BROADCOM®

Data Sheet

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 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 LEDs suitable to be used in 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 interiors, office equipment, industrial equipment, and home appliances.

Features

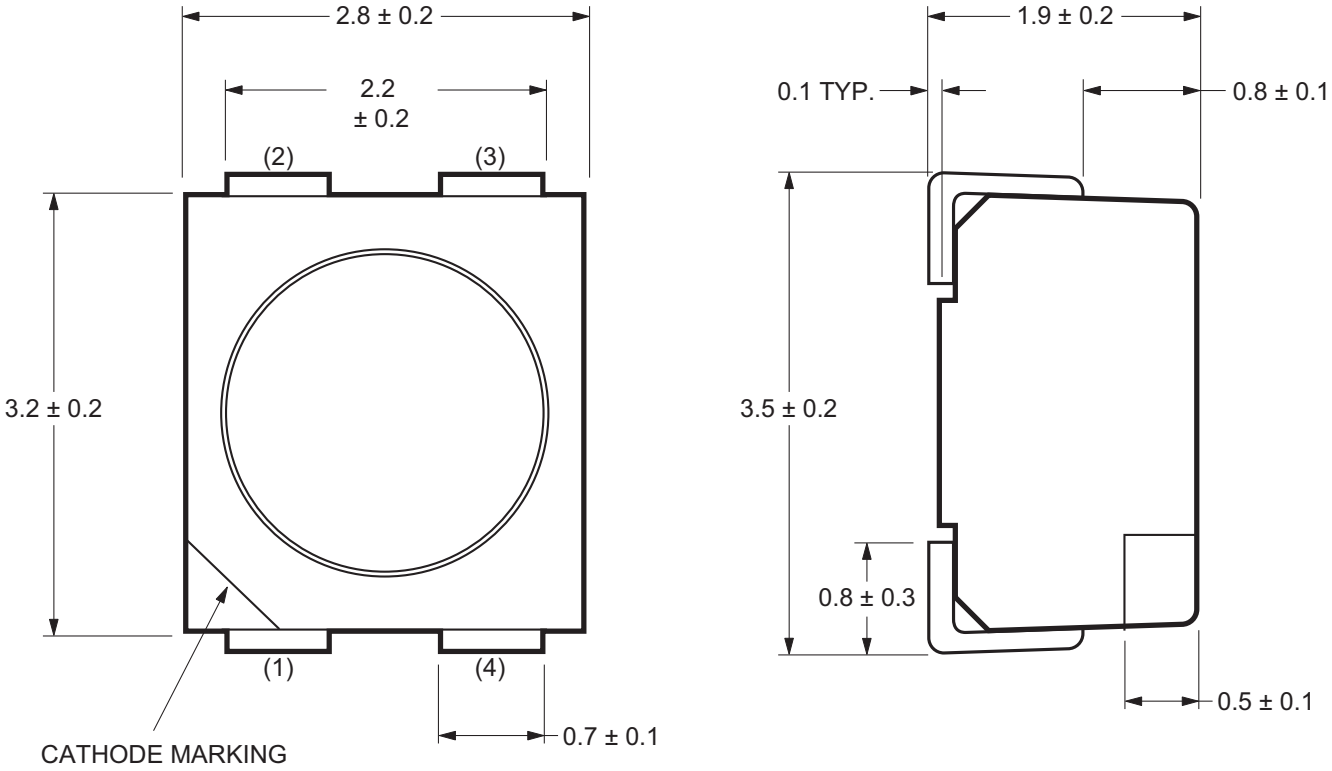
- Industry-standard PLCC-4 package (plastic leaded chip carrier)
- High-reliability LED package due to enhanced silicone resin material
- High brightness using AlInGaP dice technology
- Available in a full selection of colors
- Super-wide viewing angle of 120°
- Available in 8-mm carrier tape on a 7-inch 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-A2xx-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).

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

	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]
Part Number	**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

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 = ±12%.

Absolute Maximum Ratings (T_A = 25°C)

Parameters	AlInGaP
DC Forward Current[a]	30 mA
Peak Forward Current[b]	100 mA
Power Dissipation	78 mW
Reverse Voltage[c]	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. Duty factor = 10%, Frequency = 1 kHz.

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

Optical Characteristics (T_A = 25°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.
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, 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°C)

Dice Technology	Forward Voltage V_F (Volts) at I_F = 20 mA[a]		Reverse Voltage V_R at 100 µA[b]
	Typ.	Max.	Min.
Deep Red, Red, Orange, Yellow, Yellow Green, Emerald Green	2.0	2.6	5

a. Tolerance = ± 0.1V.

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

Part Numbering System

H S M [x_1] - A [x_2][x_3][x_4] - [x_5][x_6][x_7][x_8][x_9]

Code	Description	Option	
x_1	LED chip color	F	Bicolor or Tricolor
x_2	Package type	2	Bicolor
x_3x_4	Device-specific configuration	—	
x_5	Minimum intensity bin selection	See I_V Bin Select (x_5x_6).	
x_6	Number of intensity bins		
x_7	Color bin selection	See Color Bin Select (x_7).	
x_8x_9	Packaging option	J1	20-mA test current, top mount, 7-inch reel

Bin Information

I_V Bin Select (x_5x_6)

Individual reels contain parts from one half bin only.

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

x_5	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_5	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_5	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
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_5	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
Y	N2	M1
Z	N2	M2
1	N2	N1

Number of Half Bins from x_5

Table 5: 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 6: 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 = ±12%.

Color Bin Select (x_7)

Individual reels contain parts from one full bin only.

Table 7: Color Bin Select for HSMF-A202-xxxxx, HSMF-A203-xxxxx

x_7	Color 1 (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 8: Color Bin Select for HSMF-A201-xxxxx and HSMF-A211-xxxxx

x_7	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 9: Color Bin Select for HSMF-A205-xxxxx

x_7	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
5	EF	AB
6	EF	BC
7	EF	CD

NOTE: 0 represents full distribution.

Table 10: Color Bin Select for HSMF-A204-xxxxx and HSMF-A206-xxxxx

x_7	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 = ±1 nm.

Packaging Option (x_8x_9)

x_8x_9	Description
J1	20-mA test current, top-mount, 7-inch reel.

Figure 1: Relative Intensity vs. Wavelength

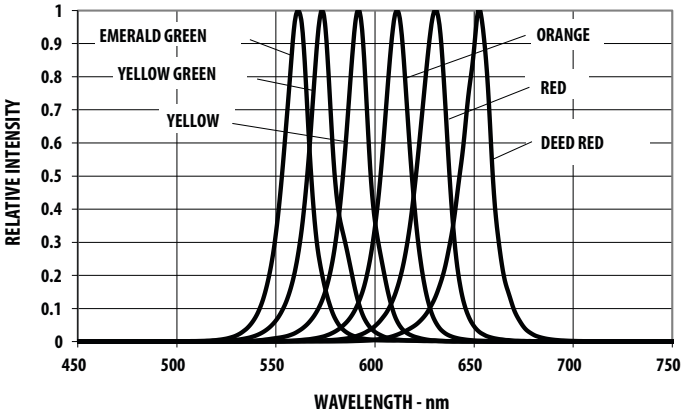


Figure 2: Forward Current vs. Forward Voltage

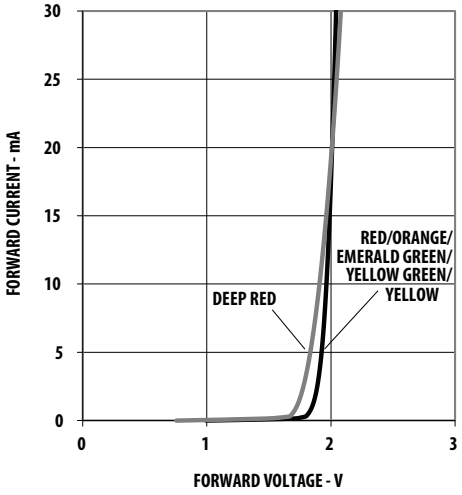


Figure 3: Relative Intensity vs. Forward Voltage

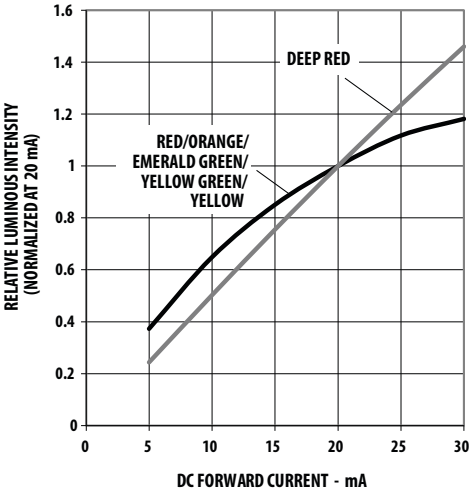


Figure 4: Maximum Forward Current vs Ambient Temperature. Derate Based on T_J MAX = 110°C, $R_{\theta JA}$ = 500°C/W (1 Chip On).

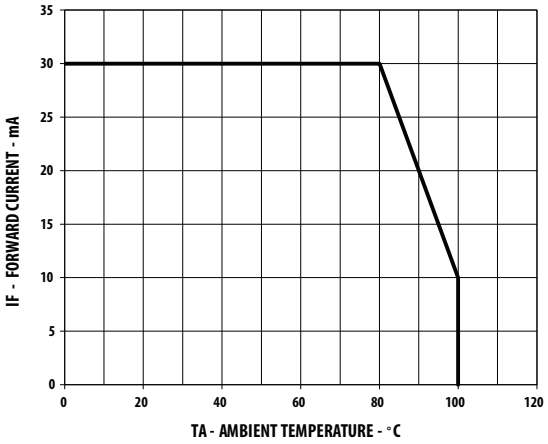
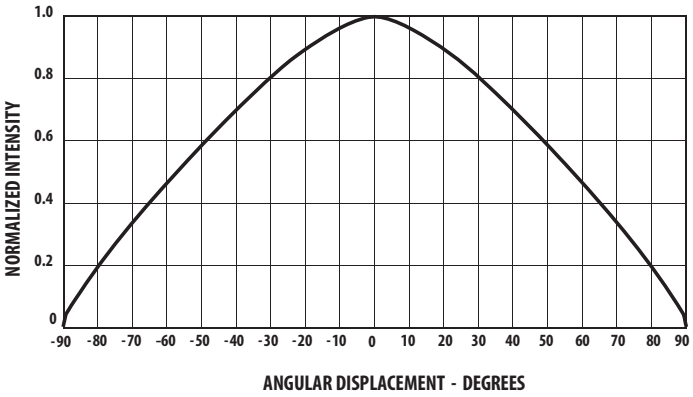


Figure 5: Radiation Pattern



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

Figure 6: Recommended Soldering Pad Pattern

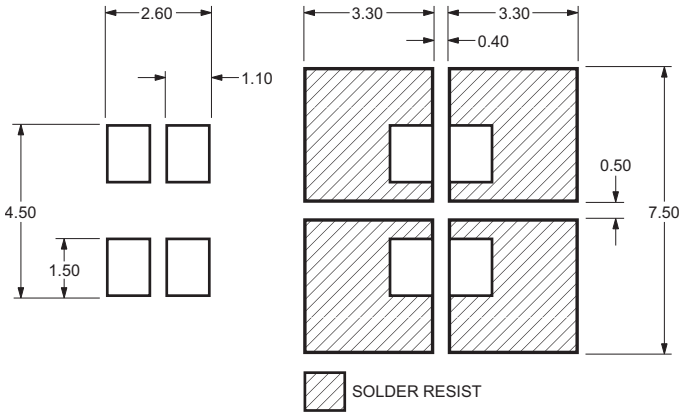


Figure 7: Tape Leader and Trailer Dimensions

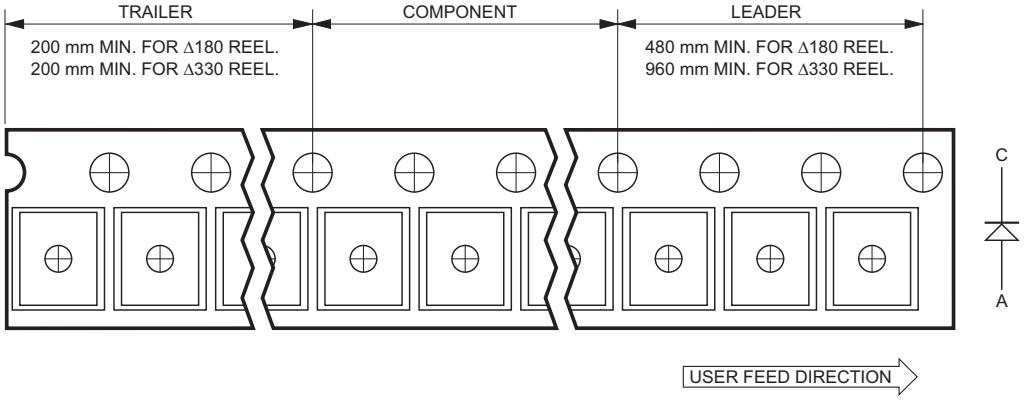


Figure 8: Carrier Tape Dimensions

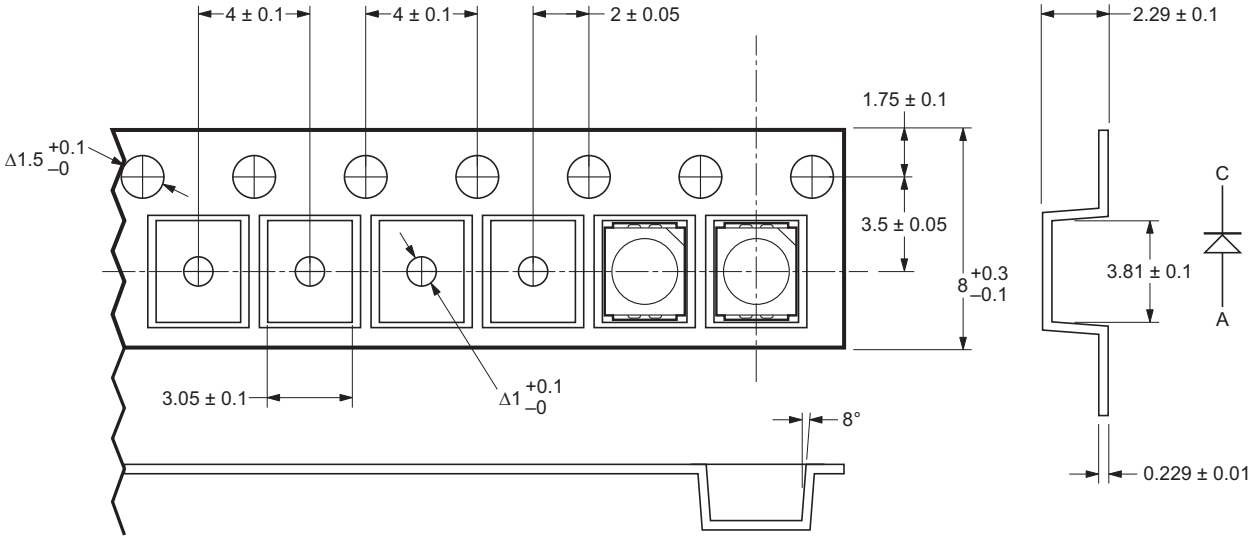


Figure 9: Reel Dimensions

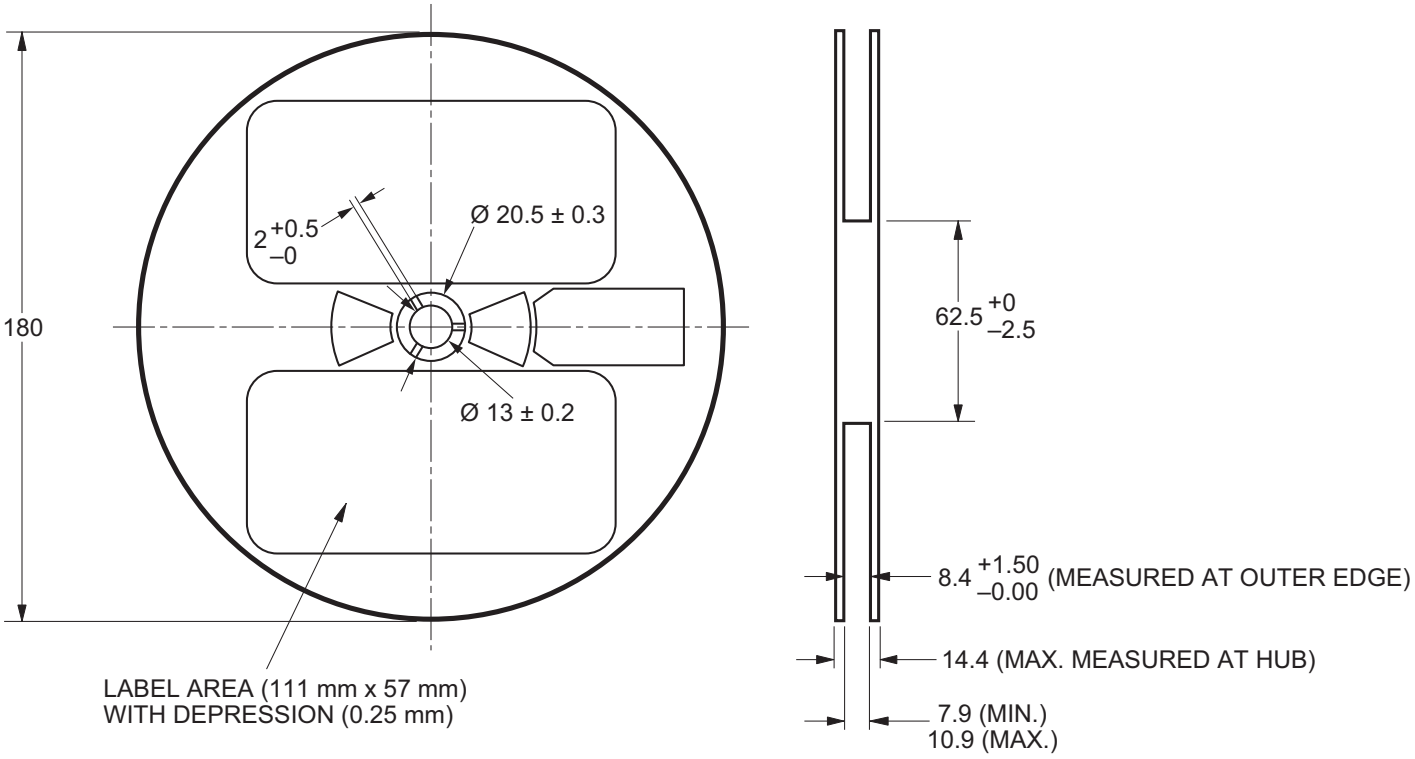
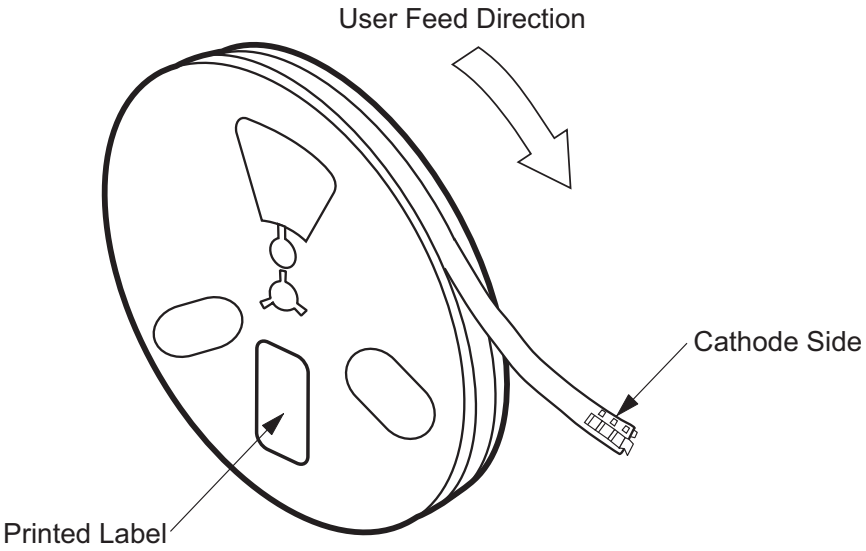


Figure 10: Reeling Orientation



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

Figure 11: Recommended Lead-Free Reflow Soldering Profile

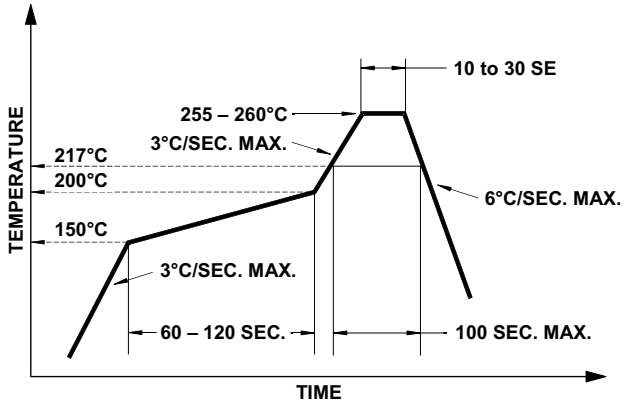
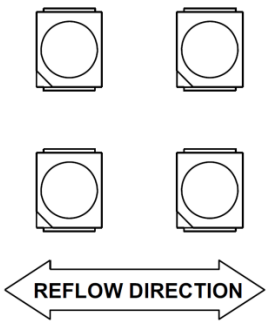


Figure 12: Recommended Board Reflow Direction



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 168 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 ± 5ºC 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 can 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 gas, 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:

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

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. And $R_{\theta J\text{-}A}$ varies from system to system depending on design and is usually not known.

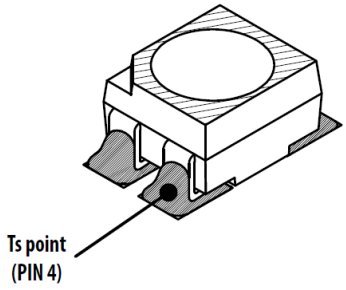
Another way of calculating T_J is by using the solder point temperature (T_S) as follows:

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

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)



T_S can be easily measured by mounting a thermocouple on the soldering joint as shown in preceding figure, whereas $R_{\theta J\text{-}S}$ is provided in the data sheet. Verify the T_S of the LEDs 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.

Disclaimer

Broadcom's products and software are not specifically designed, manufactured, or authorized for sale as parts, components, or assemblies for the planning, construction, maintenance, or direct operation of a nuclear facility or for use in medical devices or applications. The customer is solely responsible, and waives all rights to make claims against Broadcom or its suppliers, for all loss, damage, expense, or liability in connection with such use.

BROADCOM®

Lead (Pb) Free
RoHS Compliant