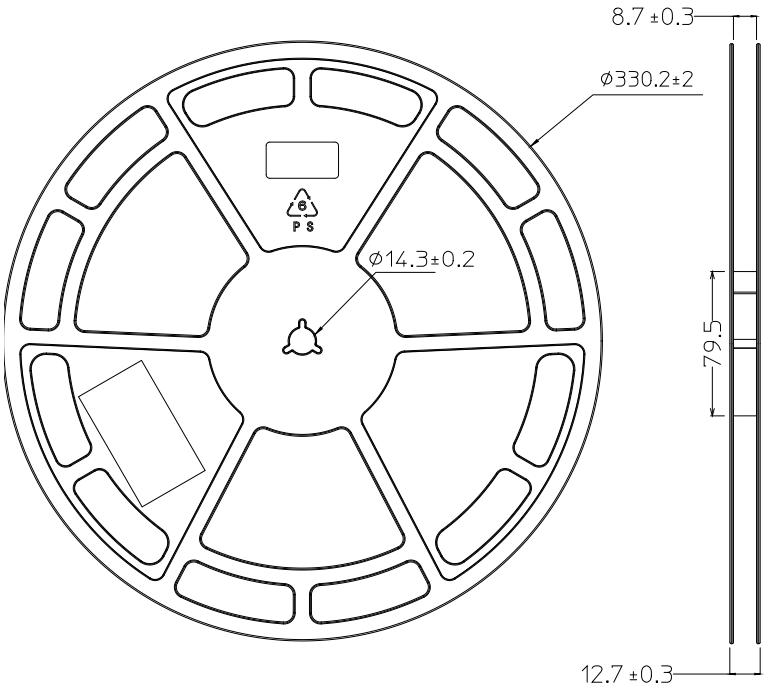
Note: All dimensions are in millimeters.

Figure 14: Carrier Tape Dimensions



Note: All dimensions are in millimeters.

Figure 15: Reel Dimensions



Note: All dimensions are in millimeters.

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 = 3s 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 16: Recommended Lead-Free Reflow Soldering Profile

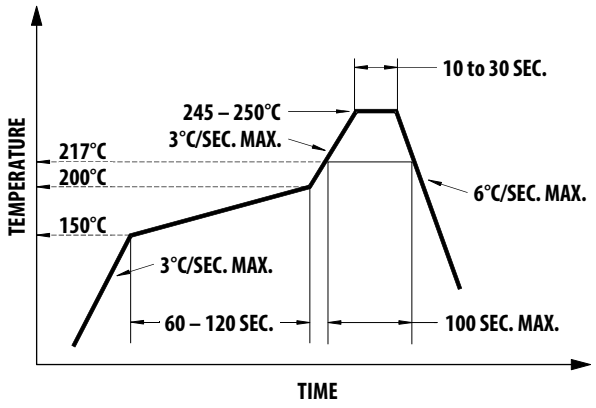
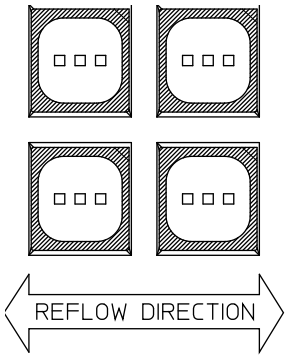


Figure 17: Recommended Board Reflow Direction



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 1.5 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 MBB.

  - Keep the LEDs at <30°C/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 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: 60°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 ambient environments 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.
- 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 changes 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 environments, protect the LED against damages caused by rain water, water, dust, oil, corrosive gases, external mechanical stresses, and so on.
- The number of reflow cycles and reflow temperature conditions used may affect optical characteristics of the LED. It is recommended to use LEDs with the same number of reflow cycles and the same reflow temperature conditions within the same finished good.

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:

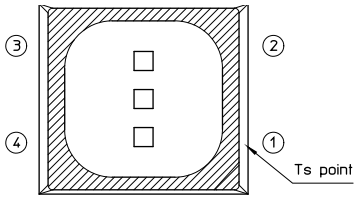
T_S = LED solder point temperature as shown in the Figure 18 (°C)

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

I_F = Forward current (A)

V_{Fmax} = Maximum forward voltage (V)

Figure 18: Solder Point Temperature on PCB



T_S can be easily measured by mounting a thermocouple on the soldering joint as shown in Figure 18, while $R_{\theta J\text{-}S}$ is provided in this 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 this 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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