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Data Sheet

HSMx-A2-xx-xxxxx Bi-Color
HSMx-A3xx-xxxxx Tri-Color

Surface Mount LED Indicators, PLCC-4 SMT LEDs



Description

This family of 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 LED 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 and InGaN dice technologies
- 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

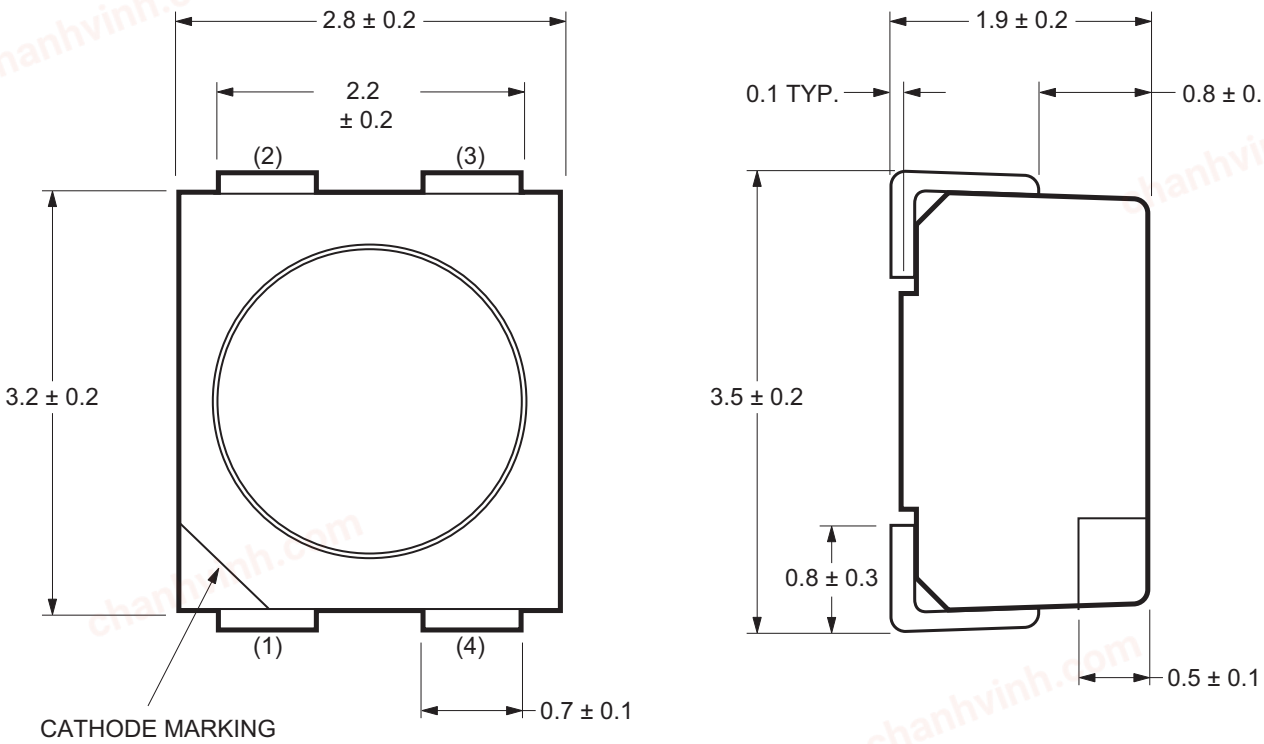
Applications

- 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. Please observe appropriate precautions during handling and processing. Refer to Avago Application Note AN-1142 for additional details.

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Package Drawing



NOTE: All dimensions in millimeters (mm).

Tri Color	
1	Cathode (Color 1)
2	Common Anode
3	Cathode (Color 3)
4	Cathode (Color 2)
Bi Color	
1	Cathode (Color 1)
2	Anode (Color 1)
3	Cathode (Color 2)
4	Anode (Color 2)

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Device Selection Guide

Bi Color

Part Number	Color 1	Color 2
HSMF-A201-xxxxx	GaP Red	GaP Yellow Green
HSMF-A202-xxxxx	GaP Red	GaP Yellow
HSMF-A203-xxxxx	GaP Red	GaP Emerald Green
HSMF-A204-xxxxx	GaP Orange	GaP Yellow Green
HSMF-A205-xxxxx	GaP Orange	GaP Emerald Green
HSMF-A206-xxxxx	GaP Yellow	GaP Yellow Green
HSMF-A211-xxxxx	AlGaAs Red	GaP Yellow Green
HSMF-A212-xxxxx	AlGaAs Red	GaP Yellow
HSMF-A222-xxxxx	AlInGaP Red	AlInGaP Amber
HSMF-A226-xxxxx	AlInGaP Amber	AlInGaP Yellow Green

	Color 1			Color 2		
	Min. I_V at 20 mA		Typical I_V at 20 mA	Min. I_V at 20 mA		Typical I_V at 20 mA
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	8.0
HSMF-A204-A00J1	K2	9.0	16.0	L1	11.2	20.0
HSMF-A205-A00J1	K2	9.0	16.0	J1	4.5	8.0
HSMF-A206-A00J1	K2	9.0	16.0	L1	11.2	20.0
HSMF-A211-A00J1	L2	14.0	25.0	L1	11.2	20.0
HSMF-A212-A00J1	L2	14.0	25.0	K1	7.2	12.0
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

NOTE: The luminous intensity I_V, is measured at the mechanical axis of the lamp package. The actual peak of the spatial radiation pattern may not be aligned with this axis.

NOTE: I_V tolerance = ±10%.

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Tri Color

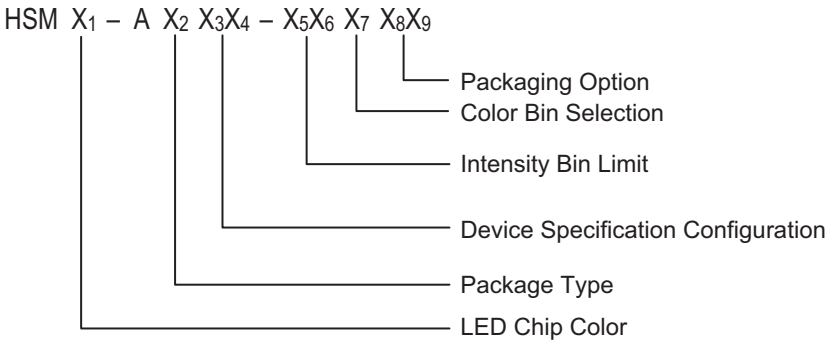
Part Number	Color 1	Color 2	Color 3
HSMF-A341-xxxxx	AlInGaP Red	InGaN Green	InGaN Blue

	Color 1			Color 2			Color 3		
	Min. Iv @ 20 mA		Typical Iv @ 20 mA	Min. Iv @ 20 mA		Typical Iv @ 20 mA	Min. Iv @ 20 mA		Typical Iv @ 20 mA
Part Number	Bin ID	(mcd)	(mcd)	Bin ID	(mcd)	(mcd)	Bin ID	(mcd)	(mcd)
HSMF-A341-A00J1	K2	9.0	13.0	L2	14.0	20.0	K2	9.2	10.0
	P1	45.0	80.0	R1	112.5	160.0	K2	9.2	10.0
	P1	45.0	80.0	R1	112.5	160.0	K2	9.2	10.0
	P1	45.0	80.0	R1	112.5	160.0	N1	28.5	40.0
	P1	45.0	80.0	R1	112.5	160.0	N1	28.5	40.0

NOTE: The luminous intensity I_V, is measured at the mechanical axis of the lamp package. The actual peak of the spatial radiation pattern may not be aligned with this axis.

NOTE: I_V tolerance = ±10%.

Part Numbering System



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Absolute Maximum Ratings (T_A = 25°C)

Parameters	AlInGaP				
	GaP	AlGaAs	Red, Amber	Yellow Green	GaN/InGaN
DC Forward Current[a]	30 mA	30 mA	30 mA[b,c]	20 mA[c]	20 mA
Peak Forward Current[d]	100 mA	100 mA	100 mA	100 mA	100 mA
Power Dissipation	78 mW	78 mW	72 mW	48 mW	120 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. Drive Current between 10 mA and 30 mA are recommended for best long-term performance.

c. Operation at current below 5 mA is not recommended.

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

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.
GaP Red	635	626	120	120	0.45
AlGaAs Red	645	637	120	63	0.45
AlInGaP Red	635	626	120	150	0.45
AlInGaP Red Orange	621	615	120	240	0.45
GaP Orange	600	602	120	380	0.45
AlInGaP Amber	592	590	120	480	0.45
GaP Yellow	583	585	120	580	0.45
AlInGaP Amber	592	590	120	480	0.45
GaP Yellow Green	565	569	120	590	0.45
GaP Emerald Green	558	560	120	650	0.45
InGaN Green	523	525	120	500	0.45
InGaN Blue	468	470	120	75	0.45
GaN Blue	428	462	120	65	0.45
AlInGaP 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.

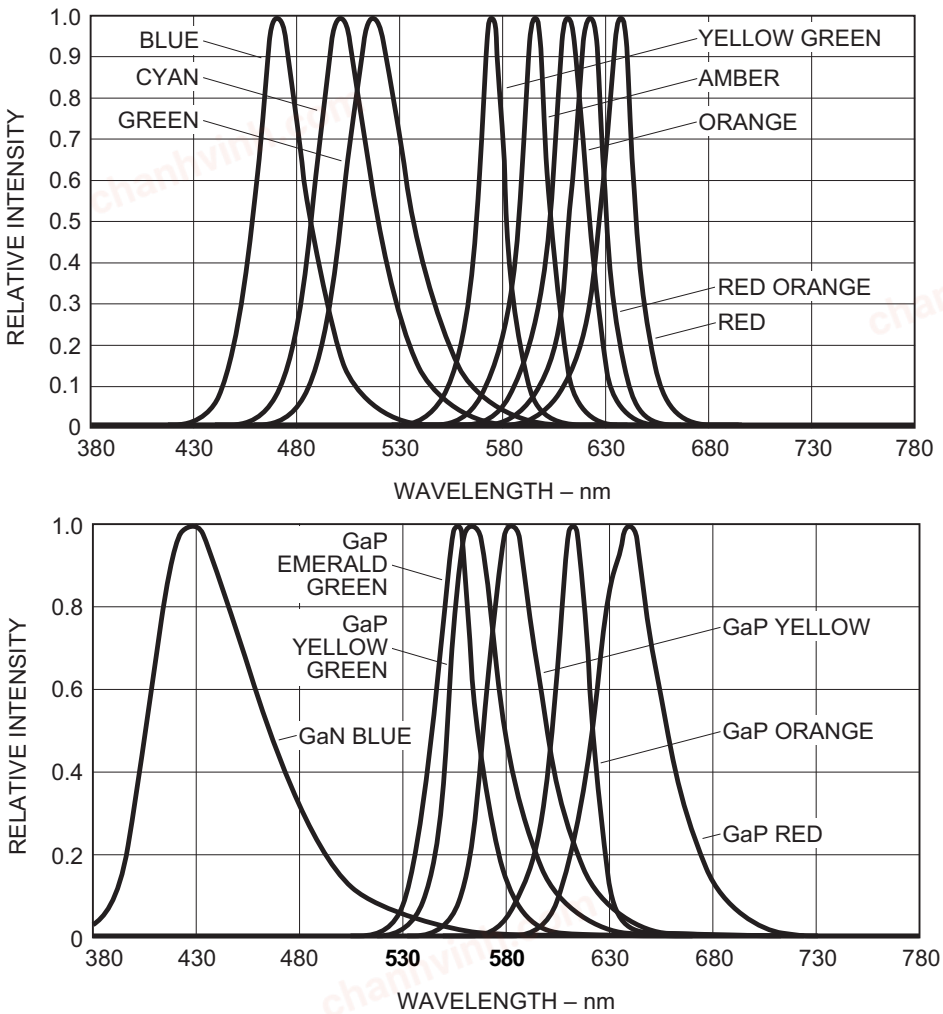
c. Radiant intensity, I_e in watts/steradian, may be calculated from the equation $I_e = I_v/\eta_v$, where I_v is the luminous intensity in candelas and η_v is the luminous efficacy in lumens/watt.

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Electrical Characteristics (T_A = 25°C)

	Forward Voltage V_F (Volts) @ I_F = 20 mA		Reverse Voltage V_R @ 100 µA	Reverse Voltage V_R @ 10 µA
Dice Technology	**Typ.**	**Max.**	**Min.**	**Min.**
GaP	2.2	2.6	5	—
AS AlGaAs	1.9	2.6	5	—
AlInGaP	1.9	2.4	5	—
GaN Blue	3.9	4.3	—	5
InGaN	3.4	4.05	—	5

Figure 1: Relative Intensity vs. Wavelength



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Figure 2: Forward Current vs. Forward Voltage

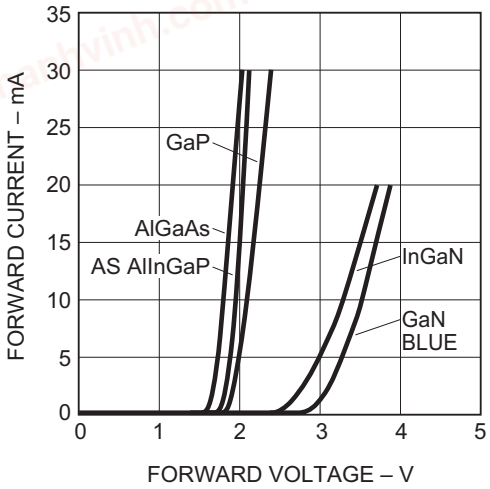


Figure 3: Relative Intensity vs. Forward Voltage

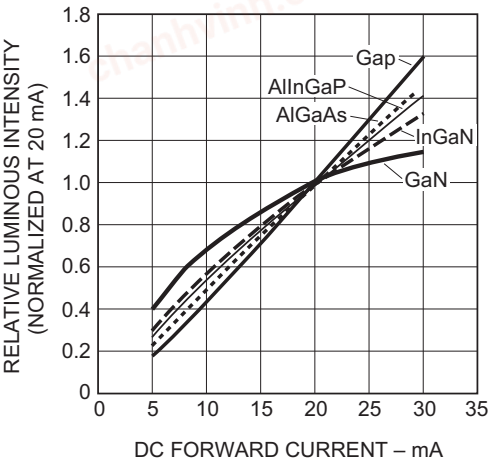
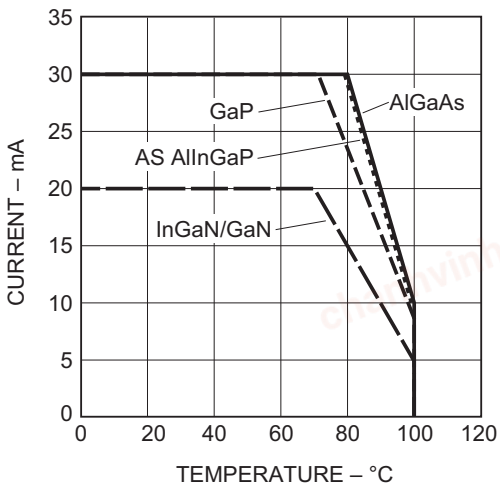


Figure 4: Maximum Forward Current vs. Ambient Temperature. Derated based on T_JMAX = 110°C, Rθ_{JA} = 500°C/W (1 chip on).



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Figure 5: Maximum Forward Current vs. Ambient Temperature. Derated based on T_JMAX = 110°C, Rθ_{JA} = 700°C/W (3 chip on).

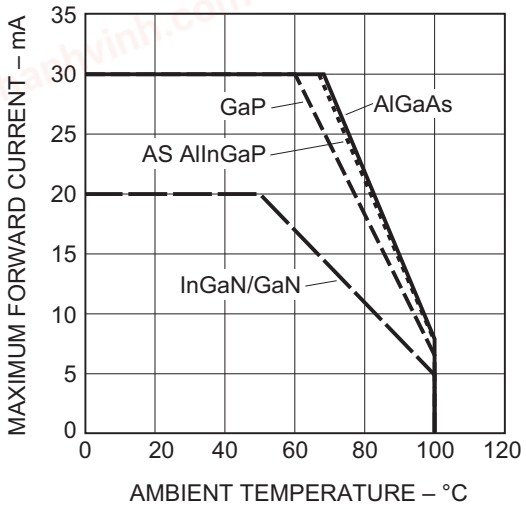
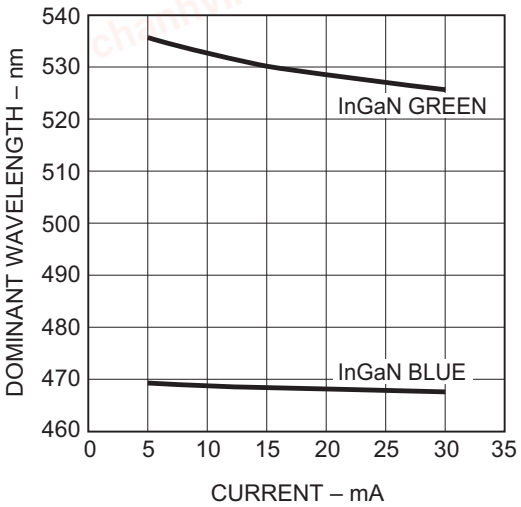
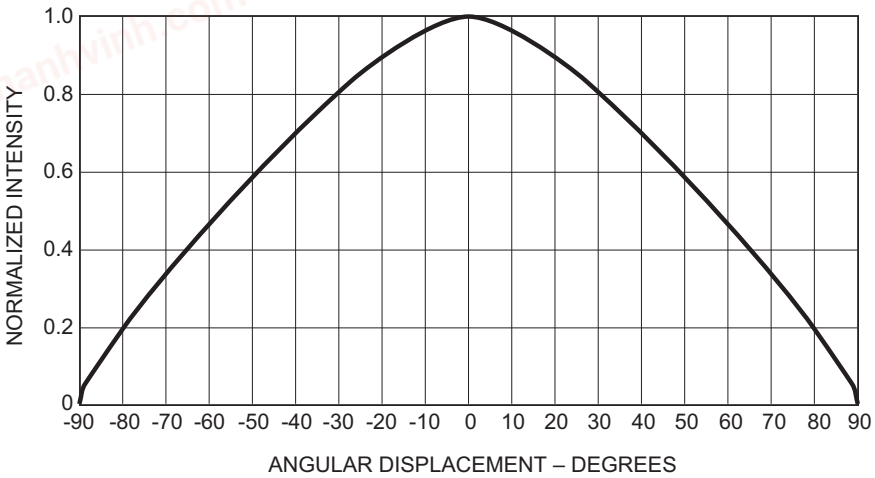


Figure 6: Dominant Wavelength vs. Forward Current – InGaN



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Figure 7: Radiation Pattern



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

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Figure 8: Recommended Soldering Pad Pattern

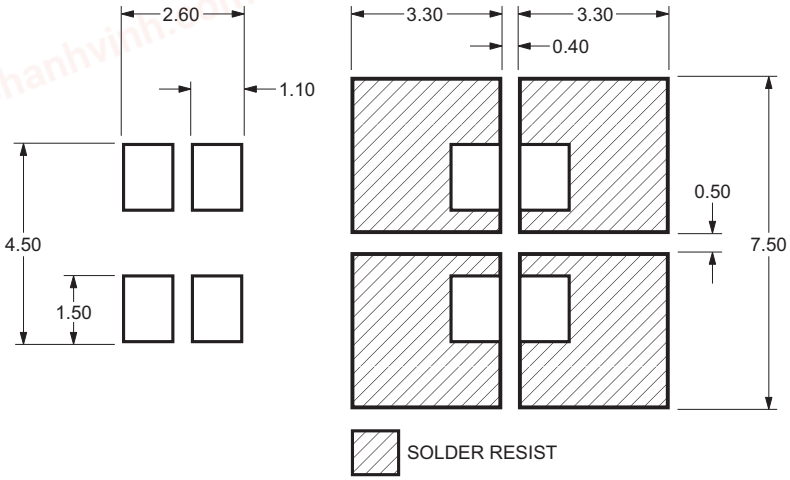


Figure 9: Tape Leader and Trailer Dimension

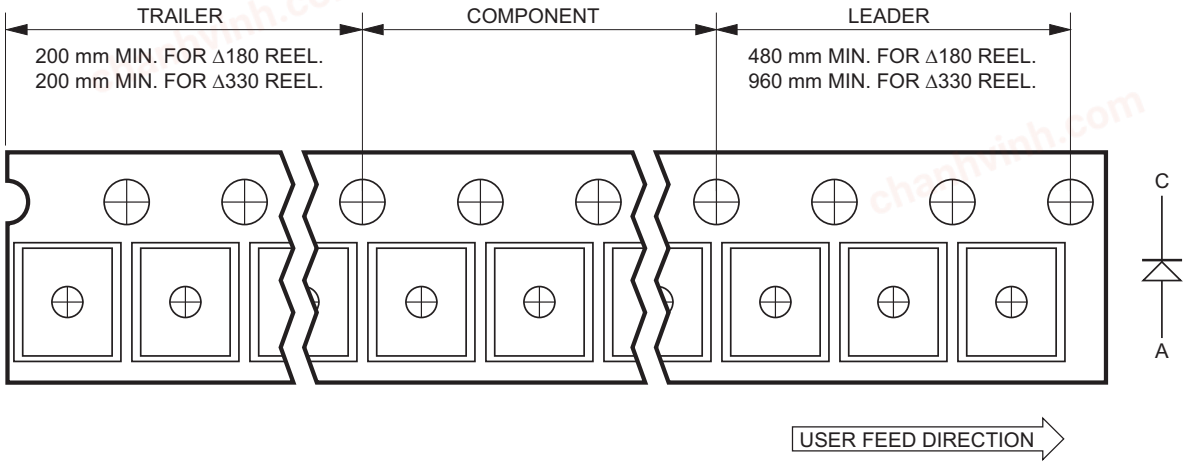
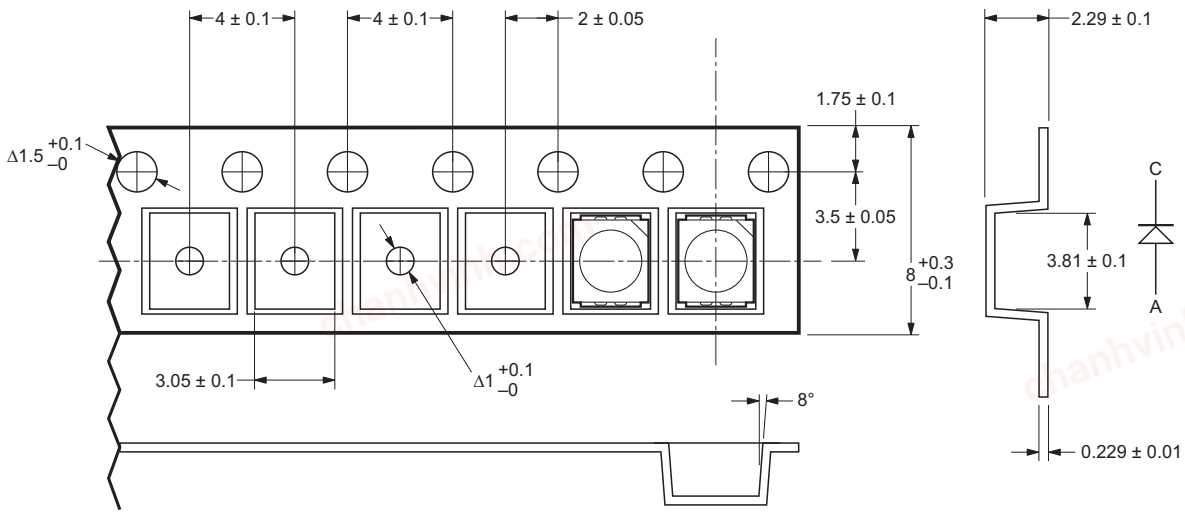


Figure 10: Tape Leader and Trailer Dimension



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Figure 11: Reel Dimension

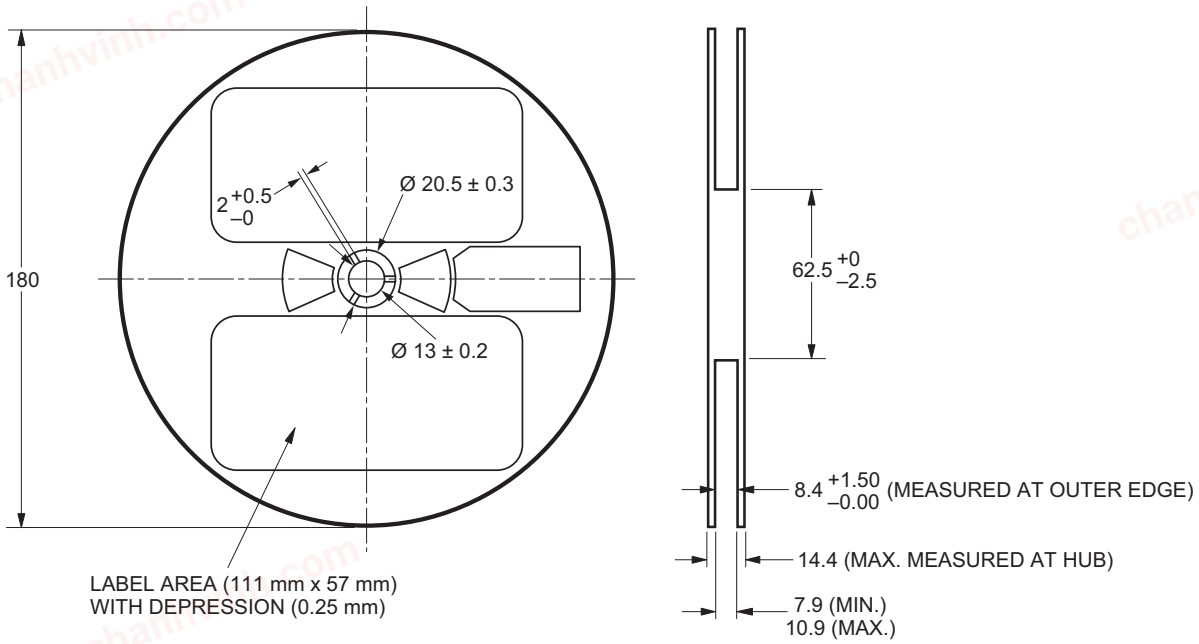
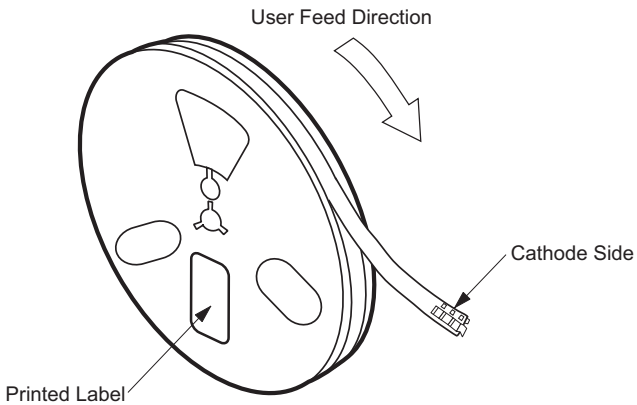


Figure 12: Reeling Orientation



NOTE: Diameter ID should be bigger than 2.3 mm.

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I_V Bin Select (X_5X_6)

Individual reel will contain parts from 1 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 (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

Table 2: Minimum Intensity Bin Selection for HSMF-A202-xxxxx (Continued)

X_5	Color 1 (Red)	Color 2 (Yellow)
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 (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

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

X_5	Color 1 (Red/ Orange)	Color 2 (Green)
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 (Red)	Color 2 (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

NOTE: 0 represents full distribution.

Table 5: Minimum Intensity Bin Selection for HSMF-A212-xxxxx

X_5	Color 1 (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

Table 6: 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

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Table 6: Minimum Intensity Bin Selection for HSMF-A222-xxxxx (Continued)

X_5	Color 1 (Red)	Color 2 (Amber)
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 7: Minimum Intensity Bin Selection for HSMF-A341-xxxxx

X_5	Color 1 (Red/ Red Orange)	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

Table 7: Minimum Intensity Bin Selection for HSMF-A341-xxxxx (Continued)

X_5	Color 1 (Red/ Red Orange)	Color 2 (Green)	Color 3 (Blue)
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 8: Number of Half Bins from X5 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

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Table 8: Number of Half Bins from X5 for HSMF-A2xx-xxxxx

X_6	Color 1	Color 2
U	3	2
V	2	0
W	2	5
X	2	4
Y	2	3
Z	2	2

NOTE: 0 represents full distribution.

Table 9: Number of Half Bins from X5 for HSMF-A3xx-xxxxx

X_6	Color 1 (Red/ Red Orange)	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 = ±10%.

Color Bin Select (X_7)

Individual reel will contain parts from 1 full bin only.

Table 10: Color Bin Select for HSMF-A202-xxxxx, HSMF-A203-xxxxx, HSMF-A212-xxxxx, HSMF-A222-xxxxx

X_7	Color 1 (Red)	Color 2 (Emerald Green/ Yellow/Blue)
0	0	0
A	0	ABC
B	0	ABCD
C	0	ABCDE
D	0	BCD
E	0	BCDE
F	0	BCDEF

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Table 10: Color Bin Select for HSMF-A202-xxxxx, HSMF-A203-xxxxx, HSMF-A212-xxxxx, HSMF-A222-xxxxx

X_7	Color 1 (Red)	Color 2 (Emerald Green/ Yellow/Blue)
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 11: Color Bin Select for HSMF-A201-xxxxx and HSMF-A211-xxxxx

X_7	Color 1 (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 12: Color Bin Select for HSMF-A205-xxxxx

X_7	Color 1 (Yellow/ Amber/Orange)	Color 2 (Emerald Green/Blue)
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

Table 12: Color Bin Select for HSMF-A205-xxxxx

X_7	Color 1 (Yellow/ Amber/Orange)	Color 2 (Emerald Green/Blue)
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 13: Color Bin Select for HSMF-A204-xxxxx and HSMF-A206-xxxxx

X_7	Color 1 (Yellow/ Amber/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

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Table 13: Color Bin Select for HSMF-A204-xxxxx and HSMF-A206-xxxxx

X_7	Color 1 (Yellow/ Amber/Orange)	Color 2 (Yellow Green)
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.

Table 14: 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

Table 14: Color Bin Select for HSMF-A3xx-xxxxx

X_7	Color 1	Color 2	Color 3
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

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

Amber/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

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Amber/Yellow	Min. (nm)	Max. (nm)
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 Orange	Min. (nm)	Max. (nm)
A	611.0	616.0
B	616.0	620.0

Red	Min. (nm)	Max. (nm)
Full Distribution		

Packaging Option (X_8X_9)

X_8X_9	
J1	20 mA test current, Top Mount, 7-inch Reel

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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 13: Recommended Lead-Free Reflow Soldering Profile

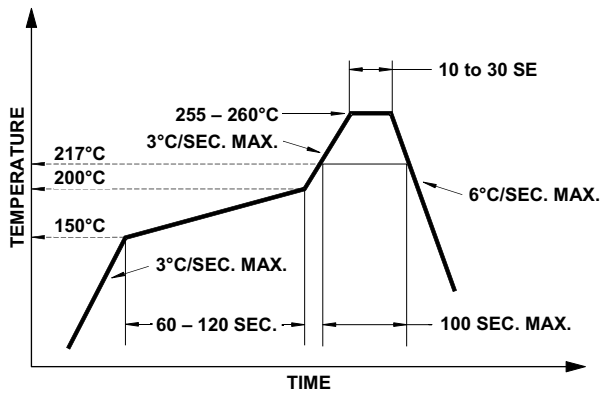
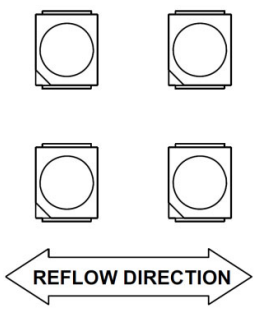


Figure 14: Recommended Board Reflow Direction



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 ± 5ºC for 20 hours.

  Baking can only be done once.

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- 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:

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

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.

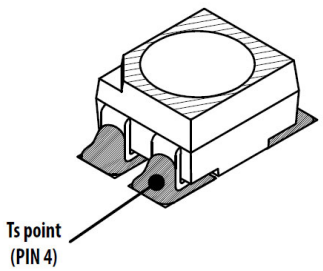
Another way of calculating T_J is by using solder point temperature T_S as follows:

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

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, while $R_{\theta J\text{-}S}$ 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.

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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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