

HSMF-A2xx-xxxxx Bicolor, HSMF-A3xx-xxxxx Tricolor 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 and interior sign application conditions.

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

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

The super-wide viewing angle of 120°, together with the built-in reflector that pushes up the intensity of the light output, makes these LED suitable to be used in interior electronic 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 interiors, office equipment, industrial equipment, and home appliances.

Features

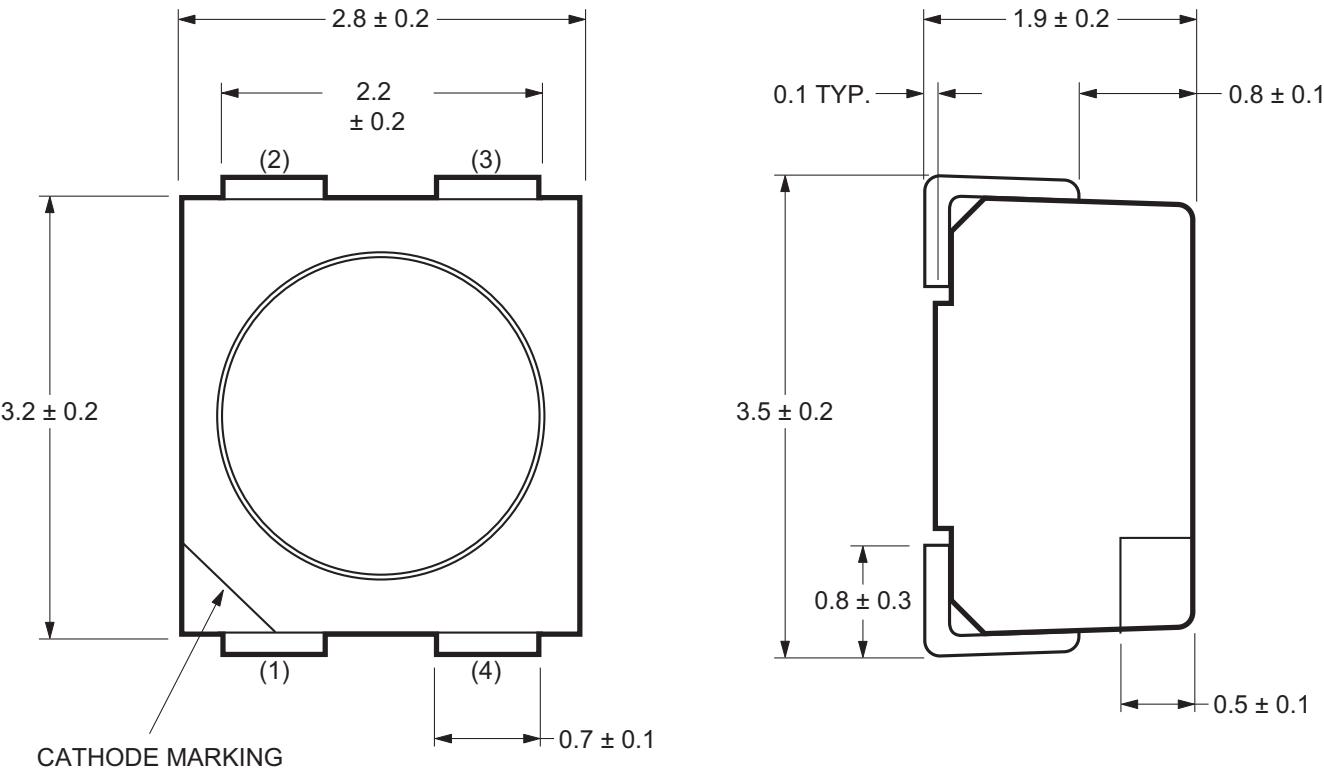
- Industry-standard PLCC-4 package (plastic leaded chip carrier)
- High-reliability LED package due to enhanced silicone resin material
- High brightness using AlInGaP and InGaN dice technologies
- Available in a full selection of colors
- Super-wide viewing angle of 120°
- Available in 8-mm carrier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

Applications

- Electronic signs and signals:
 - Interior full-color signs
 - Variable-message signs
- 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 1142 for additional details.

Package Drawing



NOTE: All dimensions are in millimeters (mm).

Tricolor	
1	Cathode (Color 1)
2	Common Anode
3	Cathode (Color 3)
4	Cathode (Color 2)
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-A222-xxxxx	AlInGaP Red	AlInGaP Amber
HSMF-A226-xxxxx	AlInGaP Amber	AlInGaP Yellow Green

Part Number	Color 1			Color 2		
	Min. I_V at 20 mA ^{a,b}		Typical I_V at 20 mA ^{a,b}	Min. I_V at 20 mA ^{a,b}		Typical I_V at 20 mA ^{a,b}
	Bin ID	(mcd)	(mcd)	Bin ID	(mcd)	(mcd)
HSMF-A222-A00J1	P1	45.0	80.0	P1	45.0	80.0
HSMF-A226-A00J1	P2	56.0	100.0	M2	22.4	60.0

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 = $\pm 12\%$.

Tricolor

Part Number	Color 1	Color 2	Color 3
HSMF-A341-xxxxx	AlInGaP Red	InGaN Green	InGaN Blue

Part Number	Color 1			Color 2			Color 3		
	Min. I_V at 20 mA ^{a,b}		Typical I_V at 20 mA ^{a,b}	Min. I_V at 20 mA ^{a,b}		Typical I_V at 20 mA ^{a,b}	Min. I_V at 20 mA		Typical I_V at 20 mA ^{a,b}
	Bin ID	(mcd)	(mcd)	Bin ID	(mcd)	(mcd)	Bin ID	(mcd)	(mcd)
HSMF-A341-A00J1	P1	45.0	80.0	R1	112.5	160.0	N1	28.5	40.0

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		InGaN
	Red, Amber	Yellow Green	Blue, Green
DC Forward Current ^a	30 mA ^{b,c}	20 mA ^c	20 mA
Peak Forward Current ^d	100 mA	100 mA	100 mA
Power Dissipation	72 mW	48 mW	120 mW
Reverse Voltage ^e	5V		
Junction Temperature	110°C		
Operating Temperature	-40°C to +100°C		
Storage Temperature	-40°C to +100°C		

- a. Derate linearly as shown in [Figure 4](#).
- b. Drive current between 10 mA and 30 mA is recommended for best long-term performance.
- c. Operation at current below 5 mA is not recommended.
- d. Duty factor = 10%, Frequency = 1 kHz.
- e. Indicates the product final test condition. Long-term reverse bias is not recommended.

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

Color	Peak Wavelength λ_{PEAK} (nm) Typ.	Dominant Wavelength λ_D (nm) ^a Typ.	Viewing Angle $2\theta_{1/2}$ (Degrees) ^b Typ.	Luminous Efficacy η_v (lm/W) ^c Typ.	Luminous Intensity/ Total Flux I_v (mcd)/ Φ_v (mlm) Typ.
Red	635	626	120	150	0.45
Amber	592	590	120	480	0.45
Green	523	525	120	500	0.45
Blue	468	470	120	75	0.45
Yellow Green	575	571	120	620	0.45

- a. The dominant wavelength, λ_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 η_v is the luminous efficacy in lumens/watt.

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

Dice Technology	Forward Voltage V_F (Volts) at $I_F = 20$ mA ^a		Reverse Voltage V_R at 100 μA ^b	Reverse Voltage V_R at 10 μA ^b
	Typ.	Max.	Min.	Min.
AlInGaP	1.9	2.4	5	—
InGaN	3.4	4.05	—	5

- a. Tolerance = $\pm 0.1\text{V}$.
- b. Indicates the product final test condition. Long-term reverse bias is not recommended.

Part Numbering System

H S M

x₁

 - A

x₂

x₃

x₄

 -

x₅

x₆

x₇

x₈

x₉

Code	Description	Option	
x ₁	LED chip color	F	Bicolor or tricolor
x ₂	Package type	2	Bicolor
		3	Tricolor
x ₃ x ₄	Device-specific configuration	—	
x ₅	Minimum intensity bin selection	See Iv Bin Select (x₅x₆) .	
x ₆	Number of intensity bins		
x ₇	Color bin selection	See Color Bin Select (x₇) .	
x ₈ x ₉	Packaging option	J1	20-mA test current, top-mount, 7-inch reel

I_v Bin Select (x₅x₆)

Individual reels contain parts from one half bin only.

**Table 1: Minimum Intensity Bin Selection for
HSMF-A222-xxxxx**

x ₅	Color 1 (Red)	Color 2 (Amber)
A	P1	P1
B	P1	P2
C	P1	Q1
D	P1	Q2
E	P1	R1
F	P2	P1
G	P2	P2
H	P2	Q1
J	P2	Q2
K	P2	R1
L	Q1	P1
M	Q1	P2
N	Q1	Q1
P	Q1	Q2
Q	Q1	R1
R	Q2	P1
S	Q2	P2
T	Q2	Q1
U	Q2	Q2
V	Q2	R1
W	R1	P1
X	R1	P2
Y	R1	Q1
Z	R1	Q2
1	R1	R1
2	R2	P1
3	R2	P2
4	R2	Q1
5	R2	Q2
6	R2	R1

**Table 2: Minimum Intensity Bin Selection for
HSMF-A341-xxxxx**

x ₅	Color 1 (Red)	Color 2 (Green)	Color 3 (Blue)
A	P1	R1	N1
B	P1	R1	N2
C	P1	R1	P1
D	P1	R2	N1
E	P1	R2	N2
F	P1	R2	P1
G	P1	S1	N1
H	P1	S1	N2
J	P1	S1	P1
K	P2	R1	N1
L	P2	R1	N2
M	P2	R1	P1
N	P2	R2	N1
P	P2	R2	N2
Q	P2	R2	P1
R	P2	S1	N1
S	P2	S1	N2
T	P2	S1	P1
U	Q1	R1	N1
V	Q1	R1	N2
W	Q1	R1	P1
X	Q1	R2	N1
Y	Q1	R2	N2
Z	Q1	R2	P1
1	Q1	S1	N1
2	Q1	S1	N2
3	Q1	S1	P1
4	Q2	R1	N1
5	Q2	R1	N2
6	Q2	R1	P1
7	Q2	R2	N1
8	Q2	R2	N2
9	Q2	R2	P1

Number of Half Bins from x_5

Table 3: 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.

Table 4: Number of Half Bins from x_5 for HSMF-A3xx-xxxxx

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

NOTE: 0 represents full distribution.

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
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 reels contain parts from one full bin only.

Table 5: Color Bin Select for HSMF-A222-xxxxx

x_7	Color 1 (Red)	Color 2 (Amber)
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 6: Color Bin Select for HSMF-A3xx-xxxxx

x ₇	Color 1	Color 2	Color 3
0	0	0	0
A	0	0	ABC
B	0	0	BCD
C	0	0	AB
D	0	0	BC
E	0	0	CD
F	0	ABC	0
G	0	ABC	ABC
H	0	ABC	BCD
J	0	ABC	AB
K	0	ABC	BC
L	0	ABC	CD
M	0	BCD	0
N	0	BCD	ABC
P	0	BCD	BCD
Q	0	BCD	AB
R	0	BCD	BC
S	0	BCD	CD
T	0	AB	ABC
U	0	AB	BCD
V	0	AB	AB
W	0	AB	BC
X	0	AB	CD
Y	0	BC	ABC
Z	0	BC	BCD
1	0	BC	AB
2	0	BC	BC
3	0	BC	CD
4	0	CD	ABC
5	0	CD	BCD
6	0	CD	AB
7	0	CD	BC
8	0	CD	CD

NOTE: 0 represents full distribution.

Color Bin Limits

Blue	Min. (nm)	Max. (nm)
A	460.0	465.0
B	465.0	470.0
C	470.0	475.0
D	475.0	480.0

Green	Min. (nm)	Max. (nm)
A	515.0	520.0
B	520.0	525.0
C	525.0	530.0
D	530.0	535.0

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

Amber	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

Red	Min. (nm)	Max. (nm)
—	618.0	635.0

Tolerance for each bin limit is ±1 nm.

Packaging Option (x₈x₉)

x ₈ x ₉	Description
J1	20-mA test current, top-mount, 7-inch reel.

Figure 1: Relative Intensity vs. Wavelength

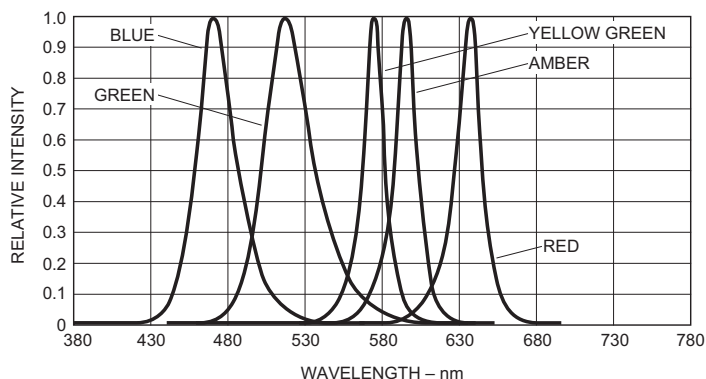


Figure 2: Forward Current vs. Forward Voltage

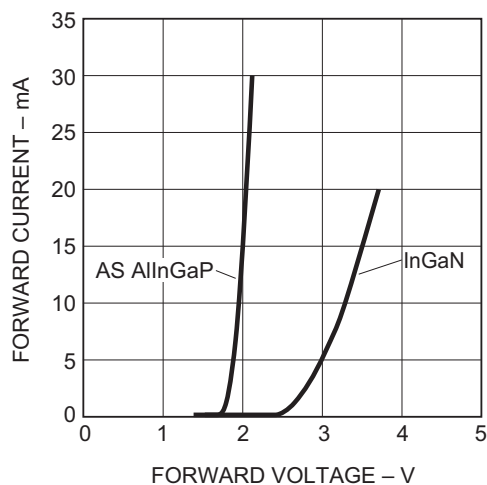


Figure 3: Relative Intensity vs. Forward Current

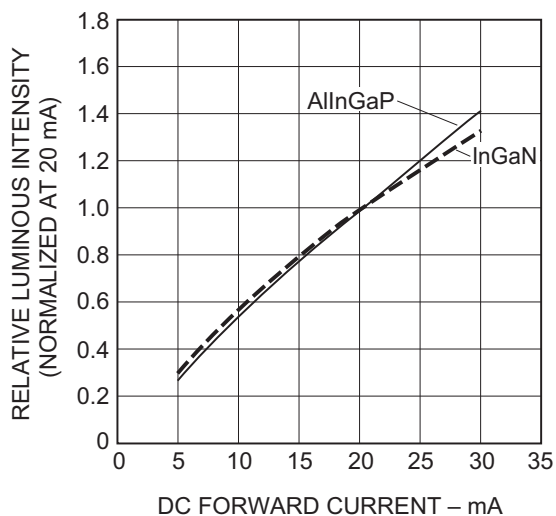


Figure 4: Maximum Forward Current vs. Ambient Temperature. Derated Based on $T_{JMAX} = 110^{\circ}\text{C}$, $R_{\theta JA} = 500^{\circ}\text{C/W}$ (1 Chip On).

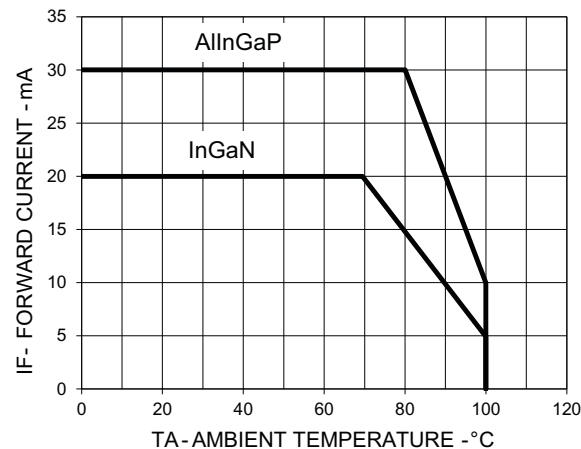


Figure 5: Maximum Forward Current vs. Ambient Temperature. Derated Based on $T_{JMAX} = 110^{\circ}\text{C}$, $R_{\theta JA} = 700^{\circ}\text{C/W}$ (3 Chips On).

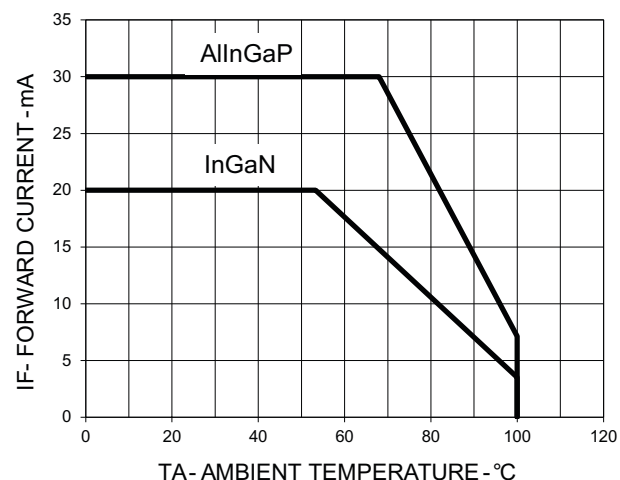


Figure 6: Dominant Wavelength vs. Forward Current – InGaN

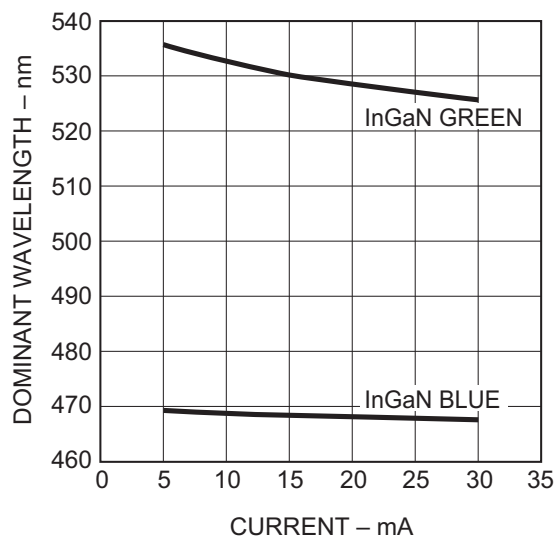
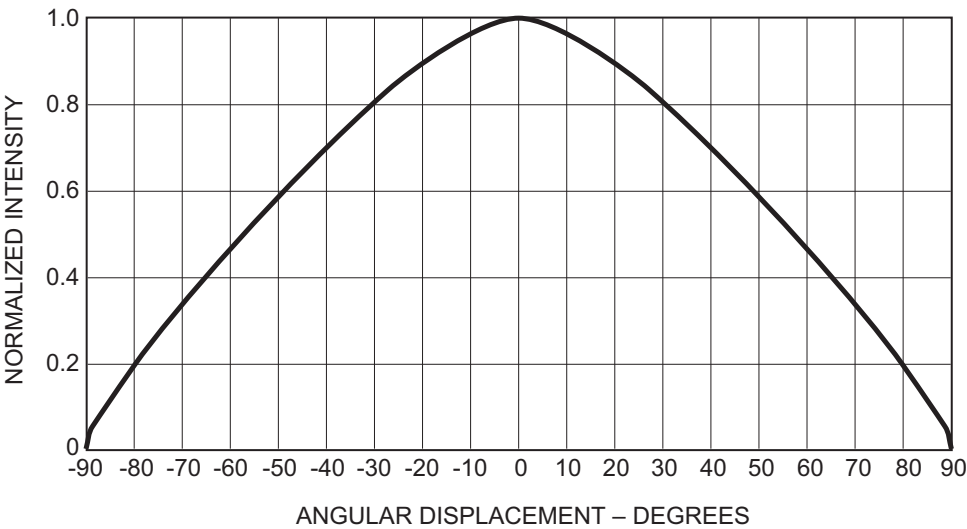


Figure 7: Radiation Pattern



NOTE: For detailed information on reflow soldering of Broadcom surface-mount LEDs, refer to Application Note 1060, *Surface Mounting SMT LED Indicator Components*.

Figure 8: Recommended Soldering Pad Pattern

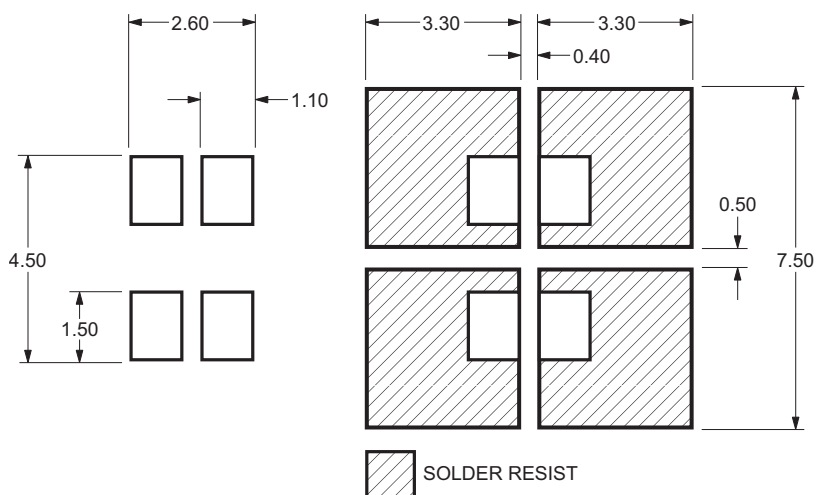


Figure 9: Tape Leader and Trailer Dimensions

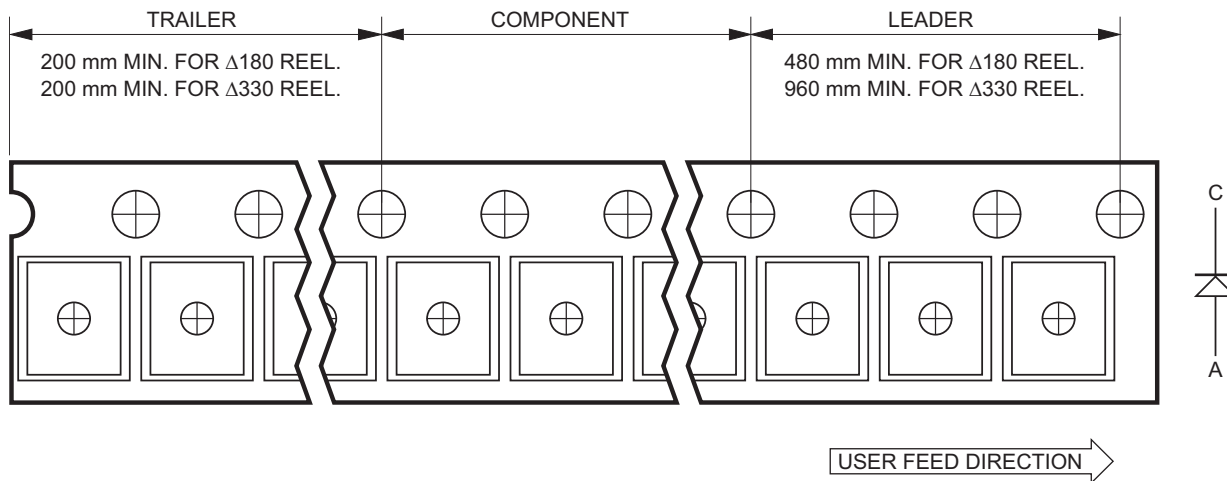


Figure 10: Tape Dimensions

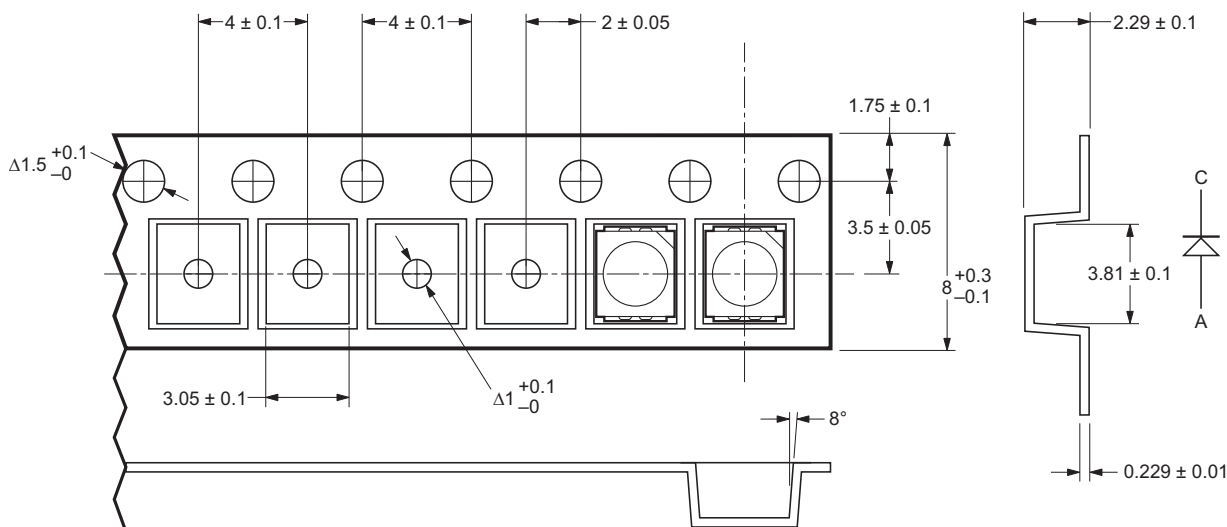


Figure 11: Reel Dimensions

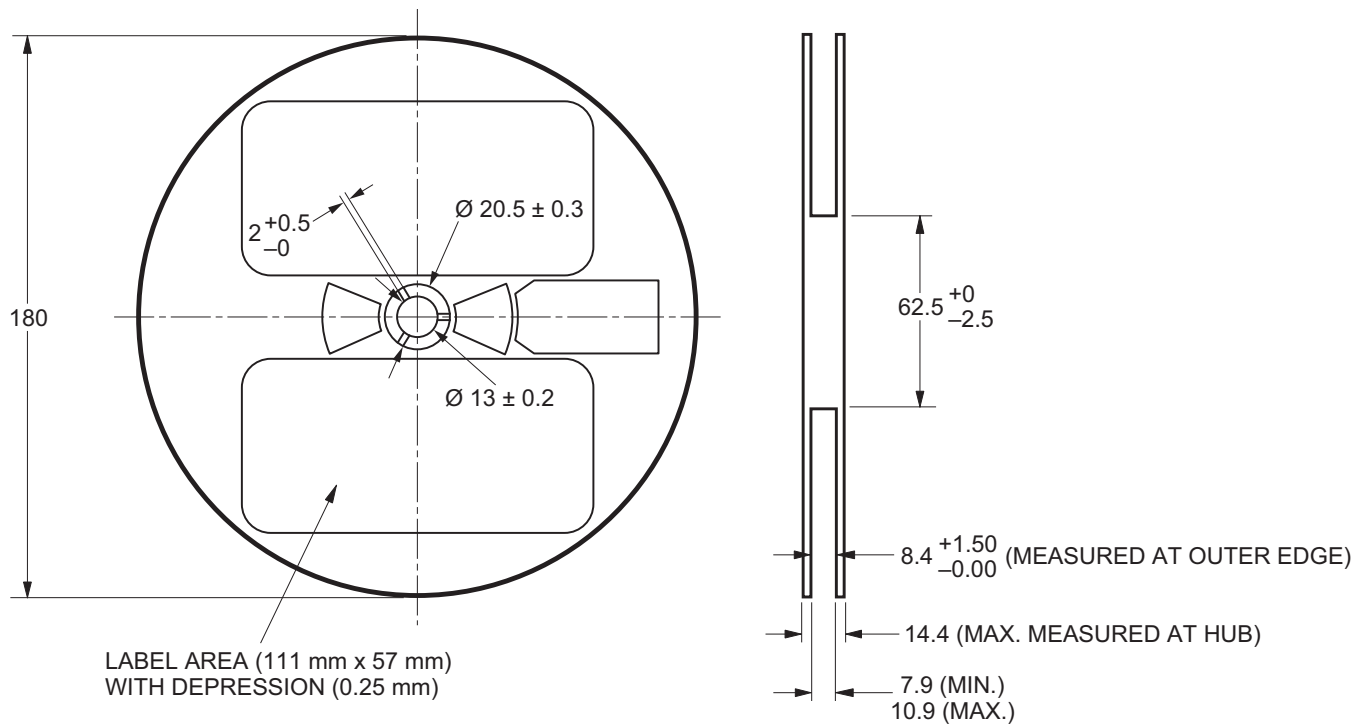
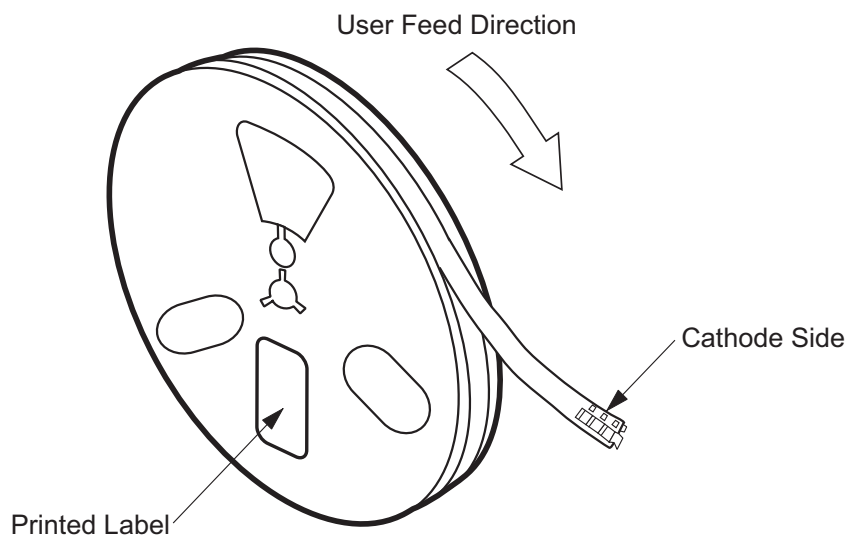


Figure 12: Reeling Orientation



NOTE: The 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 damage the LED.
- Confirm beforehand whether the functionality and performance of the LED are affected by soldering with hand soldering.

Figure 13: Recommended Lead-Free Reflow Soldering Profile

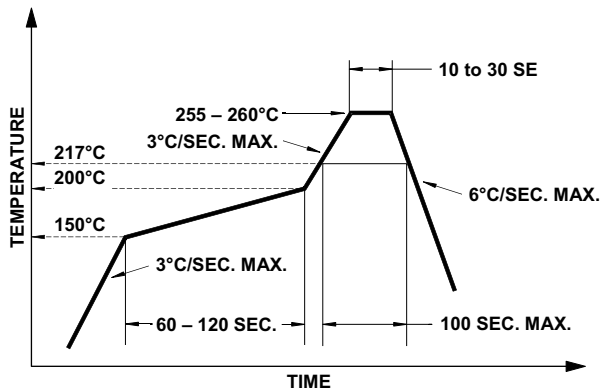
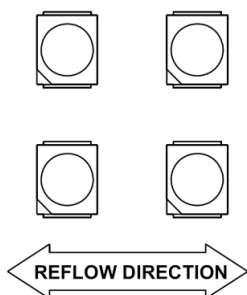


Figure 14: Recommended Board Reflow Direction



Handling Precautions

Handling Moisture-Sensitive Devices

This product has a Moisture Sensitive Level 2a rating per JEDEC J-STD-020. Refer to Broadcom Application Note 5305, *Handling Moisture-Sensitive Surface-Mount LEDs*, 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 HIC. The exposed duration must be taken in as floor life.
- Control after opening the MBB:
 - Read the HIC immediately upon opening 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 reels:

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 672 hours.
- Baking is required if:
 - The HIC 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 floor life exceeded 672 hours.

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

Baking can 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, 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 this 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 that 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 in 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 can 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 might have acidic outgas, such as, but not limited to, acrylate adhesive. These environments have an adverse effect on LED performance.
- 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 rainwater, water, dust, oil, corrosive gases, external mechanical stresses, and so on.

Thermal Management

Optical, electrical, and reliability characteristics of the LEDs 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. And $R_{\theta J-A}$ varies from system to system depending on design and is usually not known.

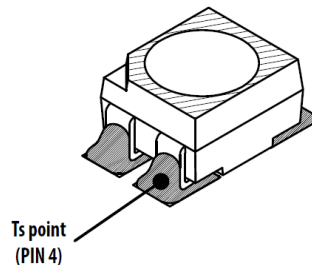
Another way of calculating T_J is by using the solder point temperature (T_S) as follows:

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

Where:

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

$R_{\theta J-S}$ = 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, whereas $R_{\theta J-S}$ 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 this data sheet.

Eye Safety Precautions

LEDs can 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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Lead (Pb) Free
RoHS Compliant