

## HDSP-311x, HDSP-313x

### 10.16-mm (0.4-in.) Single-Digit General-Purpose Seven-Segment Display



#### AV02-3585EN Description

This Broadcom® 10.16-mm (0.4-in.) LED single-digit seven-segment display uses industry-standard size package and pinout. The device is available in either common anode or common cathode. The choice of colors includes AlInGaP Red, AlInGaP Green, AlInGaP Deep Red, and AlInGaP Yellow. The gray face displays are suitable for indoor use.

#### Applications

- Suitable for indoor use
- Not recommended for industrial applications, that is, operating temperature requirements exceeding +85° C or below -25° C (see note)
- Extreme temperature cycling not recommended

**NOTE:** For additional details, contact your local Broadcom sales office or an authorized distributor.

#### Features

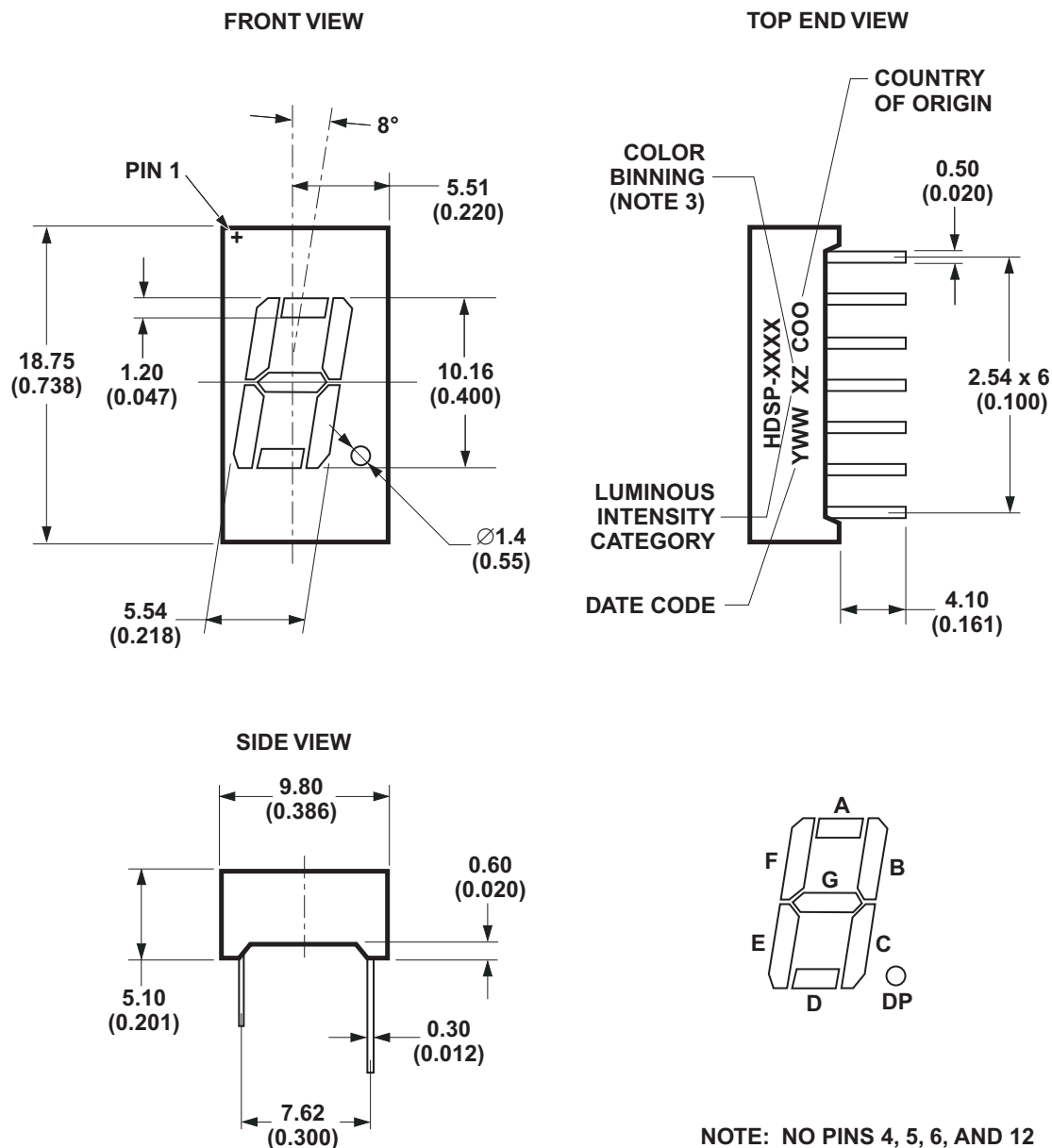
- Industry-standard size
- Industry-standard pinout
  - 10.16-mm (0.4-in.) character height
  - DIP lead on 2.54 mm
- Choice of colors
  - AlInGaP Red, AlInGaP Green, AlInGaP Deep Red, and AlInGaP Yellow
- Excellent appearance
  - Evenly lighted segments gray package gives optimum contrast
  - ± 50 ft. viewing angle
- Design flexibility
  - Common anode right hand decimal point or common cathode right hand decimal point
- Categorized for luminous intensity
  - Green and yellow categorized for color

#### Devices

| AlInGaP Red | AlInGaP Green | AlInGaP Deep Red | AlInGaP Yellow | Description                       | Package Drawing |
|-------------|---------------|------------------|----------------|-----------------------------------|-----------------|
| HDSP-311E   | HDSP-311G     | HDSP-311A        | HDSP-311Y      | Common Anode Right Hand Decimal   | A               |
| HDSP-313E   | HDSP-313G     | HDSP-313A        | HDSP-313Y      | Common Cathode Right Hand Decimal | B               |

# Package Dimensions

## Package Drawing A

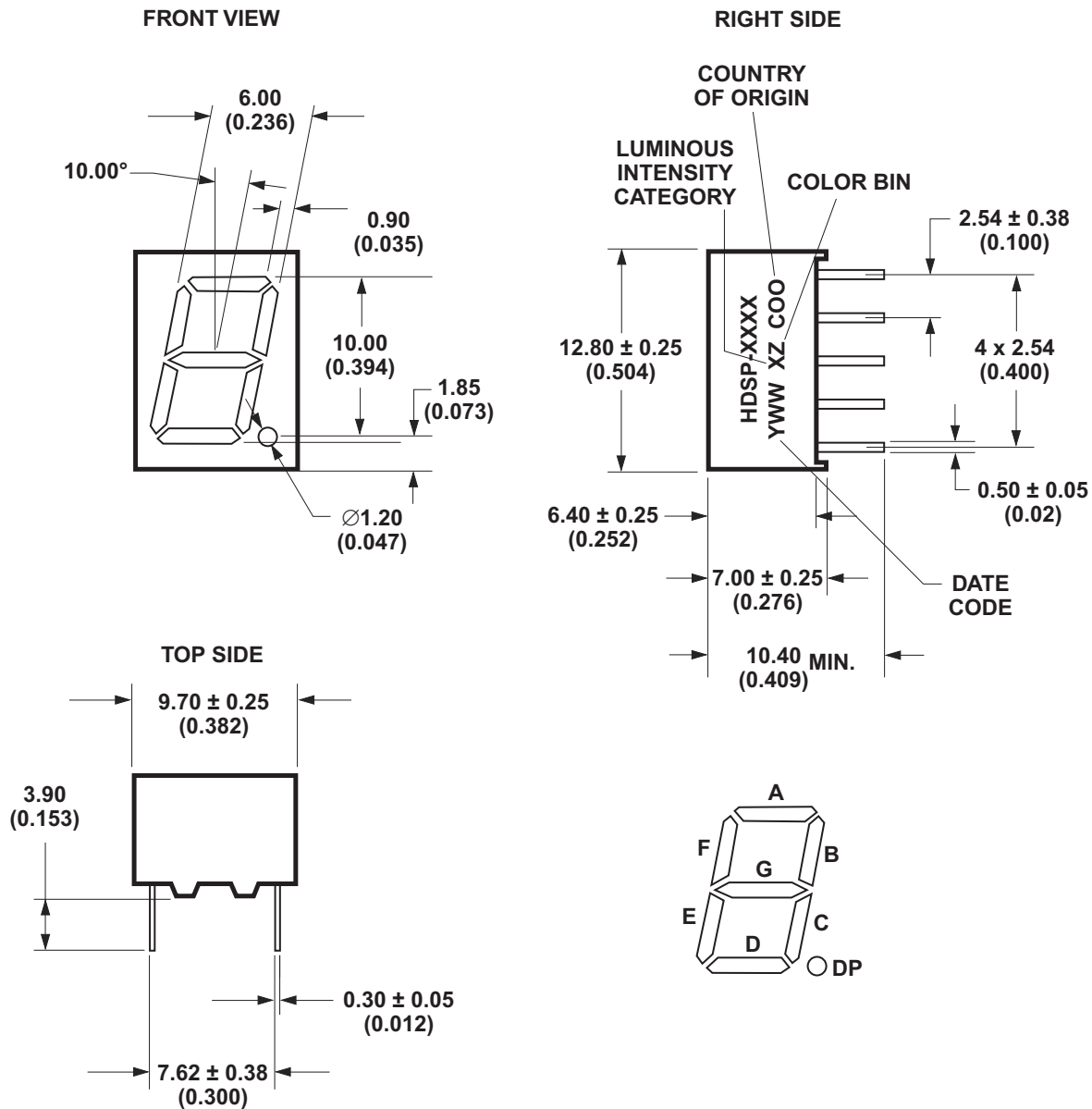


NOTE: NO PINS 4, 5, 6, AND 12

### NOTE:

1. All dimensions are in millimeters (inches).
2. Tolerance is 0.25 mm (0.01 in.) unless otherwise stated.
3. For yellow and green series product only.

# Package Drawing B

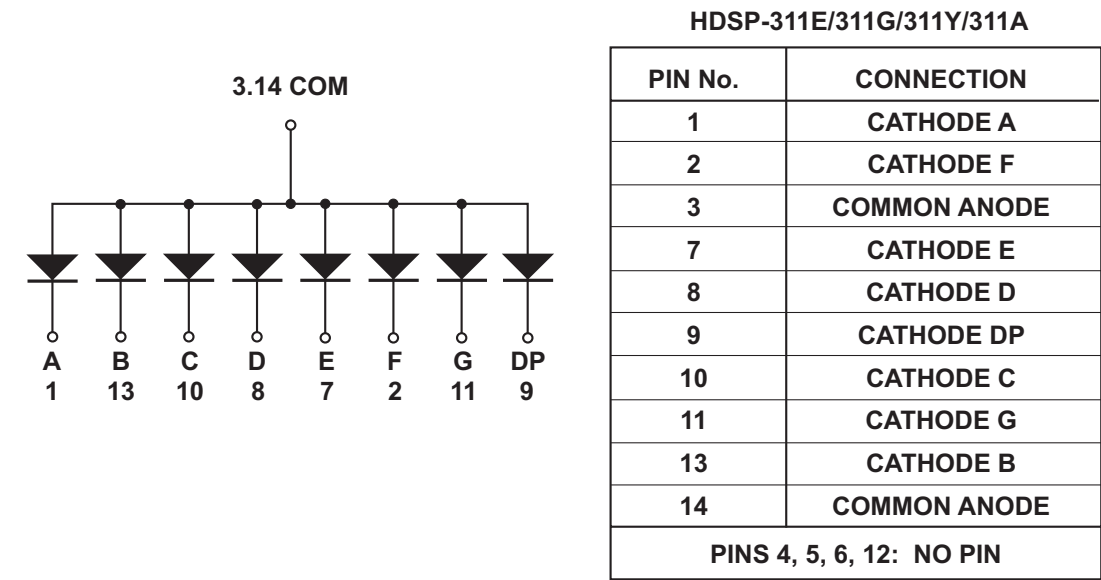


## NOTE:

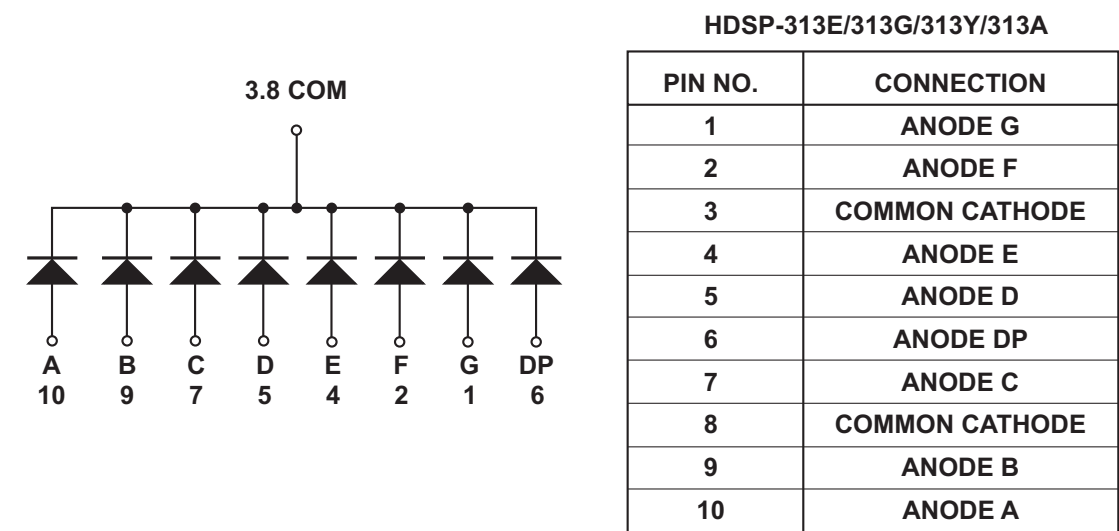
1. All dimensions are in millimeters (inches).
2. Tolerance is 0.25 mm (0.01 in.) unless otherwise stated.
3. For yellow and green series product only.

Internal Circuit Diagram

Common Anode Right-Hand Decimal



Common Cathode Right-Hand Decimal



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

| Description                                                                 | Red<br>HDSP-31xE | Green<br>HDSP-31xG | Deep Red<br>HDSP-31xA | Yellow<br>HDSP-31xY | Units |
|-----------------------------------------------------------------------------|------------------|--------------------|-----------------------|---------------------|-------|
| Power Dissipation Segment                                                   | 62.5             | 62.5               | 52                    | 50                  | mW    |
| Forward Current Segment                                                     | 25 <sup>a</sup>  | 25 <sup>b</sup>    | 20 <sup>c</sup>       | 20 <sup>d</sup>     | mA    |
| Peak Forward Current per Segment <sup>e</sup>                               | 90               | 90                 | 60                    | 60                  | mA    |
| Operating Temperature Range                                                 | -40 to +85       | -40 to +85         | -40 to +85            | -40 to +85          | °C    |
| Storage Temperature Range                                                   | -40 to +85       | -40 to +85         | -40 to +85            | -40 to +85          | °C    |
| Reverse Voltage per Segment or DP <sup>f</sup>                              | 5                | 5                  | 5                     | 5                   | V     |
| Wavesoldering Temperature for 3 Seconds<br>(at 2-mm distance from the body) | 250              | 250                | 250                   | 250                 | °C    |

- a. Derate linearly as shown in [Figure 4](#).
- b. Derate linearly as shown in [Figure 8](#).
- c. Derate linearly as shown in [Figure 12](#).
- d. Derate linearly as shown in [Figure 16](#).
- e. Duty factor = 10%, frequency = 1 kHz,  $T_A = 25^\circ\text{C}$ .
- f. Reverse Voltage is for LED testing purposes and is not recommended to be used as an application condition.

## Electrical/Optical Characteristics at $T_A = 25^\circ\text{C}$

| Device<br>HDSP- | Parameter                                     | Symbol      | Min. | Typ. | Max. | Units | Test Conditions                |
|-----------------|-----------------------------------------------|-------------|------|------|------|-------|--------------------------------|
| <b>Red</b>      |                                               |             |      |      |      |       |                                |
| 311E<br>313E    | Luminous Intensity/Segment <sup>a, b, c</sup> | $I_V$       | 2.00 | 3.60 | —    | mcd   | $I_F = 10\text{ mA}$           |
|                 | Forward Voltage <sup>d</sup>                  | $V_F$       | —    | 1.95 | 2.50 | V     | $I_F = 20\text{ mA}$           |
|                 | Peak Wavelength                               | $\lambda_P$ | —    | 633  | —    | nm    |                                |
|                 | Dominant Wavelength <sup>e</sup>              | $\lambda_d$ | —    | 622  | —    | nm    |                                |
|                 | Reverse Voltage <sup>f</sup>                  | $V_R$       | 5    | —    | —    | V     | $I_R = 100\text{ }\mu\text{A}$ |
| <b>Green</b>    |                                               |             |      |      |      |       |                                |
| 311G<br>313G    | Luminous Intensity/Segment <sup>a, b, c</sup> | $I_V$       | 3.20 | 5.90 | —    | mcd   | $I_F = 10\text{ mA}$           |
|                 | Forward Voltage <sup>d</sup>                  | $V_F$       | 1.80 | 2.10 | 2.50 | V     | $I_F = 20\text{ mA}$           |
|                 | Peak Wavelength                               | $\lambda_P$ | —    | 572  | —    | nm    |                                |
|                 | Dominant Wavelength <sup>e</sup>              | $\lambda_d$ | —    | 570  | —    | nm    |                                |
|                 | Reverse Voltage <sup>f</sup>                  | $V_R$       | 5    | —    | —    | V     | $I_R = 100\text{ }\mu\text{A}$ |
| <b>Deep Red</b> |                                               |             |      |      |      |       |                                |
| 311A<br>313A    | Luminous Intensity/Segment <sup>a, b, c</sup> | $I_V$       | 3.20 | 7.50 | —    |       | $I_F = 10\text{ mA}$           |
|                 | Forward Voltage <sup>d</sup>                  | $V_F$       | —    | 2.00 | 2.60 | V     | $I_F = 20\text{ mA}$           |
|                 | Peak Wavelength                               | $\lambda_P$ | —    | 660  | —    | nm    |                                |
|                 | Dominant Wavelength <sup>e</sup>              | $\lambda_d$ | —    | 640  | —    | nm    |                                |
|                 | Reverse Voltage <sup>f</sup>                  | $V_R$       | 5    | —    | —    | V     | $I_R = 100\text{ }\mu\text{A}$ |

| Device<br>HDSP- | Parameter                                     | Symbol      | Min. | Typ. | Max. | Units | Test Conditions         |
|-----------------|-----------------------------------------------|-------------|------|------|------|-------|-------------------------|
| <b>Yellow</b>   |                                               |             |      |      |      |       |                         |
| 311Y<br>313Y    | Luminous Intensity/Segment <sup>a, b, c</sup> | $I_V$       | 1.25 | 1.90 | —    |       | $I_F = 10 \text{ mA}$   |
|                 | Forward Voltage <sup>d</sup>                  | $V_F$       | —    | 2.10 | 2.50 | V     | $I_F = 20 \text{ mA}$   |
|                 | Peak Wavelength                               | $\lambda_P$ | —    | 592  | —    | nm    |                         |
|                 | Dominant Wavelength <sup>e</sup>              | $\lambda_d$ | —    | 588  | —    | nm    |                         |
|                 | Reverse Voltage <sup>f</sup>                  | $V_R$       | 5    | —    | —    | V     | $I_R = 100 \mu\text{A}$ |

a. The luminous intensity,  $I_V$ , is measured at the mechanical axis of the package.

b. The optical axis is closely aligned with the mechanical axis of the package.

c. Tolerance is  $\pm 15\%$ .

d. Forward voltage tolerance is  $\pm 0.1\text{V}$ .

e. The dominant wavelength,  $\lambda_d$ , is derived from the CIE Chromaticity Diagram and represents the perceived color of the device.

f. Indicates product final test condition. Long term reverse bias is not recommended.

## Intensity Bin Limits (mcd at 10 mA)

### Red

| IV Bin Category | Min.  | Max.  |
|-----------------|-------|-------|
| I               | 2.001 | 3.200 |
| J               | 3.201 | 5.050 |
| K               | 5.051 | 8.000 |

Tolerance for each bin limit is  $\pm 15\%$ .

### Green/Deep Red

| IV Bin Category | Min.  | Max.   |
|-----------------|-------|--------|
| J               | 3.201 | 5.050  |
| K               | 5.051 | 8.000  |
| L               | 8.001 | 12.650 |

Tolerance for each bin limit is  $\pm 15\%$ .

### Yellow

| IV Bin Category | Min.  | Max.  |
|-----------------|-------|-------|
| H               | 1.251 | 2.000 |
| I               | 2.001 | 3.200 |
| J               | 3.201 | 5.050 |

Tolerance for each bin limit is  $\pm 15\%$ .

## Color Bin Limits (nm at 10 mA)

| Color  | Bin | Dominant Wavelength (nm) |       |
|--------|-----|--------------------------|-------|
|        |     | Min.                     | Max.  |
| Green  | 3   | 569.1                    | 571.1 |
|        | 4   | 571.1                    | 573.1 |
|        | 5   | 573.1                    | 585.5 |
| Yellow | 1   | 585.5                    | 588.5 |
|        | 2   | 588.5                    | 591.5 |
|        | 3   | 591.5                    | 594.5 |

Tolerance for each bin limit is 1 nm.

Red

Figure 1: Relative Intensity vs. Wavelength

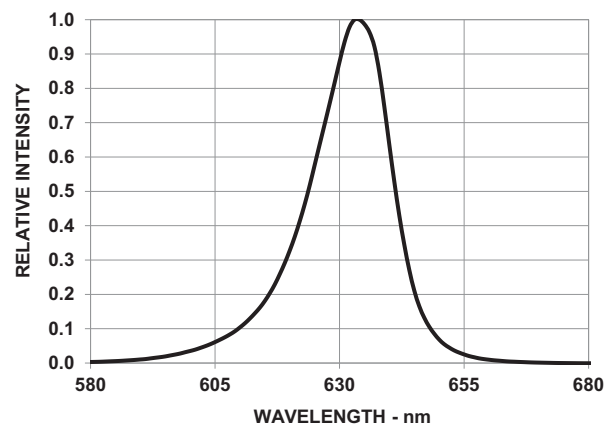


Figure 2: Forward Current vs. Forward Voltage

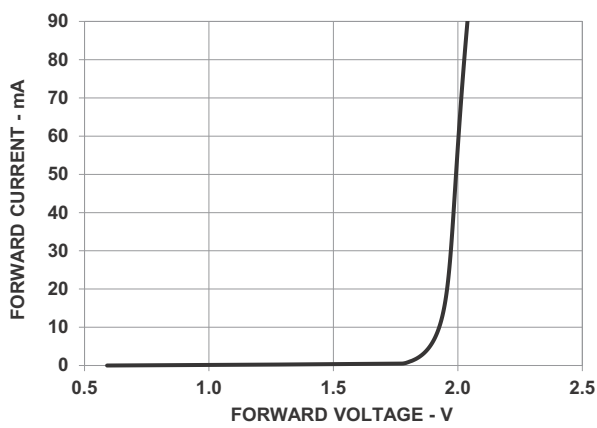


Figure 3: Relative Luminous Intensity vs. Forward Current

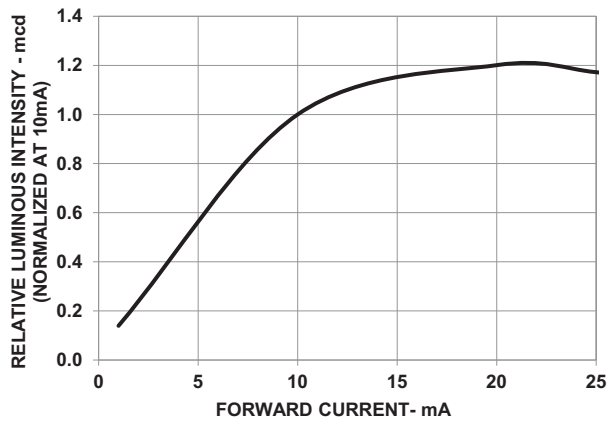
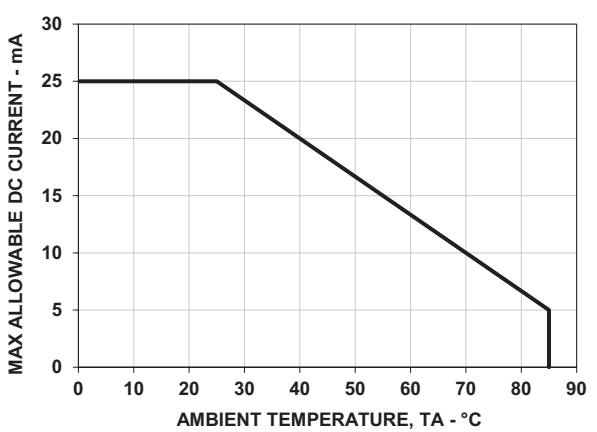


Figure 4: Maximum Forward Current vs. Ambient Temperature



Green

Figure 5: Relative Intensity vs. Wavelength

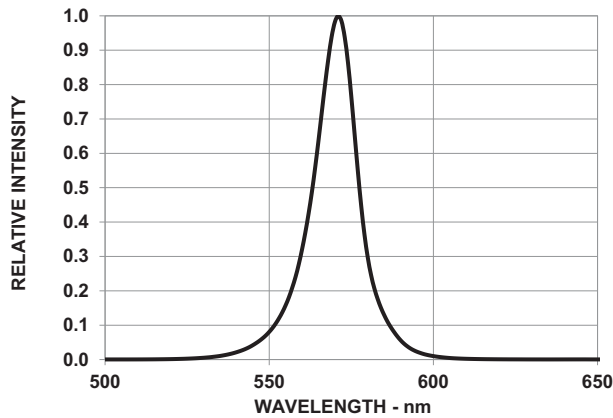


Figure 6: Forward Current vs. Forward Voltage

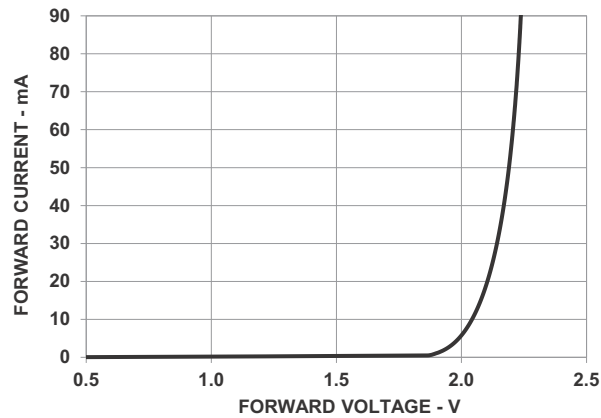


Figure 7: Relative Luminous Intensity vs. Forward Current

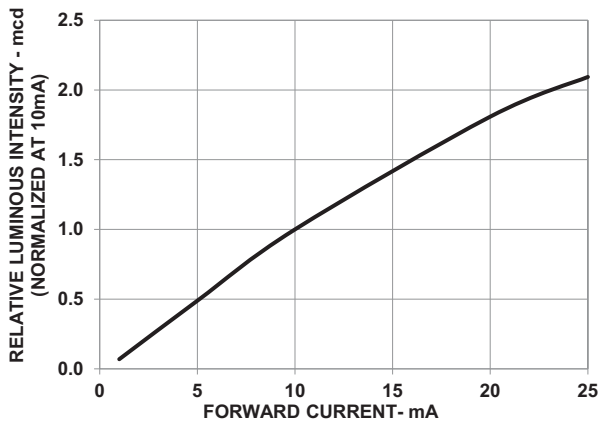
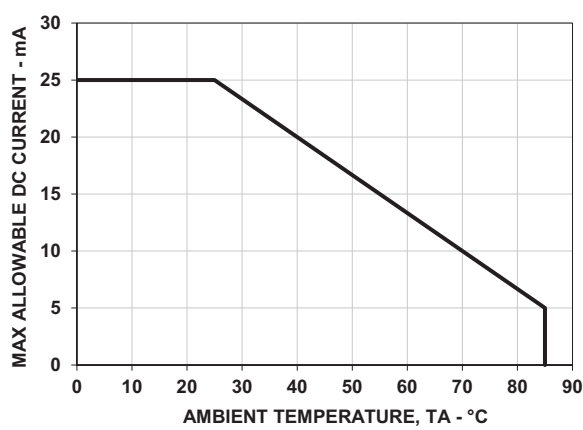


Figure 8: Maximum Forward Current vs. Ambient Temperature



Deep Red

Figure 9: Relative Intensity vs. Wavelength

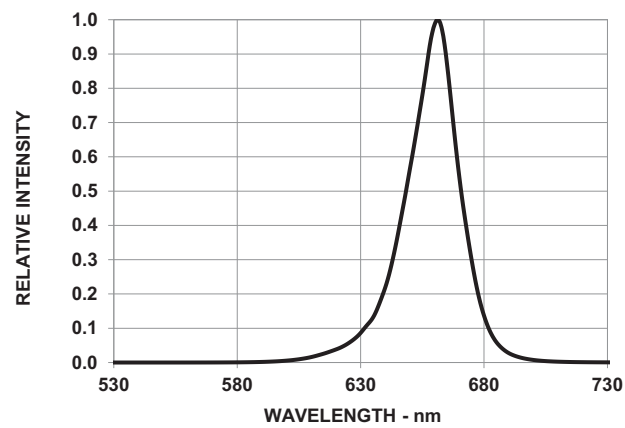


Figure 10: Forward Current vs. Forward Voltage

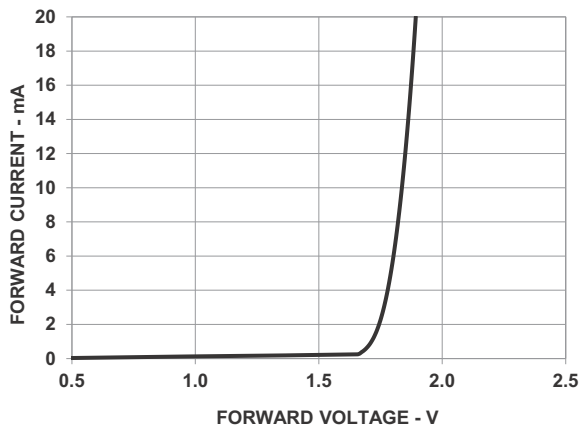


Figure 11: Relative Luminous Intensity vs. Forward Current

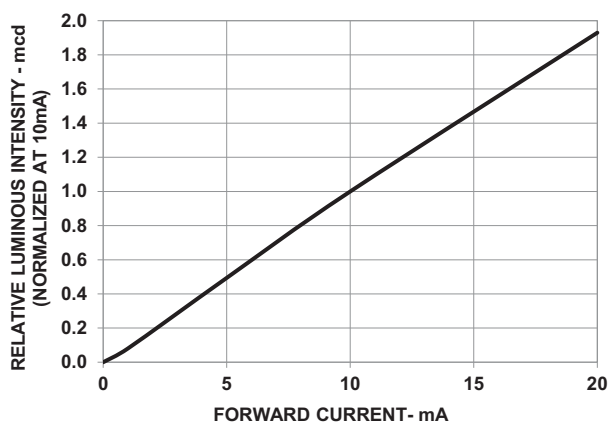
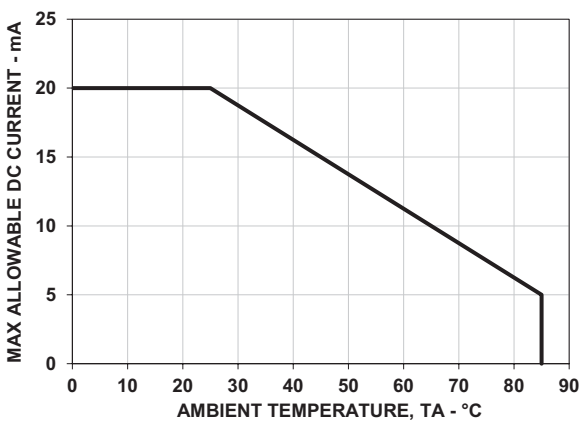


Figure 12: Maximum Forward Current vs. Ambient Temperature



Yellow

Figure 13: Relative Intensity vs. Wavelength

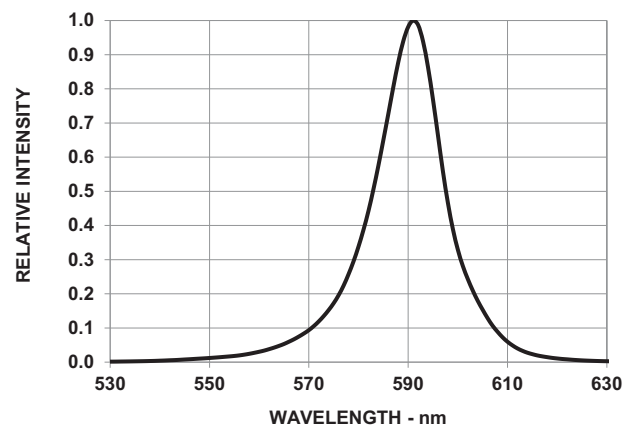


Figure 14: Forward Current vs. Forward Voltage

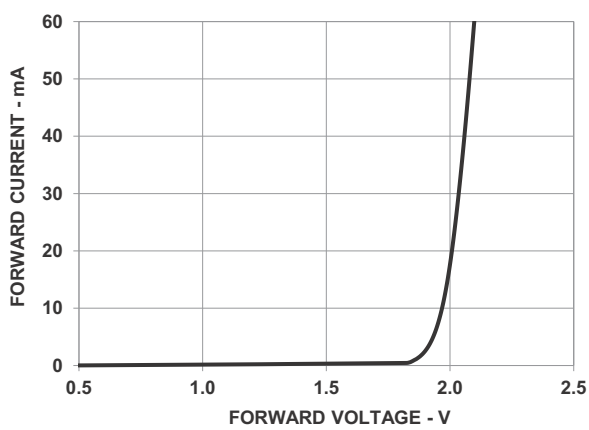


Figure 15: Relative Luminous Intensity vs. Forward Current

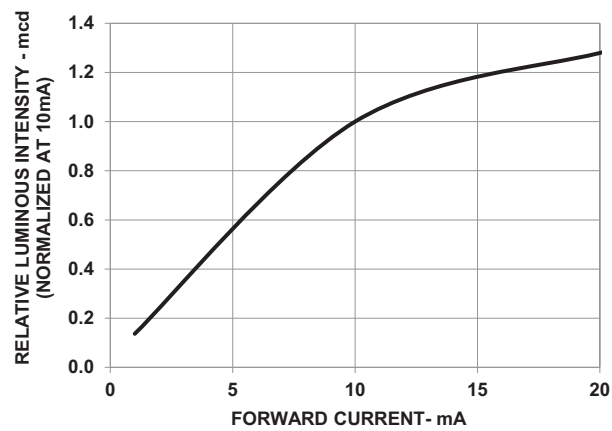
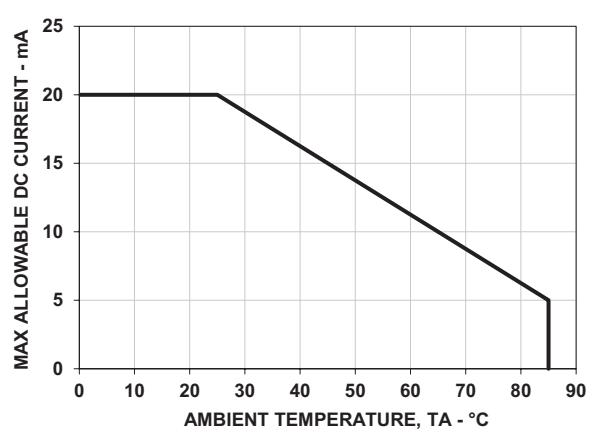


Figure 16: Maximum Forward Current vs. Ambient Temperature



## Precautionary Notes

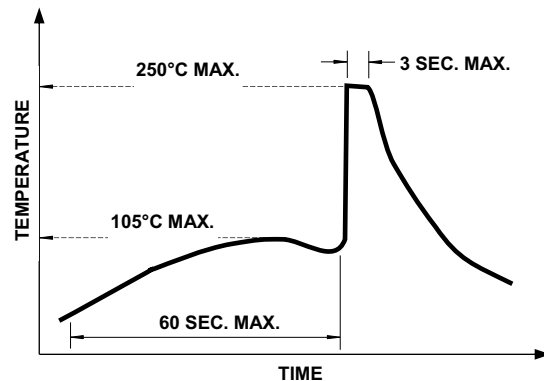
### Soldering and Handling Precautions

- Set and maintain the wave soldering parameters according to the recommended temperature and dwell time. Perform daily checks on the profile to ensure that it conforms to the recommended conditions. Exceeding these conditions will over-stress the LEDs and cause premature failures.
- Use only bottom preheaters to reduce thermal stress experienced by the LEDs.
- Recalibrate the soldering profile before loading a new type of PCB. A PCB with different size and design (component density) will have different heat capacity and might cause a change in temperature experienced by the PCB if the same wave soldering setting is used.
- Do not perform wave soldering more than once.
- Loosely fit any alignment fixture used during wave soldering and do not apply stress on the LEDs. Use non-metal material because it absorbs less heat during the wave soldering process.
- At elevated temperatures, the LEDs are more susceptible to mechanical stress. Allow the PCB to be sufficiently cooled to room temperature before handling. Do not apply stress to the LED when it is hot.
- Use wave soldering to solder the LED. Use hand soldering only for rework or touch up if unavoidable, but it must be strictly controlled to following conditions:
  - Soldering iron tip temperature = 315°C maximum
  - Soldering duration = 2 seconds maximum
  - Number of cycles = 1 only
  - Power of soldering iron = 50W maximum
- For ESD sensitive devices, apply proper ESD precautions at the soldering station. Use only an ESD-safe soldering iron.
- 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 are affected by soldering with hand soldering.
- Keep the heat source at least 1.6 mm away from the LED body during soldering.
- Design an appropriate hole size to avoid problems during insertion.
- Do not use cleaning agents from the ketone family (acetone, methyl ethylketone, and so on) and from the chlorinated hydrocarbon family (methylene chloride, trichloroethylene, carbon tetrachloride, and so on) to

clean the LED displays. All of these solvents attack or dissolve the encapsulating epoxies used to form the package of plastic LED parts.

- For the purposes of cleaning, wash with DI water only. Perform the cleaning process at room temperature only. Clear any water or moisture from the LED display immediately after washing.
- Use *No clean* solder paste for soldering.

Figure 17: Recommended Wave Soldering Profile



**NOTE:** The measurements are performed with a thermocouple mounted at the bottom of the PCB.

### Application Precautions

- The drive current of the LED must not exceed the maximum allowable limit across temperature as stated in the data sheet. Use constant current driving to ensure consistent performance.
- The circuit design must cater to the entire 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 (such as 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.

- 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 a harsh or an outdoor environment, protect the LED against damages caused by rain, water, dust, oil, corrosive gases, external mechanical stresses, and so on.

## 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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Lead (Pb) Free  
RoHS Compliant