

## **HSMx-A10x-xxxxx**

### **PLCC-2, Surface Mount LED Indicator**



## **Description**

This family of SMT LEDs is packaged in the industry standard PLCC-2 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 will be shipped in single intensity and color bin, except red color, to provide close uniformity.

These LEDs are compatible with IR solder reflow process. Due to the high reliability feature of these products, they can also be mounted using through-the-wave soldering process.

The super wide viewing angle at 120° makes these LEDs ideally suited for panel, push button, or general backlighting in automotive interior, office equipment, industrial equipment, and home appliances. The flat top emitting surface makes it easy for these LEDs to mate with light pipes. With the built-in reflector pushing up the intensity of the light output, these LEDs are also suitable to be used as LED pixels in interior electronic signs.

## **Features**

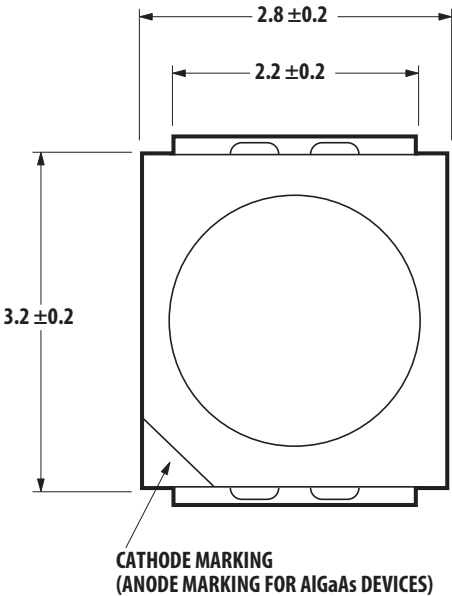
- Industry standard PLCC-2 package
- High reliability LED package
- High brightness using AlInGaP and InGaN dice technologies
- Available in full selection of colors
- Super wide viewing angle at 120
- Available in 8 mm carrier tape on 7 inch reel (2000 pieces)
- Compatible with both IR and TTW soldering process

## **Applications**

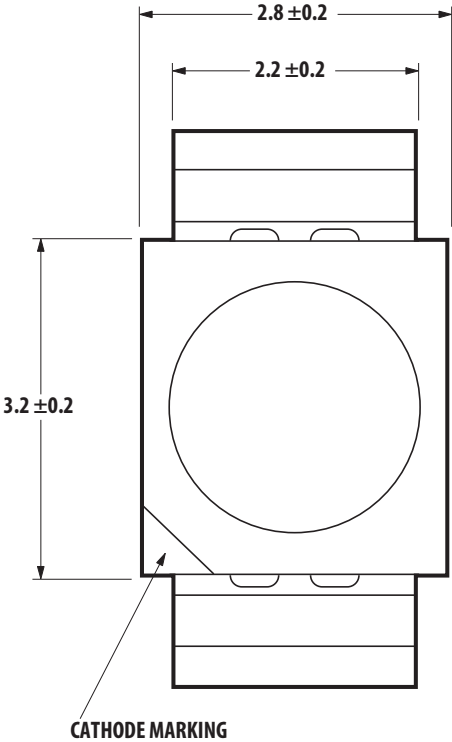
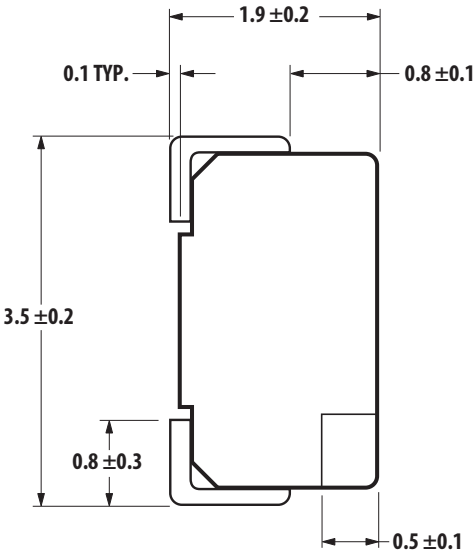
- Interior automotive
  - Instrument panel backlighting
  - Central console backlighting
  - Switch/push button backlighting
- Electronic signs and signals
  - Interior full color sign
  - Variable message sign
- Office automation, home appliances, industrial equipment
  - Front panel backlighting
  - Push button backlighting
  - Display backlighting

**CAUTION!** HSMN, M, and E-A10x-xxxxx LEDs are Class 2 ESD sensitive. Please observe appropriate precautions during handling and processing. Refer to Broadcom Application Note AN-1142 for additional details.

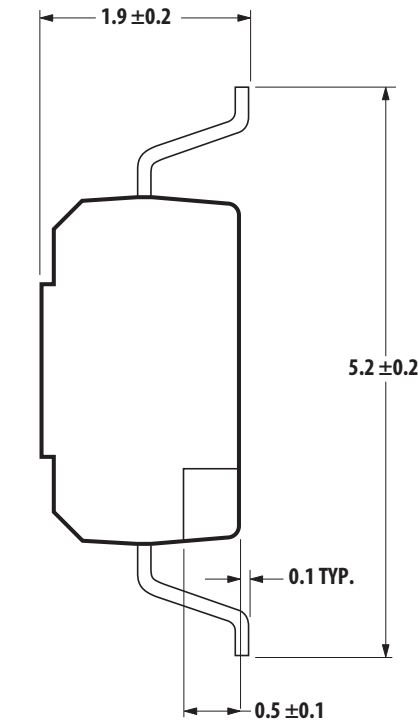
# Package Dimensions



TOP MOUNT



REVERSE MOUNT



NOTE: ALL DIMENSIONS IN MILLIMETERS.

## Device Selection Guide

### Red

| Part Number     | Min IV (mcd) | Typ. IV (mcd) | Max. IV (mcd) | Test Current (mA) | Dice Technology |
|-----------------|--------------|---------------|---------------|-------------------|-----------------|
| HSMS-A100-J00J1 | 4.50         | 15.00         | —             | 20                | GaP             |
| HSMS-A100-L00J1 | 11.20        | 15.00         | —             | 20                | GaP             |
| HSMS-A100-J80J2 | 5.60         | —             | 14.00         | 10                | GaP             |
| HSMH-A100-L00J1 | 11.20        | 15.00         | —             | 20                | AlGaAs          |
| HSMH-A100-N00J1 | 28.50        | 50.00         | —             | 20                | AlGaAs          |
| HSMC-A100-Q00J1 | 71.50        | 100.00        | —             | 20                | AlInGaP         |
| HSMC-A100-R00J1 | 112.50       | 140.00        | —             | 20                | AlInGaP         |
| HSMC-A101-S00J1 | 180.00       | 220.00        | —             | 20                | AlInGaP         |
| HSMZ-A100-T00J1 | 285.00       | 350.00        | —             | 20                | AlInGaP         |
| HSMC-A100-N00H1 | 28.50        | —             | —             | 20                | AlInGaP         |
| HSMC-A100-Q70J1 | 90.00        | —             | 180.0         | 20                | AlInGaP         |
| HSMC-A101-S30J1 | 180.00       | —             | 355.0         | 20                | AlInGaP         |
| HSMC-A101-S40J1 | 180.00       | —             | 450.0         | 20                | AlInGaP         |
| HSMZ-A100-R00J1 | 112.50       | —             | —             | 20                | AlInGaP         |
| HSMZ-A100-T70J1 | 355.00       | —             | 715.0         | 20                | AlInGaP         |

### Red Orange

| Part Number     | Min IV (mcd) | Typ. IV (mcd) | Max. IV (mcd) | Test Current (mA) | Dice Technology |
|-----------------|--------------|---------------|---------------|-------------------|-----------------|
| HSMJ-A100-Q00J1 | 71.50        | 100.00        | —             | 20                | AlInGaP         |
| HSMJ-A101-S00J1 | 180.00       | 200.00        | —             | 20                | AlInGaP         |
| HSMJ-A100-T40J1 | 285.00       | —             | 715.00        | 20                | AlInGaP         |
| HSMV-A100-T00J1 | 285.00       | 350.00        | —             | 20                | AlInGaP         |
| HSMJ-A100-R40J1 | 112.50       | —             | 285.00        | 20                | AlInGaP         |

### Orange

| Part Number     | Min IV (mcd) | Typ. IV (mcd) | Max. IV (mcd) | Test Current (mA) | Dice Technology |
|-----------------|--------------|---------------|---------------|-------------------|-----------------|
| HSMD-A100-J00J1 | 4.50         | 15.00         | —             | 20                | GaP             |
| HSMD-A100-L00J1 | 11.20        | 15.00         | —             | 20                | GaP             |
| HSMD-A100-K4PJ2 | 7.20         | —             | 18.00         | 10                | GaP             |
| HSML-A100-Q00J1 | 71.50        | 100.00        | —             | 20                | AlInGaP         |
| HSML-A101-S00J1 | 180.00       | 220.00        | —             | 20                | AlInGaP         |

## Yellow/Amber

| Part Number     | Min IV (mcd) | Typ. IV (mcd) | Max. IV (mcd) | Test Current (mA) | Dice Technology |
|-----------------|--------------|---------------|---------------|-------------------|-----------------|
| HSMY-A100-J00J1 | 4.50         | 12.00         | —             | 20                | GaP             |
| HSMY-A100-L00J1 | 11.20        | 12.00         | —             | 20                | GaP             |
| HSMA-A100-Q00J1 | 71.50        | 100.00        | —             | 20                | AlInGaP         |
| HSMA-A101-S00J1 | 180.00       | 220.00        | —             | 20                | AlInGaP         |
| HSMU-A100-S00J1 | 180.00       | 320.00        | —             | 20                | AlInGaP         |
| HSMA-A101-R8WJ1 | 140.00       | —             | 355.00        | 20                | AlInGaP         |
| HSMA-A100-Q00H1 | 71.50        | —             | —             | 20                | AlInGaP         |
| HSMA-A100-R40J1 | 112.50       | —             | 285.00        | 20                | AlInGaP         |
| HSMA-A100-R45J1 | 12.50        | —             | 285.00        | 20                | AlInGaP         |
| HSMA-A101-S3WJ1 | 180.00       | —             | 355.00        | 20                | AlInGaP         |

## Yellow Green

| Part Number     | Min IV (mcd) | Typ. IV (mcd) | Max. IV (mcd) | Test Current (mA) | Dice Technology |
|-----------------|--------------|---------------|---------------|-------------------|-----------------|
| HSMG-A100-J02J1 | 4.50         | 18.00         | —             | 20                | GaP             |
| HSMG-A100-K72J2 | 9.00         | —             | 18.00         | 10                | GaP             |
| HSME-A100-M02J1 | 18.00        | 70.00         | —             | 20                | AlInGaP         |
| HSME-A100-N82J1 | 35.50        | —             | 90.00         | 20                | AlInGaP         |

## Emerald Green

| Part Number     | Min IV (mcd) | Typ. IV (mcd) | Max. IV (mcd) | Test Current (mA) | Dice Technology |
|-----------------|--------------|---------------|---------------|-------------------|-----------------|
| HSMG-A100-H01J1 | 2.80         | 8.00          | —             | 20                | GaP             |
| HSME-A100-L01J1 | 11.20        | 40.00         | —             | 20                | AlInGaP         |
| HSME-A100-M3PJ1 | 18.00        | —             | 35.50         | 20                | AlInGaP         |
| HSMG-A100-K42J2 | 7.20         | —             | 18            | 20                | GaP             |
| HSMG-A100-L02J1 | 11.20        | —             | —             | 20                | GaP             |

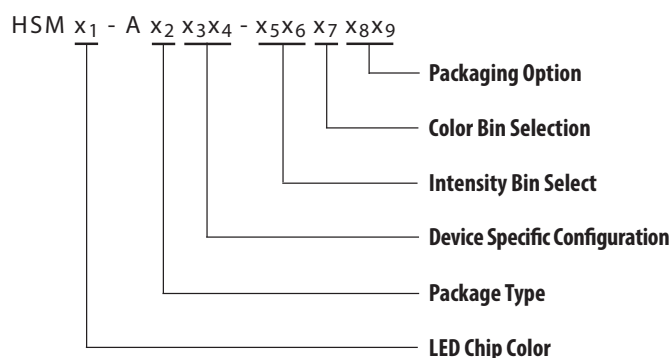
## Green

| Part Number     | Min IV (mcd) | Typ. IV (mcd) | Max. IV (mcd) | Test Current (mA) | Dice Technology |
|-----------------|--------------|---------------|---------------|-------------------|-----------------|
| HSMM-A101-R00J1 | 112.50       | 200.00        | —             | 20                | InGaP           |
| HSMM-A100-S00J1 | 180.00       | 350.00        | —             | 20                | InGaP           |
| HSMM-A100-U4PJ1 | 450.00       | —             | 1125.00       | 20                | InGaP           |
| HSMM-A101-R00H1 | 112.50       | —             | —             | 20                | InGaP           |

## Blue

| Part Number     | Min IV (mcd) | Typ. IV (mcd) | Max. IV (mcd) | Test Current (mA) | Dice Technology |
|-----------------|--------------|---------------|---------------|-------------------|-----------------|
| HSMN-A101-N00J1 | 28.50        | 50.00         | —             | 20                | InGaN           |
| HSMN-A100-P00J1 | 45.00        | 70.00         | —             | 20                | InGaN           |
| HSMN-A100-S4YJ1 | 180.00       | —             | 450.00        | 20                | InGaN           |
| HSMN-A100-R8YJ1 | 140.00       | —             | 355.00        | 20                | InGaN           |
| HSMN-A100-R00J1 | 112.50       | —             | —             | 20                | InGaN           |

## Part Numbering System



## Absolute Maximum Ratings (T<sub>A</sub> = 25°C)

| Parameters                        | HSMS/D/Y/G      | HSMH   | HSMC/J/L/A            | HSME               | HSMZ/V/U              | HSMN/N |
|-----------------------------------|-----------------|--------|-----------------------|--------------------|-----------------------|--------|
| DC Forward Current <sup>a</sup>   | 30 mA           | 30 mA  | 30 mA <sup>b, c</sup> | 20 mA <sup>c</sup> | 30 mA <sup>b, c</sup> | 30 mA  |
| Peak Forward Current <sup>d</sup> | 100 mA          | 100 mA | 100 mA                | 100 mA             | 100 mA                | 100 mA |
| Power Dissipation                 | 63 mW           | 60 mW  | 63 mW                 | 48 mW              | 63 mW                 | 114 mW |
| Reverse Voltage                   | 5V              |        |                       |                    |                       |        |
| Junction Temperature              | 110°C           |        |                       |                    |                       |        |
| Operating Temperature             | -55°C to +100°C |        |                       |                    |                       |        |
| Storage Temperature               | -55°C to +100°C |        |                       |                    |                       |        |

- Derate linearly as shown in [Figure 4](#).
- Drive current between 10 mA and 30 mA is recommended for best long term performance.
- Operation at current below 5 mA is not recommended.
- Duty factor = 10%, Frequency = 1 kHz.

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

| Color         | Part Number | Dice Technology | Peak Wavelength<br>$\lambda_{\text{PEAK}}$ (nm)<br>Typ. | Dominant Wavelength <sup>a</sup><br>$\lambda_D$ (nm)<br>Typ. | Viewing Angle<br>$2\theta_{1/2}$ <sup>b</sup><br>(Degrees)<br>Typ. | Luminous Efficacy $\eta_v$ <sup>c</sup><br>(lm/W)<br>Typ. | Luminous Intensity/Total Flux $I_v$ (mcd)/<br>$\Phi_v$ (lm) Typ. |
|---------------|-------------|-----------------|---------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------|-----------------------------------------------------------|------------------------------------------------------------------|
| Red           | HSMS-A100   | GaP             | 635                                                     | 626                                                          | 120                                                                | 120                                                       | 0.45                                                             |
|               | HSMH-A100   | AlGaAs          | 645                                                     | 637                                                          | 120                                                                | 63                                                        | 0.45                                                             |
|               | HSMC-A10x   | AlInGaP         | 635                                                     | 626                                                          | 120                                                                | 150                                                       | 0.45                                                             |
|               | HSMZ-A100   | AlInGaP         | 635                                                     | 626                                                          | 120                                                                | 155                                                       | 0.45                                                             |
| Red           | HSMJ-A10x   | AlInGaP         | 621                                                     | 615                                                          | 120                                                                | 240                                                       | 0.45                                                             |
| Orange        | HSMV-A100   | AlInGaP         | 623                                                     | 617                                                          | 120                                                                | 263                                                       | 0.45                                                             |
| Orange        | HSM D-A100  | GaP             | 600                                                     | 602                                                          | 120                                                                | 380                                                       | 0.45                                                             |
|               | HSML-A10x   | AlInGaP         | 609                                                     | 605                                                          | 120                                                                | 320                                                       | 0.45                                                             |
| Amber         | HSMY-A100   | GaP             | 583                                                     | 585                                                          | 120                                                                | 520                                                       | 0.45                                                             |
|               | HSMA-A10x   | AlInGaP         | 592                                                     | 590                                                          | 120                                                                | 480                                                       | 0.45                                                             |
|               | HSMU-A100   | AlInGaP         | 594                                                     | 592                                                          | 120                                                                | 500                                                       | 0.45                                                             |
| Yellow Green  | HSMG-A100   | GaP             | 565                                                     | 569                                                          | 120                                                                | 590                                                       | 0.45                                                             |
|               | HSME-A100   | AlInGaP         | 575                                                     | 570                                                          | 120                                                                | 560                                                       | 0.45                                                             |
| Emerald Green | HSMG-A100   | GaP             | 558                                                     | 560                                                          | 120                                                                | 650                                                       | 0.45                                                             |
|               | HSME-A100   | AlInGaP         | 566                                                     | 560                                                          | 120                                                                | 610                                                       | 0.45                                                             |
| Green         | HSMM-A10x   | InGaN           | 523                                                     | 525                                                          | 120                                                                | 500                                                       | 0.45                                                             |
| Blue          | HSMN-A10x   | InGaN           | 468                                                     | 470                                                          | 120                                                                | 75                                                        | 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, may 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 ( $T_A = 25^\circ\text{C}$ )

| Part Number  | Forward Voltage $V_F$ (Volts) at $I_F = 20\text{ mA}$ |      | Reverse Voltage $V_R$<br>at 100 $\mu\text{A}$ Min. | Reverse Voltage $V_R$<br>at 10 $\mu\text{A}$ Min. | Thermal Resistance<br>$R_{\theta_{JP}}$ ( $^\circ\text{C/W}$ ) |
|--------------|-------------------------------------------------------|------|----------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------|
|              | Typ.                                                  | Max. |                                                    |                                                   |                                                                |
| HSMS/D/Y/G   | 2.2                                                   | 2.6  | 5                                                  |                                                   | 180                                                            |
| HSMH         | 1.9                                                   | 2.6  | 5                                                  |                                                   | 180                                                            |
| HSMC/J/L/A/E | 1.9                                                   | 2.4  | 5                                                  |                                                   | 280                                                            |
| HSMZ/V/U     | 1.9                                                   | 2.4  | 5                                                  |                                                   | 280                                                            |
| HSMM/N       | 3.4                                                   | 4.05 |                                                    | 5                                                 | 280                                                            |

Figure 1: Relative Intensity vs. Wavelength

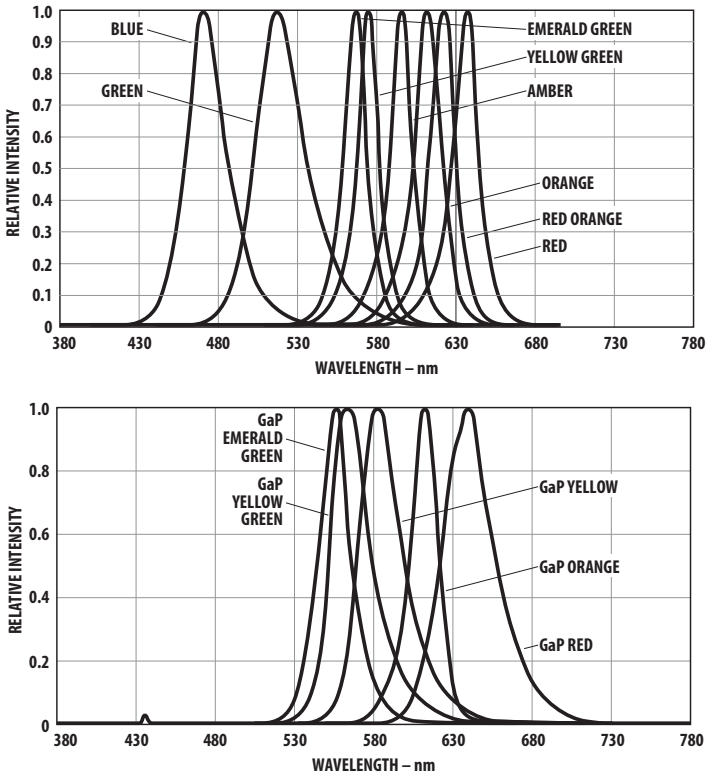


Figure 2: Forward Current vs. Forward Voltage

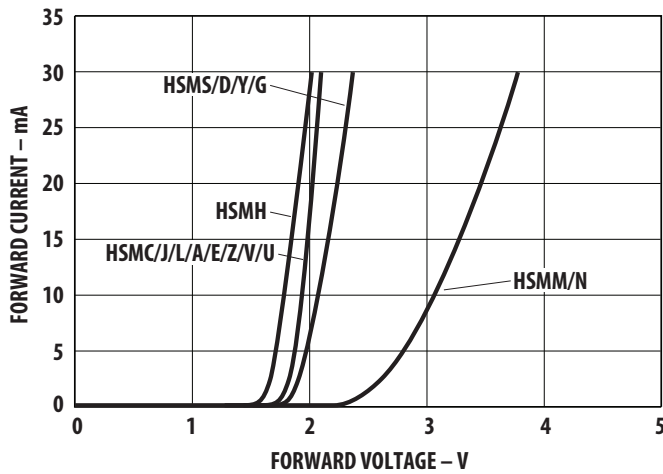


Figure 3: Relative Intensity vs. Forward Current

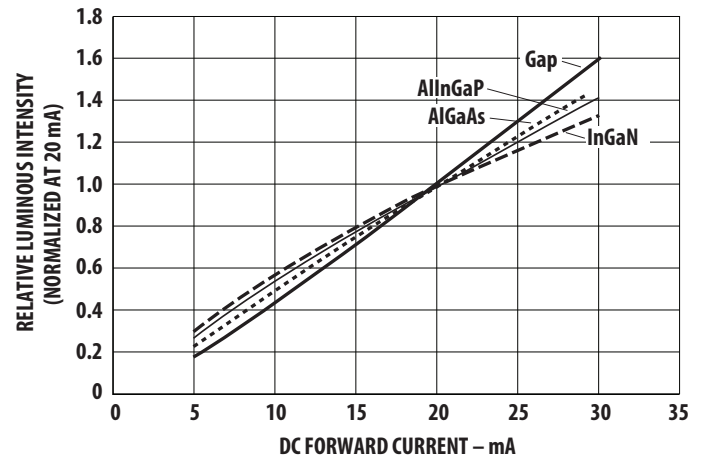
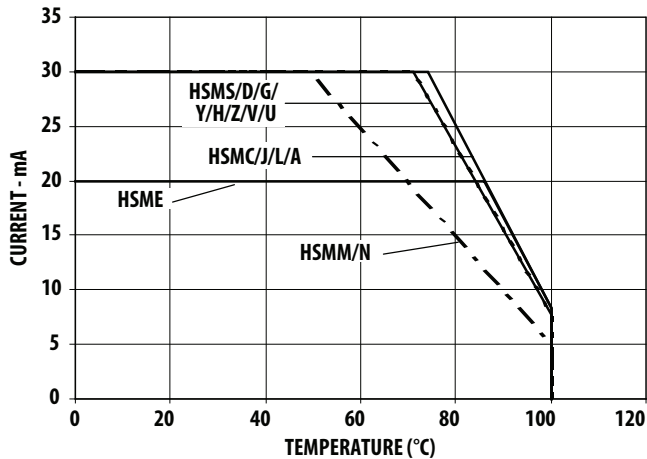
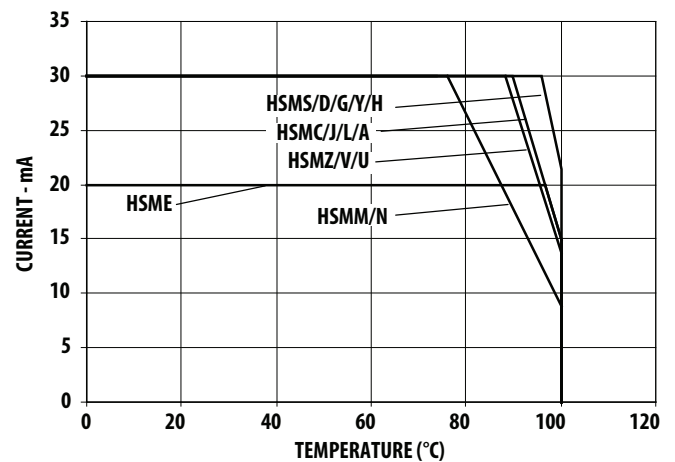
Figure 4: Maximum Forward Current vs. Ambient Temperature, Derated Based on  $T_{JMAX} = 110^{\circ}\text{C}$ ,  $R\theta_{JA} = 500^{\circ}\text{C/W}$ Figure 5: Maximum Forward Current vs. Solder Point Temperature, Derated Based on  $T_{JMAX} = 110^{\circ}\text{C}$ ,  $R\theta_{JA} = 180^{\circ}\text{C/W}$  or  $280^{\circ}\text{C/W}$ 

Figure 6: Dominant Wavelength vs. Forward Current (InGa Devices)

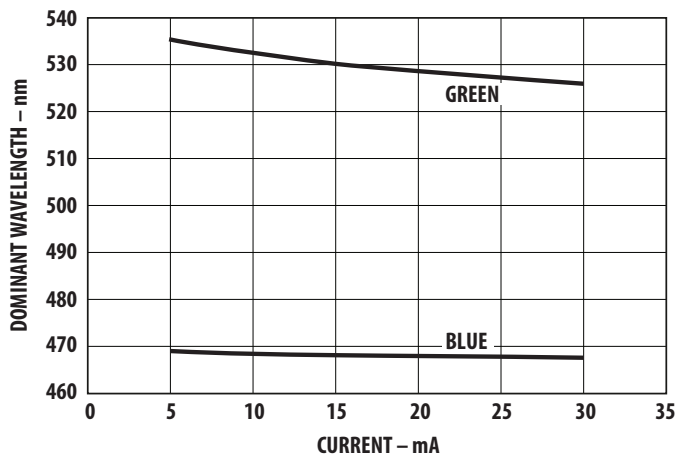


Figure 7: Forward Voltage Shift vs. Temperature

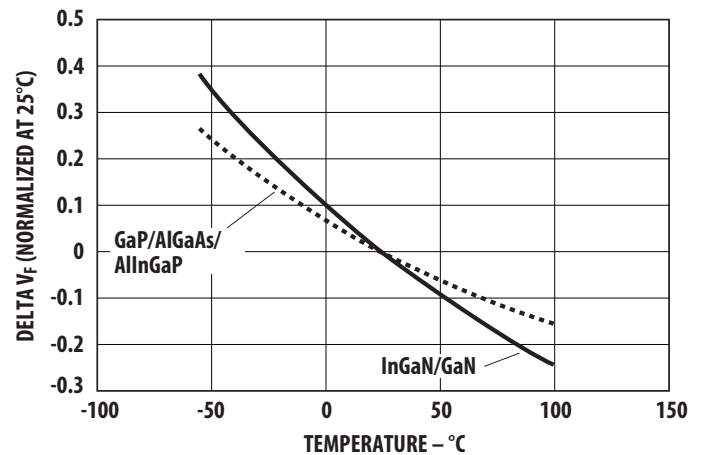
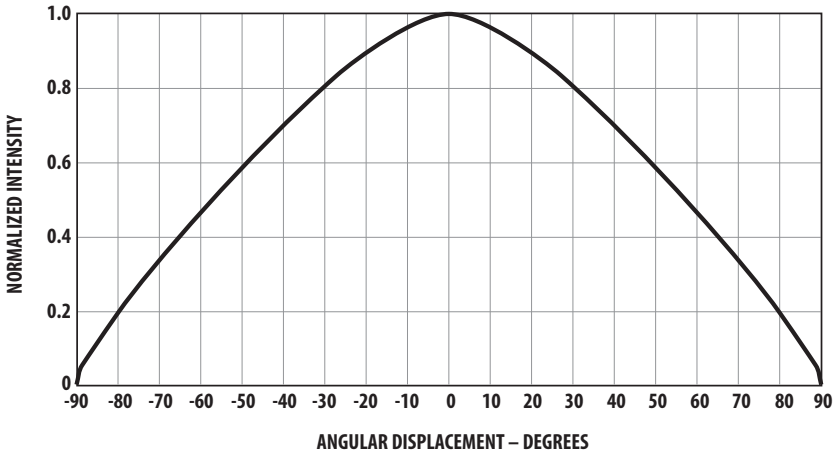




Figure 8: Radiation Pattern



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

Reflow soldering must not be done more than twice. Observe necessary precautions of handling moisture sensitive device as stated in the following section.

Figure 9: Recommended Soldering Pad Pattern

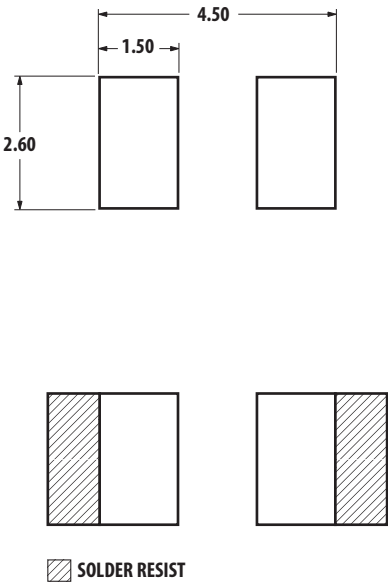


Figure 10: Tape Leader and Trailer Dimensions

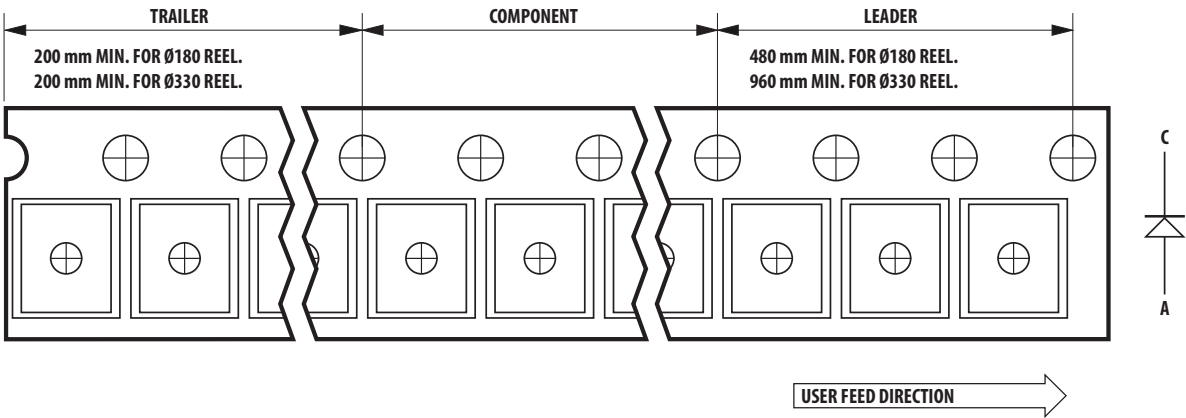


Figure 11: Tape Dimensions

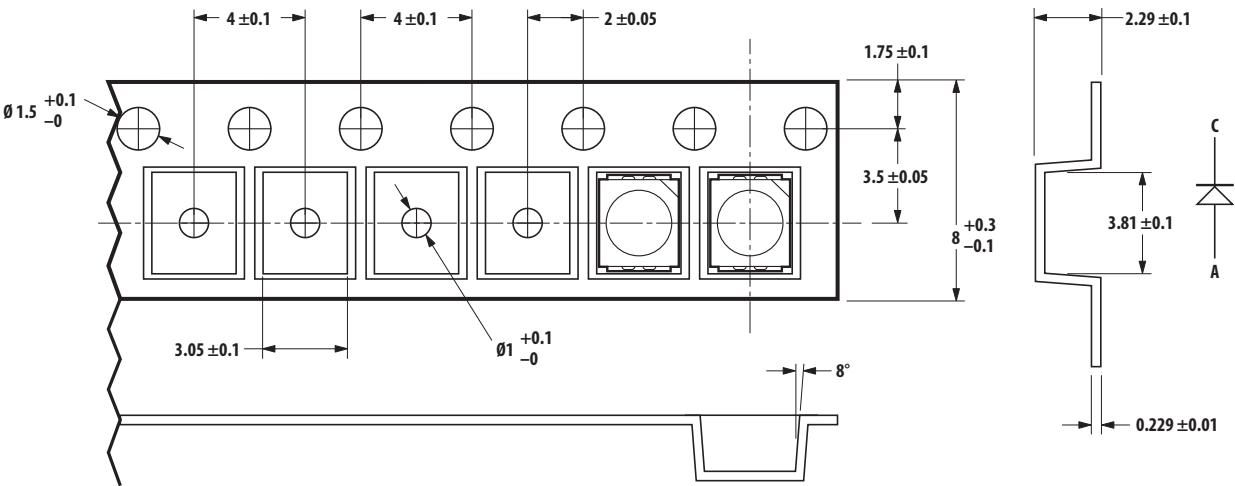


Figure 12: Reel Dimensions

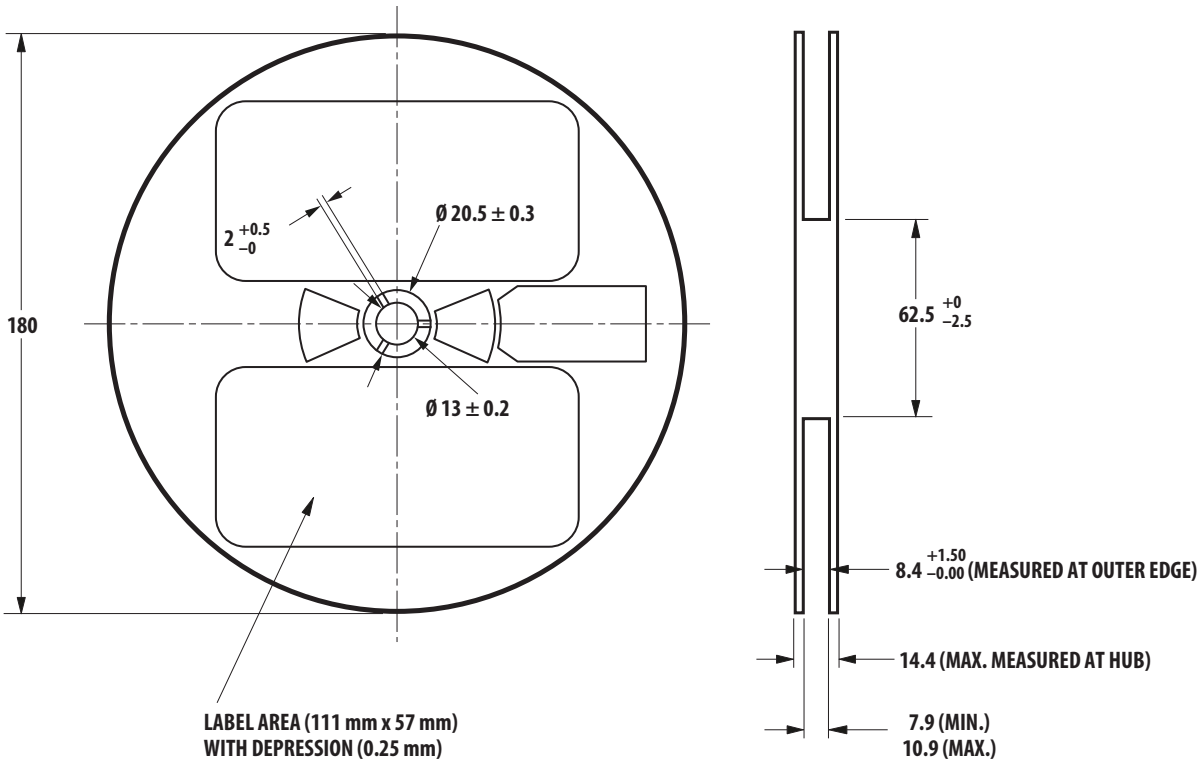
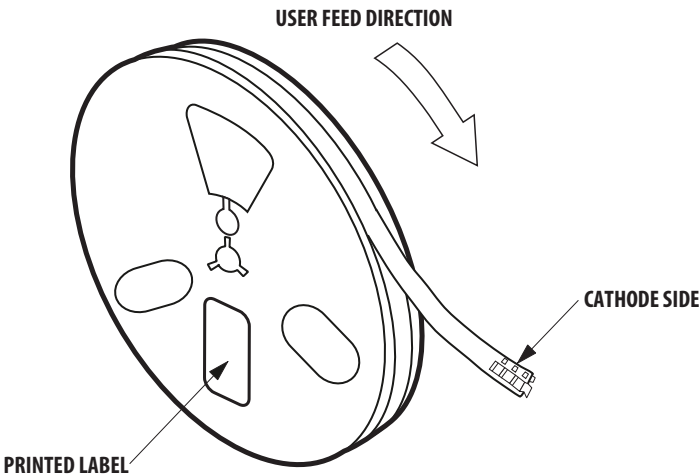


Figure 13: Reeling Orientation



## Intensity Bin Select ( $X_5X_6$ )

Individual reel will contain parts from one half bin only.

| $X_5$ | Min. $I_V$ Bin                   |
|-------|----------------------------------|
|       |                                  |
| $X_6$ |                                  |
| 0     | Full Distribution                |
| 2     | 2 half bins starting from $X_51$ |
| 3     | 3 half bins starting from $X_51$ |
| 4     | 4 half bins starting from $X_51$ |
| 5     | 5 half bins starting from $X_51$ |
| 6     | 2 half bins starting from $X_52$ |
| 7     | 3 half bins starting from $X_52$ |
| 8     | 4 half bins starting from $X_52$ |
| 9     | 5 half bins starting from $X_52$ |

## Intensity Bin Limits

| Bin ID | Min. (mcd) | Max. (mcd) |
|--------|------------|------------|
| G1     | 1.80       | 2.24       |
| G2     | 2.24       | 2.80       |
| H1     | 2.80       | 3.55       |
| H2     | 3.55       | 4.50       |
| 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    |
| W1     | 1125.00    | 1400.00    |
| W2     | 1400.00    | 1800.00    |
| X1     | 1800.00    | 2240.00    |
| X2     | 2240.00    | 2850.00    |

Tolerance of each bin limit =  $\pm 12\%$

## Color Bin Select (X<sub>7</sub>)

Individual reel will contain parts from one full bin only.

| X <sub>7</sub> |                        |
|----------------|------------------------|
| 0              | Full distribution      |
| Z              | A and B only           |
| Y              | B and C only           |
| W              | C and D only           |
| V              | D and E only           |
| U              | E and F only           |
| T              | F and G only           |
| S              | G and H only           |
| Q              | A, B, and C only       |
| P              | B, C, and D only       |
| N              | C, D, and E only       |
| M              | D, E, and F only       |
| L              | E, F, and G only       |
| K              | F, G, and H only       |
| 1              | A, B, C, and D only    |
| 2              | E, F, G, and H only    |
| 3              | B, C, D, and E only    |
| 4              | C, D, E, and F only    |
| 5              | A, B, C, D, and E only |
| 6              | B, C, D, E, and F only |

## Color Bin Limits

| Color                | Min. (nm) | Max. (nm) |
|----------------------|-----------|-----------|
| <b>Blue</b>          |           |           |
| A                    | 460.0     | 465.0     |
| B                    | 465.0     | 470.0     |
| C                    | 470.0     | 475.0     |
| D                    | 475.0     | 480.0     |
| <b>Green</b>         |           |           |
| A                    | 515.0     | 520.0     |
| B                    | 520.0     | 525.0     |
| C                    | 525.0     | 530.0     |
| D                    | 530.0     | 535.0     |
| <b>Emerald Green</b> |           |           |
| A                    | 552.5     | 555.5     |
| B                    | 555.5     | 558.5     |
| C                    | 558.5     | 561.5     |
| D                    | 561.5     | 564.5     |
| <b>Yellow Green</b>  |           |           |
| E                    | 564.5     | 567.5     |
| F                    | 567.5     | 570.5     |
| G                    | 570.5     | 573.5     |
| H                    | 573.5     | 576.5     |
| <b>Amber</b>         |           |           |
| 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     |
| <b>Orange</b>        |           |           |
| 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     |
| <b>Red Orange</b>    |           |           |
| A                    | 611.0     | 616.0     |
| B                    | 616.0     | 620.0     |
| <b>Red</b>           |           |           |
| Full distribution    |           |           |

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

| Option | Test Current | Package Type  | Reel Size |
|--------|--------------|---------------|-----------|
| J1     | 20 mA        | Top Mount     | 7 inches  |
| J4     | 20 mA        | Top Mount     | 13 inches |
| H1     | 20 mA        | Reverse Mount | 7 inches  |
| H4     | 20 mA        | Reverse Mount | 13 inches |
| J2     | 10 mA        | Top Mount     | 7 inches  |
| J5     | 10 mA        | Top Mount     | 13 inches |
| H2     | 10 mA        | Reverse Mount | 7 inches  |
| H5     | 10 mA        | Reverse Mount | 13 inches |
| L2     | 2 mA         | Top Mount     | 7 inches  |

## Precautionary Notes

### Soldering

- Do not perform reflow soldering more than twice. Observe necessary precautions of handling moisture-sensitive device 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 max.
  - Soldering duration = 3s max.
  - Number of cycles = 1 only
  - Power of soldering iron = 50W max.
- Do not touch the LED package body with the soldering iron except for the soldering terminals, as 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 14: Recommended Pb-Free Reflow Soldering Profile

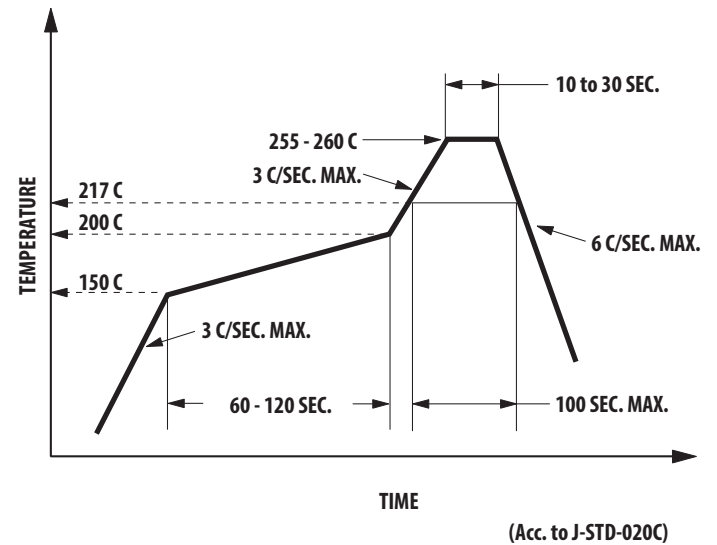
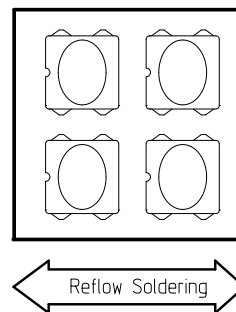


Figure 15: Recommended Board Reflow Direction



### Handling Precautions

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 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, 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°/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 168 hours.

The recommended baking condition is: 60±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 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.
- 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.
- 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.
- This LED is designed to have enhanced gas corrosion resistance. Its performance has been tested according to the conditions below:
  - IEC 60068-2-43: 25°C/75% RH, H<sub>2</sub>S 15 ppm, 21 days
  - IEC 60068-2-42: 25°C/75% RH, SO<sub>2</sub> 25 ppm, 21 days
  - IEC 60068-2-60: 25°C/75% RH, SO<sub>2</sub> 200 ppb, NO<sub>2</sub> 200 ppb, H<sub>2</sub>S 10 ppb, Cl<sub>2</sub> 10 ppb, 21 days.
- As actual application might not be exactly similar to the test conditions, do verify that the LED will not be damaged by prolonged exposure in the intended environment.
- 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

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:

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

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 the solder point temperature,  $T_S$  as follows:

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

where;

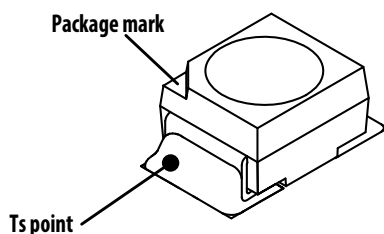
$T_S$  = LED solder point temperature as shown in the following figure ( $^{\circ}\text{C}$ )

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

$I_F$  = forward current (A)

$V_{Fmax}$  = maximum forward voltage (V)

**Figure 16: Solder Point Temperatures on PCB**



$T_S$  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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