

## **HSMF-A2xx-xxxxx Bicolor Surface-Mount LED Indicators PLCC-4 SMT LEDs**



### **Description**

This Broadcom® family of surface-mount (SMT) LEDs is packaged in the industry-standard PLCC-4 package. These SMT LEDs have high-reliability performance and are designed to work under a wide range of environmental conditions. This high reliability feature makes them ideally suited to be used under harsh interior automotive as well as interior signs application conditions.

To facilitate easy pick-and-place assembly, the LEDs are packed in EIA-compliant tape and reel. Every reel is shipped in single intensity and color bin, except red color to provide close uniformity.

These LEDs are compatible with IR and TTW solder reflow process.

This super wide viewing angle at 120°, together with the built-in reflector pushing up the intensity of the light output, makes these LEDs suitable to be used in the interior electronics signs. The flat top emitting surface makes it easy for these LEDs to mate with light pipes. This is suitable for general backlighting in automotive interior, office equipment, industrial equipment, and home appliances.

### **Features**

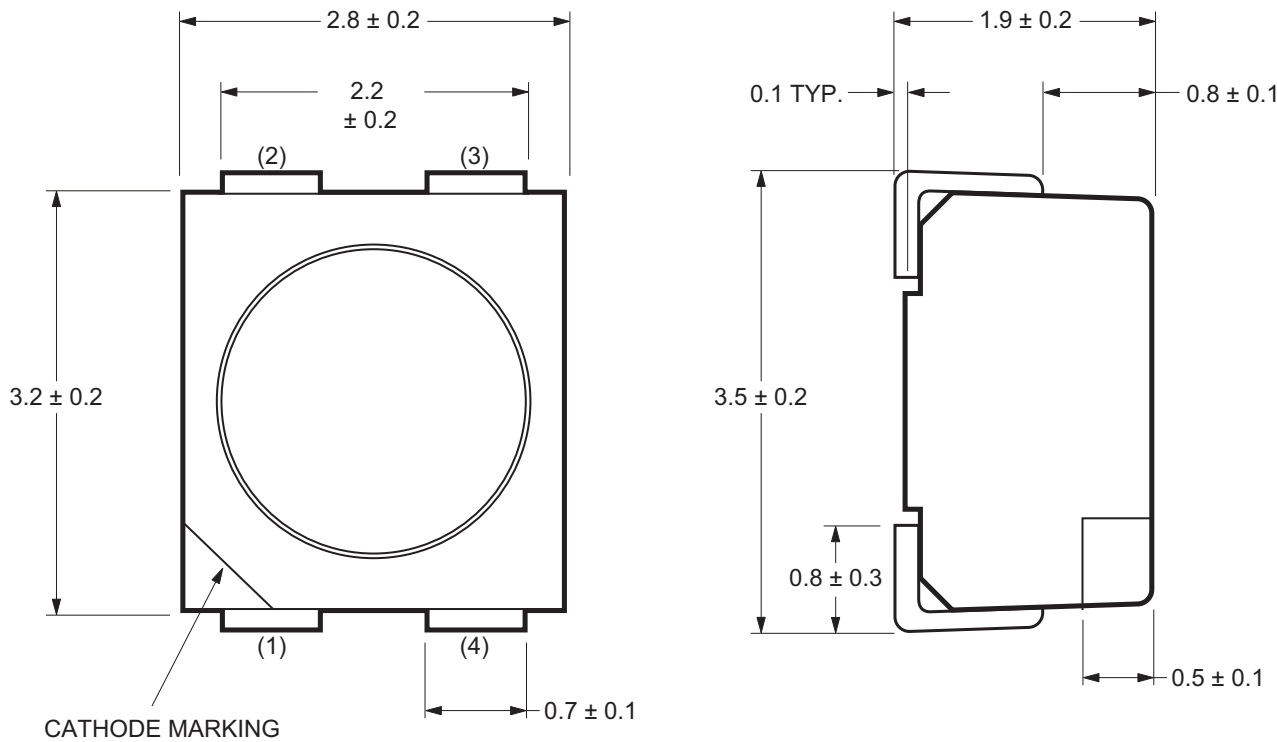
- Industry-standard PLCC-4 package (plastic leaded chip carrier)
- High-reliability LED package due to enhanced silicone resin material
- High brightness using AlInGaP dice technology
- Available in full selection of colors
- Super wide viewing angle at 120°
- Available in 8-mm carrier tape on 7-inch reel
- Compatible with IR soldering process

### **Applications**

- Electronic signs and signals
  - Interior full color sign
  - Variable message sign
- Interior automotive
  - Instrument cluster backlighting
  - Central console backlighting
  - Cabin backlighting
- Office automation, home appliances, industrial equipment
  - Front panel backlighting
  - Display backlighting

**CAUTION!** HSMF-Axxx-xxxxx LEDs are Class 2 ESD sensitive. Observe appropriate precautions during handling and processing. Refer to Application Note AN-1142 for additional details.

Package Drawing



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

Bicolor	
1	Cathode (Color 1)
2	Anode (Color 1)
3	Cathode (Color 2)
4	Anode (Color 2)

# Device Selection Guide

## Bicolor

Part Number	Color 1	Color 2
HSMF-A201-xxxxx	Red	Yellow Green
HSMF-A202-xxxxx	Red	Yellow
HSMF-A203-xxxxx	Red	Emerald Green
HSMF-A204-xxxxx	Orange	Yellow Green
HSMF-A205-xxxxx	Orange	Emerald Green
HSMF-A206-xxxxx	Yellow	Yellow Green
HSMF-A211-xxxxx	Deep Red	Yellow Green
HSMF-A212-xxxxx	Deep Red	Yellow

Part Number	Color 1			Color 2		
	Min. $I_V$ at 20 mA <sup>a, b</sup>		Typical $I_V$ at 20 mA <sup>a, b</sup>	Min. $I_V$ at 20 mA <sup>a, b</sup>		Typical $I_V$ at 20 mA <sup>a, b</sup>
	Bin ID	(mcd)	(mcd)	Bin ID	(mcd)	(mcd)
HSMF-A201-A00J1	K2	9.0	16.0	L1	11.2	20.0
HSMF-A202-A00J1	K2	9.0	16.0	K1	7.2	12.0
HSMF-A203-A00J1	K2	9.0	16.0	J1	4.5	25.0
HSMF-A204-A00J1	K2	9.0	23.0	L1	11.2	20.0
HSMF-A205-A00J1	K2	9.0	23.0	J1	4.5	25.0
HSMF-A206-A00J1	K2	9.0	12.0	L1	11.2	20.0
HSMF-A211-A00J1	L2	14.0	46.0	L1	11.2	20.0
HSMF-A212-A00J1	L2	14.0	46.0	K1	7.2	12.0

a. The luminous intensity  $I_V$  is measured at the mechanical axis of the lamp package. The actual peak of the spatial radiation pattern might not be aligned with this axis

b.  $I_V$  tolerance =  $\pm 12\%$ .

## Absolute Maximum Ratings ( $T_A = 25^\circ\text{C}$ )

Parameters	AlInGaP
DC Forward Current <sup>a</sup>	30 mA
Peak Forward Current <sup>b</sup>	100 mA
Power Dissipation	78 mW
Reverse Voltage	5V
Junction Temperature	110°C
Operating Temperature	-55°C to +100°C
Storage Temperature	-55°C to +100°C

a. Derate linearly as shown in [Figure 4](#).

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

## Optical Characteristics ( $T_A = 25^\circ\text{C}$ )

Color	Peak Wavelength $\lambda_{\text{PEAK}}$ (nm) Typ.	Dominant Wavelength $\lambda_D$ (nm) <sup>a</sup> Typ.	Viewing Angle $2\theta_{1/2}$ (Degrees) <sup>b</sup> Typ.	Luminous Efficacy $\eta_V$ (lm/W) <sup>c</sup> Typ.	Luminous Intensity/ Total Flux $I_V$ (mcd)/ $\phi_V$ (mlm) Typ.
Deep Red	652	637	120	85	0.45
Red	632	626	120	200	0.45
Orange	610	605	120	350	0.45
Yellow	590	589	120	510	0.45
Yellow Green	573	570	120	560	0.45
Emerald Green	561	560	120	660	0.45

- a. The dominant wavelength,  $\lambda_D$ , is derived from the CIE Chromaticity Diagram and represents the color of the device.
- b.  $\theta_{1/2}$  is the off-axis angle where the luminous intensity is 1/2 the peak intensity.
- c. Radiant intensity,  $I_e$  in watts/steradian, can be calculated 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.

## Electrical Characteristics ( $T_A = 25^\circ\text{C}$ )

Dice Technology	Forward Voltage $V_F$ (Volts) at $I_F = 20\text{ mA}$		Reverse Voltage $V_R$ at $100\text{ }\mu\text{A}$
	Typ.	Max.	Min.
Deep Red, Red, Orange, Yellow, Yellow Green, Emerald Green	2.0	2.6	5

## Part Numbering System

H S M x<sub>1</sub> - A x<sub>2</sub> x<sub>3</sub> x<sub>4</sub> - x<sub>5</sub> x<sub>6</sub> x<sub>7</sub> x<sub>8</sub> x<sub>9</sub>

Code	Description	Option	
x <sub>1</sub>	LED Chip Color	F	Bicolor or Tricolor
x <sub>2</sub>	Package Type	2	Bicolor
x <sub>3</sub> x <sub>4</sub>	Device Specific Configuration		
x <sub>5</sub>	Minimum Intensity Bin Selection	Refer to the <a href="#">I<sub>V</sub> Bin Select (x<sub>5</sub>x<sub>6</sub>)</a> .	
x <sub>6</sub>	Number of Intensity Bins		
x <sub>7</sub>	Color Bin Selection	Refer to <a href="#">Color Bin Select (x<sub>7</sub>)</a> .	
x <sub>8</sub> x <sub>9</sub>	Packaging Option	J1	20 mA test current, Top Mount, 7-inch reel

## Bin Information

### I<sub>V</sub> Bin Select (x<sub>5</sub>x<sub>6</sub>)

Individual reel will contain parts from one half bin only.

**Table 1: Minimum Intensity Bin Selection for HSMF-A201-xxxxx, HSMF-A204-xxxxx, HSMF-A206-xxxxx**

x <sub>5</sub>	Color 1 (Red/ Yellow/Orange)	Color 2 (Yellow Green)
A	K2	L1
B	K2	L2
C	K2	M1
D	K2	M2
E	K2	N1
F	L1	L1
G	L1	L2
H	L1	M1
J	L1	M2
K	L1	N1
L	L2	L1
M	L2	L2
N	L2	M1
P	L2	M2
Q	L2	N1
R	M1	L1
S	M1	L2
T	M1	M1
U	M1	M2
V	M1	N1
W	M2	L1
X	M2	L2
Y	M2	M1
Z	M2	M2
1	M2	N1

**Table 2: Minimum Intensity Bin Selection for HSMF-A202-xxxxx**

x <sub>5</sub>	Color 1 (Red)	Color 2 (Yellow)
A	K2	K1
B	K2	K2
C	K2	L1
D	K2	L2
E	K2	M1
F	L1	K1
G	L1	K2
H	L1	L1
J	L1	L2
K	L1	M1
L	L2	K1
M	L2	K2
N	L2	L1
P	L2	L2
Q	L2	M1
R	M1	K1
S	M1	K2
T	M1	L1
U	M1	L2
V	M1	M1
W	M2	K1
X	M2	K2
Y	M2	L1
Z	M2	L2
1	M2	M1

**Table 3: Minimum Intensity Bin Selection for HSMF-A203-xxxxx and HSMF-A205-xxxxx**

x <sub>5</sub>	Color 1 (Red/Orange)	Color 2 (Emerald Green)
A	K2	J1
B	K2	J2
C	K2	K1
D	K2	K2
E	K2	L1
F	L1	J1
G	L1	J2
H	L1	K1
J	L1	K2
K	L1	L1
L	L2	J1

**Table 3: Minimum Intensity Bin Selection for HSMF-A203-xxxxx and HSMF-A205-xxxxx (Continued)**

x <sub>5</sub>	Color 1 (Red/Orange)	Color 2 (Emerald Green)
M	L2	J2
N	L2	K1
P	L2	K2
Q	L2	L1
R	M1	J1
S	M1	J2
T	M1	K1
U	M1	K2
V	M1	L1
W	M2	J1
X	M2	J2
Y	M2	K1
Z	M2	K2
1	M2	L1

**Table 4: Minimum Intensity Bin Selection for HSMF-A211-xxxxx**

x <sub>5</sub>	Color 1 (Deep Red)	Color 2 (Yellow Green)
A	L2	L1
B	L2	L2
C	L2	M1
D	L2	M2
E	L2	N1
F	M1	L1
G	M1	L2
H	M1	M1
J	M1	M2
K	M1	N1
L	M2	L1
M	M2	L2
N	M2	M1
P	M2	M2
Q	M2	N1
R	N1	L1
S	N1	L2
T	N1	M1
U	N1	M2
V	N1	N1
W	N2	L1
X	N2	L2

**Table 4: Minimum Intensity Bin Selection for HSMF-A211-xxxxx (Continued)**

x <sub>5</sub>	Color 1 (Deep Red)	Color 2 (Yellow Green)
Y	N2	M1
Z	N2	M2
1	N2	N1

**NOTE:** 0 represents full distribution.**Table 5: Minimum Intensity Bin Selection for HSMF-A212-xxxxx**

x <sub>5</sub>	Color 1 (Deep Red)	Color 2 (Yellow)
A	L2	K1
B	L2	K2
C	L2	L1
D	L2	L2
E	L2	M1
F	M1	K1
G	M1	K2
H	M1	L1
J	M1	L2
K	M1	M1
L	M2	K1
M	M2	K2
N	M2	L1
P	M2	L2
Q	M2	M1
R	N1	K1
S	N1	K2
T	N1	L1
U	N1	L2
V	N1	M1
W	N2	K1
X	N2	K2
Y	N2	L1
Z	N2	L2
1	N2	M1

## Number of Half Bins from $x_5$

Table 6: Number of Half Bins from  $x_5$  for HSMF-A2xx-xxxxx

$x_6$	Color 1	Color 2
0	0	0
A	0	5
B	0	4
C	0	3
D	0	2
E	5	0
F	5	5
G	5	4
H	5	3
J	5	2
K	4	0
L	4	5
M	4	4
N	4	3
P	4	2
Q	3	0
R	3	5
S	3	4
T	3	3
U	3	2
V	2	0
W	2	5
X	2	4
Y	2	3
Z	2	2

**NOTE:** 0 represents full distribution.

## Intensity Bin Limits

Table 7: Intensity Bin Limits

Bin ID	Min. (mcd)	Max. (mcd)
J1	4.50	5.60
J2	5.60	7.20
K1	7.20	9.00
K2	9.00	11.20
L1	11.20	14.00
L2	14.00	18.00
M1	18.00	22.40
M2	22.40	28.50

Table 7: Intensity Bin Limits (Continued)

Bin ID	Min. (mcd)	Max. (mcd)
N1	28.50	35.50
N2	35.50	45.00
P1	45.00	56.00
P2	56.00	71.50
Q1	71.50	90.00
Q2	90.00	112.50
R1	112.50	140.00
R2	140.00	180.00
S1	180.00	224.00
S2	224.00	285.00
T1	285.00	355.00
T2	355.00	450.00
U1	450.00	560.00
U2	560.00	715.00
V1	715.00	900.00
V2	900.00	1125.00

**NOTE:** Tolerance of each bin limit =  $\pm 12\%$ .

## Color Bin Select ( $x_7$ )

Individual reel will contain parts from one full bin only.

Table 8: Color Bin Select for HSMF-A202-xxxxx, HSMF-A203-xxxxx, HSMF-A212-xxxxx

$x_7$	Color 1 (Red/Deep Red)	Color 2 (Emerald Green/ Yellow)
0	0	0
A	0	ABC
B	0	ABCD
C	0	ABCDE
D	0	BCD
E	0	BCDE
F	0	BCDEF
G	0	CDE
H	0	DEF
J	0	CDEF
K	0	AB
L	0	BC
M	0	CD
N	0	DE
P	0	EF

**NOTE:** 0 represents full distribution.

**Table 9: Color Bin Select for HSMF-A201-xxxxx and HSMF-A211-xxxxx**

x <sub>7</sub>	Color 1 (Red/Deep Red)	Color 2 (Yellow Green)
0	0	0
A	0	EFG
B	0	FGH
C	0	EF
D	0	FG
E	0	GH

**NOTE:** 0 represents full distribution.**Table 10: Color Bin Select for HSMF-A205-xxxxx**

x <sub>7</sub>	Color 1 (Orange)	Color 2 (Emerald Green)
0	0	0
A	ABC	ABC
B	BCD	ABC
C	CDE	ABC
D	ABC	BCD
E	BCD	BCD
F	CDE	BCD
G	ABC	CDE
H	BCD	CDE
J	CDE	CDE
K	DEF	ABC
L	DEF	BCD
M	DEF	CDE
N	AB	AB
P	BC	AB
Q	CD	AB
R	DE	AB
S	AB	BC
T	BC	BC
U	CD	BC
V	DE	BC
W	AB	CD
X	BC	CD
Y	CD	CD
Z	DE	CD
1	AB	DE
2	BC	DE
3	CD	DE
4	DE	DE

**Table 10: Color Bin Select for HSMF-A205-xxxxx (Continued)**

x <sub>7</sub>	Color 1 (Orange)	Color 2 (Emerald Green)
5	EF	AB
6	EF	BC
7	EF	CD

**NOTE:** 0 represents full distribution.**Table 11: Color Bin Select for HSMF-A204-xxxxx and HSMF-A206-xxxxx**

x <sub>7</sub>	Color 1 (Yellow/ Orange)	Color 2 (Yellow Green)
0	0	0
A	ABC	EFG
B	BCD	EFG
C	CDE	EFG
D	DEF	EFG
E	ABC	FGH
F	BCD	FGH
G	CDE	FGH
H	DEF	FGH
J	AB	EF
K	BC	EF
L	CD	EF
M	DE	EF
N	EF	EF
P	AB	FG
Q	BC	FG
R	CD	FG
S	DE	FG
T	EF	FG
U	AB	GH
V	BC	GH
W	CD	GH
X	DE	GH
Y	EF	GH

**NOTE:** 0 represents full distribution.



## Color Bin Limits

Emerald Green	Min. (nm)	Max. (nm)
A	552.5	555.5
B	555.5	558.5
C	558.5	561.5
D	561.5	564.5

Yellow Green	Min. (nm)	Max. (nm)
E	564.5	567.5
F	567.5	570.5
G	570.5	573.5
H	573.5	576.5

Yellow	Min. (nm)	Max. (nm)
A	582.0	584.5
B	584.5	587.0
C	587.0	589.5
D	589.5	592.0
E	592.0	594.5
F	594.5	597.0

Orange	Min. (nm)	Max. (nm)
A	597.0	600.0
B	600.0	603.0
C	603.0	606.0
D	606.0	609.0
E	609.0	612.0

Red	Min. (nm)	Max. (nm)
—	618.0	635.0

**NOTE:** Tolerance for each bin limit =  $\pm 1$  nm.

## Packaging Option (x<sub>8</sub>x<sub>9</sub>)

x <sub>8</sub> x <sub>9</sub>	
J1	20-mA test current, Top Mount, 7-inch Reel

Figure 1: Relative Intensity vs. Wavelength

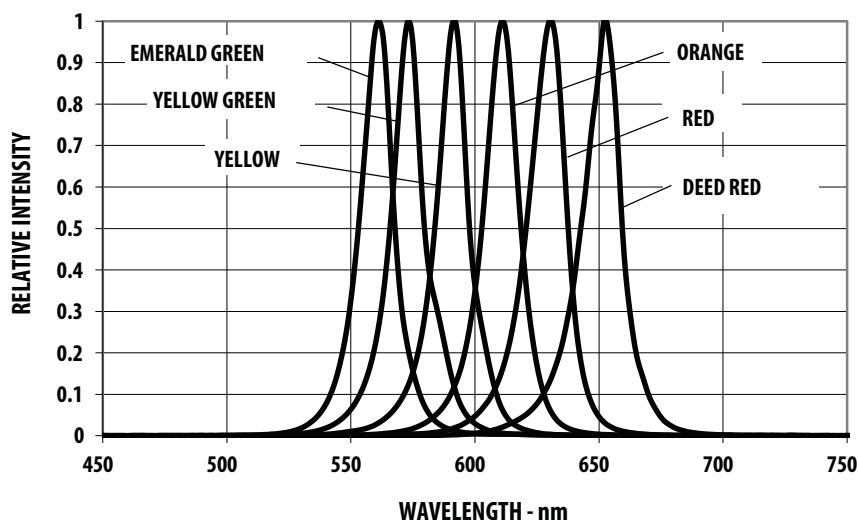


Figure 2: Forward Current vs. Forward Voltage

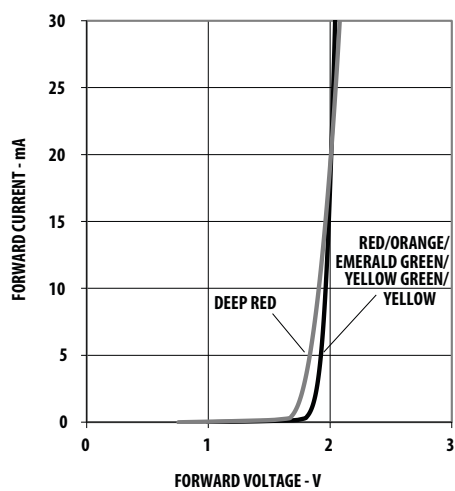


Figure 3: Relative Intensity vs. Forward Voltage

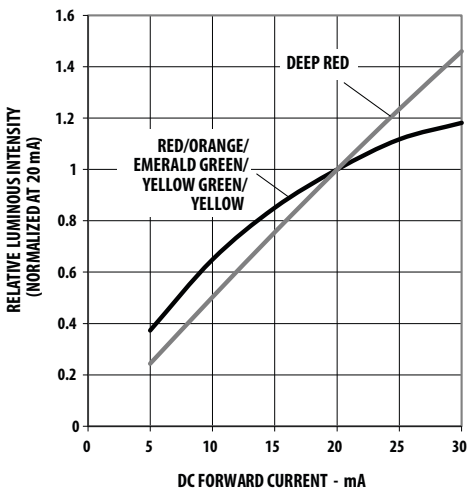


Figure 4: Maximum Forward Current vs Ambient Temperature, Derate Based on T<sub>J</sub> MAX = 110°C, R<sub>θJA</sub> = 500°C/W (1 chip on)

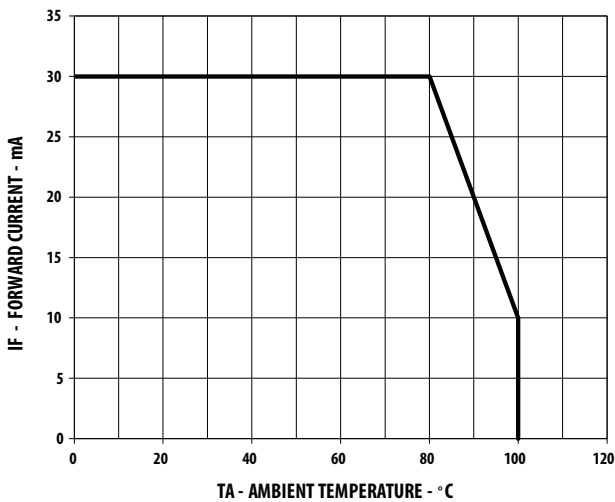
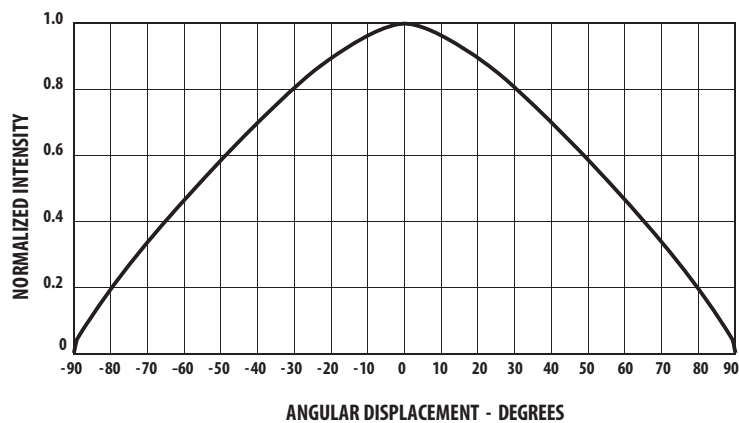
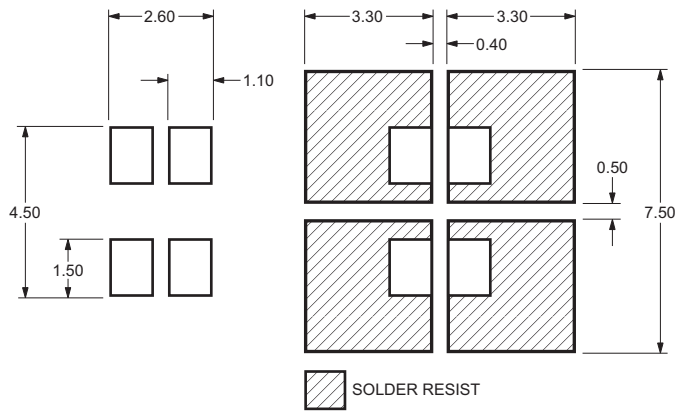


Figure 5: Radiation Pattern

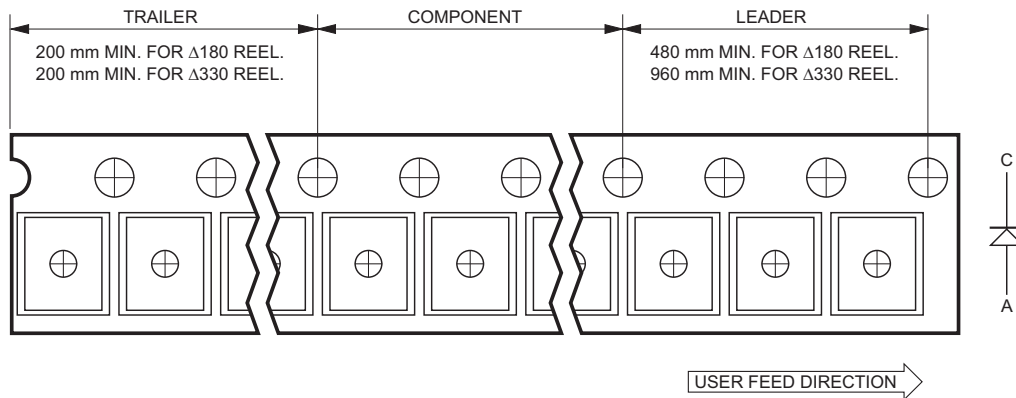


**NOTE:** For detail information on reflow soldering of Broadcom surface-mount LEDs, refer to the Application Note AN1060 Surface-Mounting SMT LED Indicator Components.

**Figure 6: Recommended Soldering Pad Pattern**



**Figure 7: Tape Leader and Trailer Dimension**



**Figure 8: Tape Leader and Trailer Dimension**

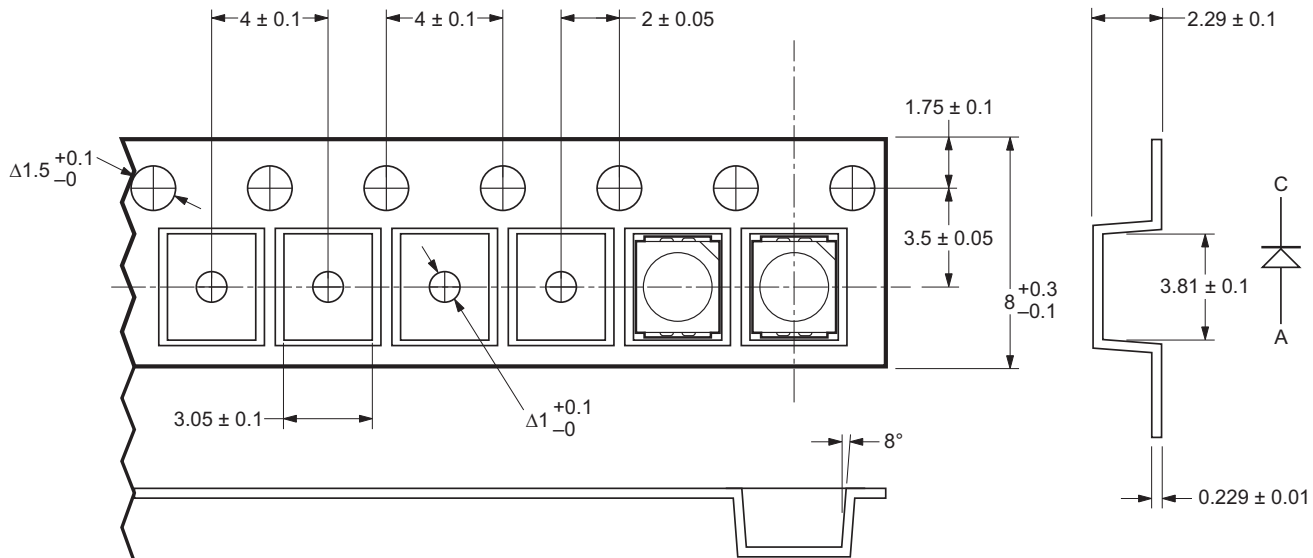


Figure 9: Reel Dimensions

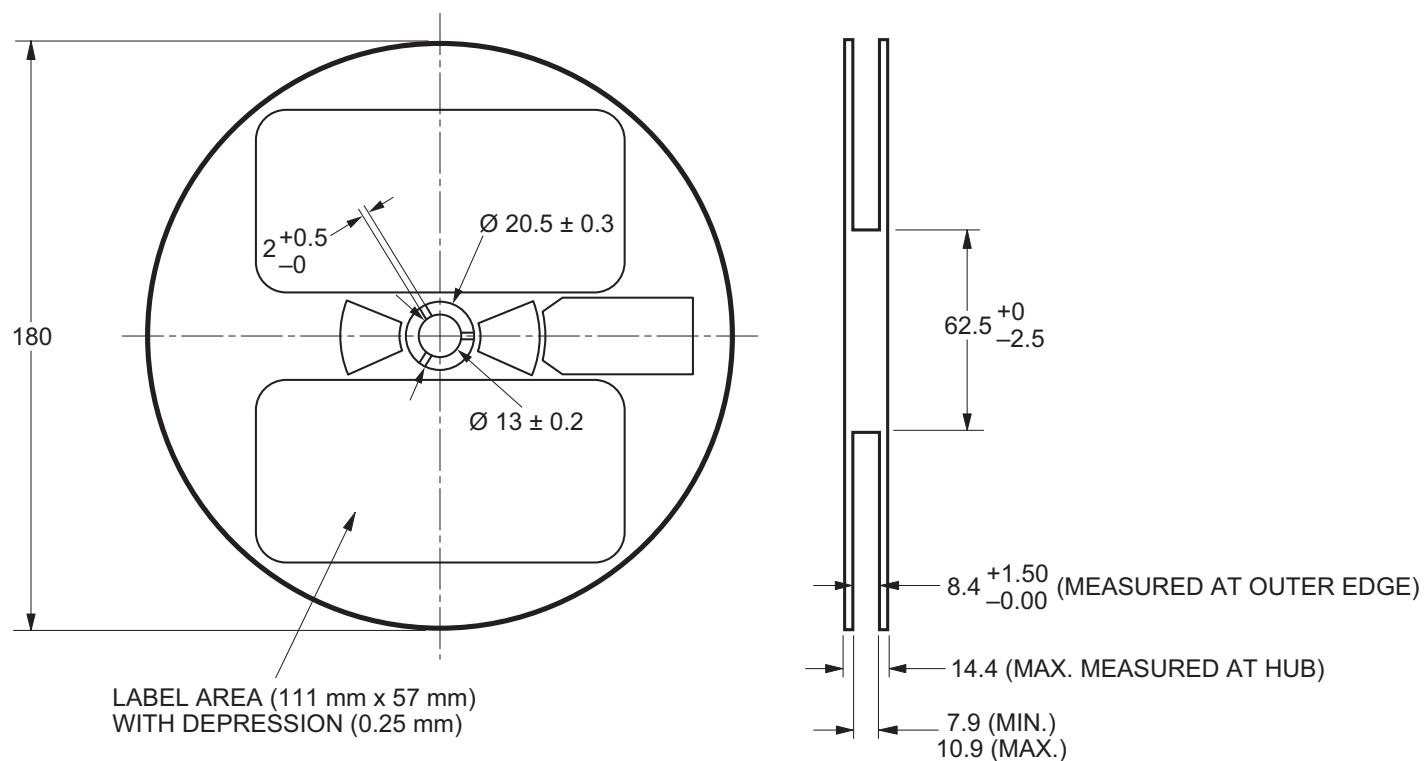
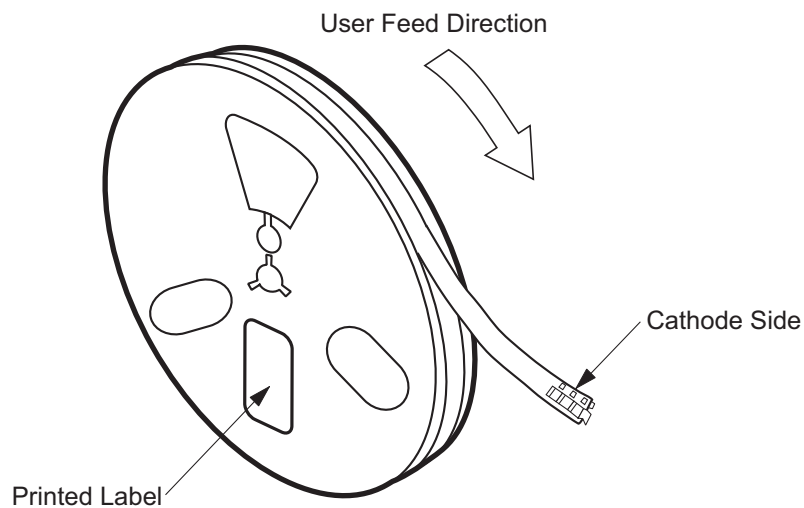


Figure 10: Reeling Orientation



**NOTE:** Diameter ID should be bigger than 2.3 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 11: Recommended Lead-Free Reflow Soldering Profile

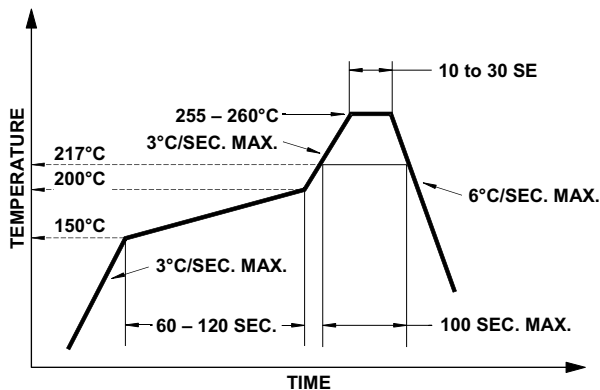
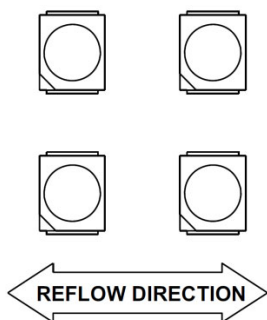


Figure 12: Recommended Board Reflow Direction



## Handling Precautions

### Handling of Moisture-Sensitive Devices

This product has a Moisture Sensitive Level 2a 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, the MBB must be properly resealed with fresh desiccant and the 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 672 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 672 hours.

The recommended baking condition is: 60°C ± 5°C 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 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 (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

Optical, electrical, and reliability characteristics of LED are affected by temperature. The junction temperature ( $T_J$ ) of the LED must be kept below 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 ( $^{\circ}\text{C}$ )

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

$I_F$  = 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.

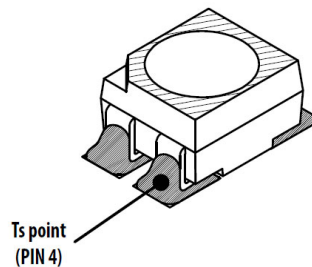
Another way of calculating  $T_J$  is by using solder point temperature  $T_S$  as follows:

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

where:

$T_S$  = LED solder point temperature as shown in the following figure ( $^{\circ}\text{C}$ )

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



$T_S$  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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