Data Sheet

# HSMF-C16x

## Miniature Bi-Color Surface Mount ChipLEDs

## Description

The Broadcom® HSMF-C16x series of bi-color ChipLEDs is designed with the smallest footprint to achieve high density of components on board. They have the industry-standard footprint of 1.6 mm x 0.8 mm and a height of only 0.5 mm. This makes them very suitable for cellular phone and mobile equipment backlighting and indication. They are available in a wide range of color combinations. In order to facilitate automated pick and place operation, these ChipLEDs are shipped in tape and reel, with 4000 units per reel. These parts are compatible with reflow soldering.

## Features

- Small size
- 0603 industry-standard footprint
- Diffused optics
- Operating temperature range of –40°C to +85°C
- Compatible with reflow soldering
- Available in various color combination
- Available in 8-mm tape on 7 inch (178 mm) diameter reels

## Applications

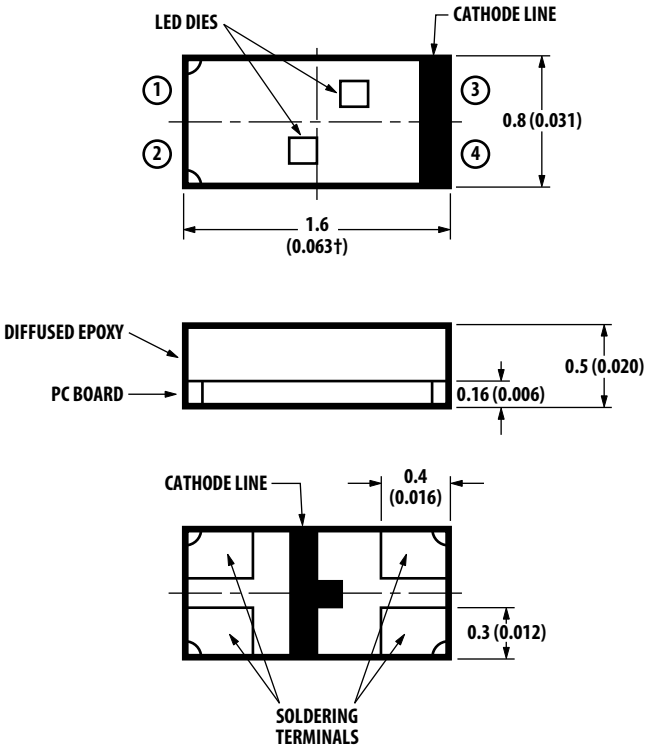
- Keypad backlighting
- Symbol indicator
- LCD backlighting
- Pushbutton backlighting
- Front-panel indicator

## Device Selection Guide

| Part Number | Color | Package Description |
|---|---|---|
| HSMF-C162 | AlInGaP Red/AlInGaP Amber | Untinted, Diffused |
| HSMF-C163 | AlInGaP Red/InGaN Green | Untinted, Diffused |
| HSMF-C164 | AlInGaP Red/InGaN Blue | Untinted, Diffused |
| HSMF-C165 | AlInGaP Red/AlInGaP Green | Untinted, Diffused |
| HSMF-C166 | AlInGaP Yellow/AlInGaP Green | Untinted, Diffused |
| HSMF-C167 | AlInGaP Orange/AlInGaP Green | Untinted, Diffused |
| HSMF-C169 | AlInGaP Amber/InGaN Blue | Untinted, Diffused |

**CAUTION!** The HSMF-C16x LEDs are Class 1A ESD sensitive per JESD22-A114C.01 standard. Observe appropriate precautions during handling and processing. Refer to Application Note AN-1142 for additional details.

# Package Dimensions




**NOTE:**

- All Dimensions are in millimeters (inches).
- Tolerance is ± 0.1 mm (± 0.004 in.) unless otherwise specified.

| Polarity | HSMF-C162 | HSMF-C163 | HSMF-C164 | HSMF-C165 | HSMF-C166 | HSMF-C167 | HSMF-C169 |
|---|---|---|---|---|---|---|---|
|  | Amber | Green | Blue | Green | Green | Green | Blue |
| | Red | Red | Red | Red | Yellow | Orange | Amber |

# Absolute Maximum Ratings for Each Die at $T_A$ = 25°C

| Parameter | AlInGaP | InGaN | Unit |
|---|---|---|---|
| DC Forward Current[a] | 20 | 10 | mA |
| Power Dissipation | 52 | 38 | mW |
| Reverse Voltage | 5 | 5 | V |
| LED Junction Temperature | 95 | 95 | °C |
| Operating and Storage Temperature Range | –40 to 85 | | °C |
| Soldering Temperature | See reflow soldering profile (Figure 6 and Figure 7) | | |

a. Derate linearly as shown in Figure 4.

# Electrical Characteristics ($T_A$ = 25°C)

| Part Number | Test Current | Color | Forward Voltage,[a] $V_F$ (V) | | | Reverse Current,[b] $I_R$ (µA) at $V_R$ = 5V | Thermal Resistance,[c] $R\theta_{J-S}$ (°C/W) |
|---|---|---|---|---|---|---|---|
| | | | Minimum | Typical | Maximum | Maximum | Typical |
| HSMF-C162 | 20 mA | AlInGaP Red | 1.60 | 1.90 | 2.40 | 100 | 300 |
| | | AlInGaP Amber | 1.60 | 1.90 | 2.40 | 100 | 300 |
| HSMF-C163 | 10 mA | AlInGaP Red | 1.60 | 1.80 | 2.40 | 100 | 300 |
| | | InGaN Green | 2.90 | 3.40 | 3.70 | 100 | 500 |
| HSMF-C164 | 10 mA | AlInGaP Red | 1.60 | 1.80 | 2.40 | 100 | 300 |
| | | InGaN Blue | 2.90 | 3.40 | 3.70 | 100 | 500 |
| HSMF-C165 | 20 mA | AlInGaP Red | 1.60 | 1.95 | 2.60 | 100 | 325 |
| | | AlInGaP Green | 1.60 | 2.20 | 2.60 | 100 | 325 |
| HSMF-C166 | 20 mA | AlInGaP Yellow | 1.60 | 2.10 | 2.60 | 100 | 325 |
| | | AlInGaP Green | 1.60 | 2.20 | 2.60 | 100 | 325 |
| HSMF-C167 | 20 mA | AlInGaP Orange | 1.60 | 2.20 | 2.60 | 100 | 325 |
| | | AlInGaP Green | 1.60 | 2.20 | 2.60 | 100 | 325 |
| HSMF-C169 | 10 mA | AlInGaP Amber | 1.60 | 1.90 | 2.40 | 100 | 300 |
| | | InGaN Blue | 2.90 | 3.40 | 3.70 | 100 | 500 |

a. Forward voltage tolerance is ±0.1V.

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

c. Thermal resistance from LED junction to solder point.

# Optical Characteristics ($T_A$ = 25°C)

| Part Number | Test Current | Color | Luminous Intensity, $I_V$ [a] (mcd) | | Dominant Wavelength, $\lambda_d$ [b] (nm) | Peak Wavelength, $\lambda_p$ (nm) | Viewing Angle $2\theta_{1/2}$ [c] (Degrees) |
|---|---|---|---|---|---|---|---|
| | | | Minimum | Typical | Typical | Typical | Typical |
| HSMF-C162 | 20 mA | AlInGaP Red | 28.5 | 90.0 | 626 | 637 | 120 |
| | | AlInGaP Amber | 28.5 | 90.0 | 592 | 595 | 120 |
| HSMF-C163 | 10 mA | AlInGaP Red | 11.2 | 35.0 | 626 | 637 | 120 |
| | | InGaN Green | 18.0 | 45.0 | 525 | 523 | 120 |
| HSMF-C164 | 10 mA | AlInGaP Red | 11.2 | 35.0 | 626 | 637 | 120 |
| | | InGaN Blue | 2.80 | 10.0 | 470 | 468 | 120 |
| HSMF-C165 | 20 mA | AlInGaP Red | 2.80 | 10.0 | 621 | 636 | 120 |
| | | AlInGaP Green | 4.50 | 15.0 | 572 | 570 | 120 |
| HSMF-C166 | 20 mA | AlInGaP Yellow | 2.80 | 8.0 | 586 | 589 | 120 |
| | | AlInGaP Green | 4.50 | 15.0 | 572 | 570 | 120 |
| HSMF-C167 | 20 mA | AlInGaP Orange | 2.80 | 8.0 | 604 | 605 | 120 |
| | | AlInGaP Green | 4.50 | 15.0 | 572 | 570 | 120 |
| HSMF-C169 | 10 mA | AlInGaP Amber | 28.5 | 90.0 | 592 | 595 | 120 |
| | | InGaN Blue | 2.80 | 10.0 | 470 | 468 | 120 |

a. The luminous intensity, $I_V$, is measured at the mechanical axis of the package, and it is tested with a single current pulse condition. The actual peak of the spatial radiation pattern may not be aligned with the axis.

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

c. $\theta_{1/2}$ is the off-axis angle where the luminous intensity is one half the peak intensity.

# Color Bin Limits[1]

## Green Color Bins

| Bin ID | Dominant Wavelength (nm) | |
|---|---|---|
| | Minimum | Maximum |
| A | 561.5 | 564.5 |
| B | 564.5 | 567.5 |
| C | 567.5 | 570.5 |
| D | 570.5 | 573.5 |
| E | 573.5 | 576.5 |

Tolerance: ±0.5 nm.

1. Bin categories are established for classification of products. Products may not be available in all categories. Contact your Broadcom representative for information on current available bins.

## InGaN Blue Color Bins

| Bin ID | Dominant Wavelength (nm) | |
|---|---|---|
| | Minimum | Maximum |
| A | 460.0 | 465.0 |
| B | 465.0 | 470.0 |
| C | 470.0 | 475.0 |
| D | 475.0 | 480.0 |

Tolerance: ±1 nm.

## Orange Color Bins

| Bin ID | Dominant Wavelength (nm) | |
|---|---|---|
| | Minimum | Maximum |
| 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 |
| F | 612.0 | 615.0 |

Tolerance: ±1 nm.

## Amber/Yellow Color Bins

| Bin ID | Dominant Wavelength (nm) | |
|---|---|---|
| | Minimum | Maximum |
| 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 |

Tolerance: ±0.5 nm.

## Red Color Bins

| Bin ID | Dominant Wavelength (nm) | |
|---|---|---|
| | Minimum | Maximum |
| – | 620.0 | 635.0 |

Tolerance: ±1 nm

## InGaN Green Color Bins

| Bin ID | Dominant Wavelength (nm) | |
|---|---|---|
| | Minimum | Maximum |
| A | 515.0 | 520.0 |
| B | 520.0 | 525.0 |
| C | 525.0 | 530.0 |
| D | 530.0 | 535.0 |

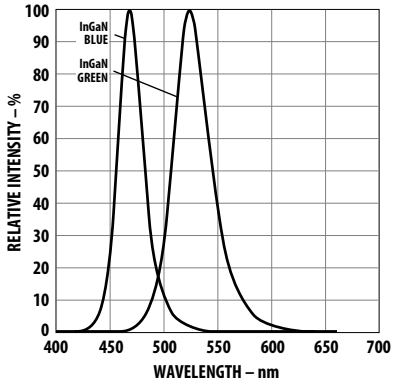
Tolerance: ±1 nm.

## Light Intensity ($I_V$) Bin Limits

| Bin ID | Intensity (mcd) | |
|---|---|---|
| | Minimum | Maximum |
| A | 0.11 | 0.18 |
| B | 0.18 | 0.29 |
| C | 0.29 | 0.45 |
| D | 0.45 | 0.72 |
| E | 0.72 | 1.10 |
| F | 1.10 | 1.80 |
| G | 1.80 | 2.80 |
| H | 2.80 | 4.50 |
| J | 4.50 | 7.20 |
| K | 7.20 | 11.20 |
| L | 11.20 | 18.00 |
| M | 18.00 | 28.50 |
| N | 28.50 | 45.00 |
| P | 45.00 | 71.50 |
| Q | 71.50 | 112.50 |
| R | 112.50 | 180.00 |
| S | 180.00 | 285.00 |
| T | 285.00 | 450.00 |
| U | 450.00 | 715.00 |
| V | 715.00 | 1125.00 |
| W | 1125.00 | 1800.00 |
| X | 1800.00 | 2850.00 |
| Y | 2850.00 | 4500.00 |

Tolerance: ±15%.

**Figure 1: Relative Intensity versus Wavelength**



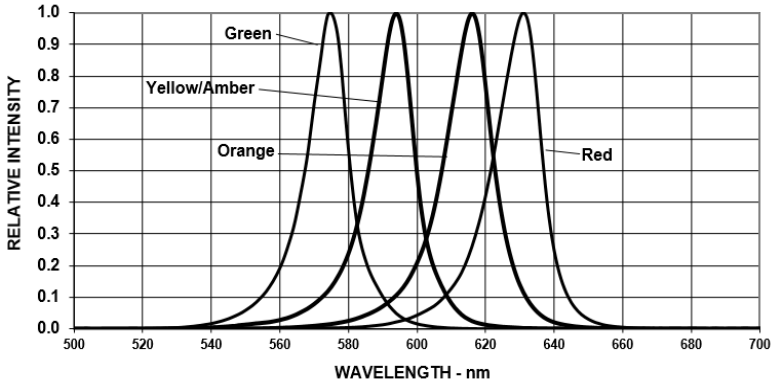
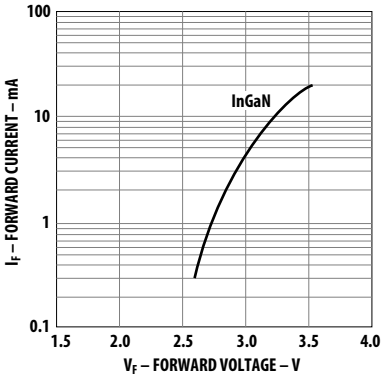




**Figure 2: Forward Current versus Forward Voltage**



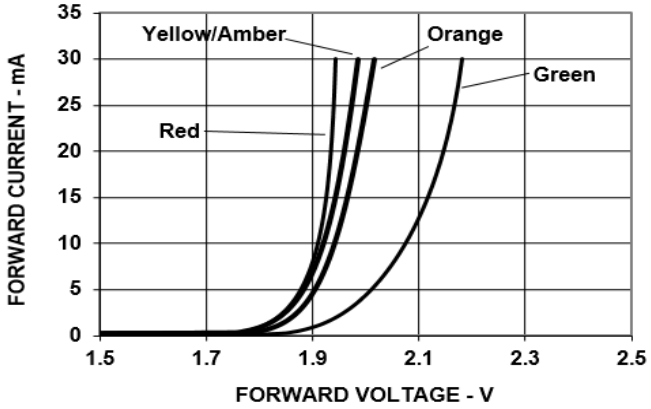
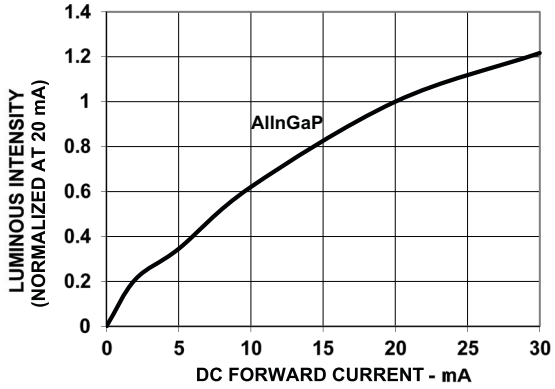




**Figure 3: Luminous Intensity versus Forward Current**



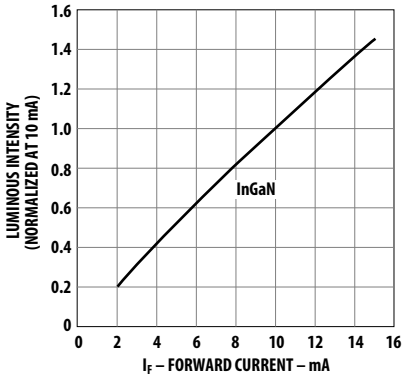



**Figure 4: Maximum Forward Current versus Ambient Temperature**

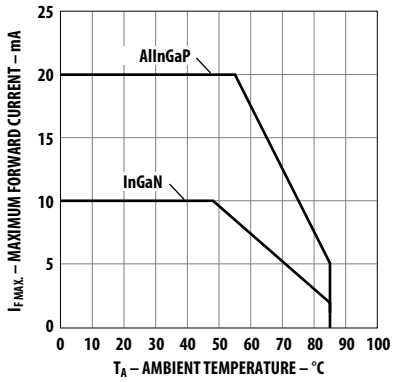



**Figure 5: Relative Intensity versus Angle**

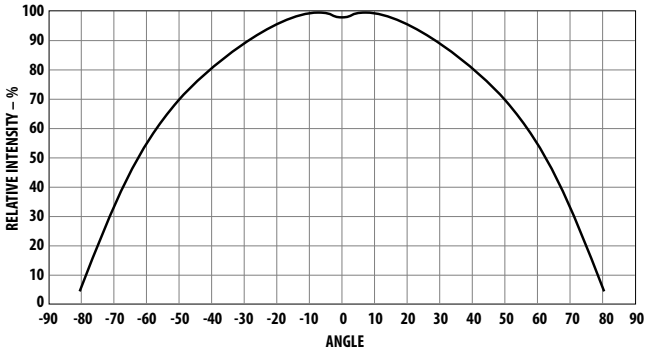



**Figure 6: Recommended Reflow Soldering Profile**

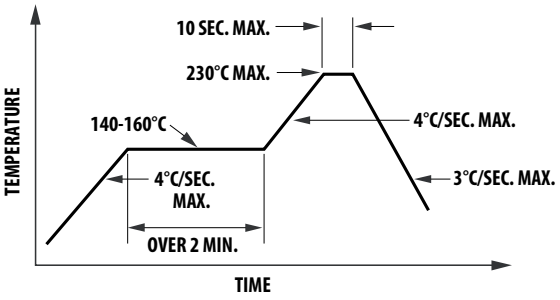



**Figure 7: Recommended Pb-free Reflow Soldering Profile**

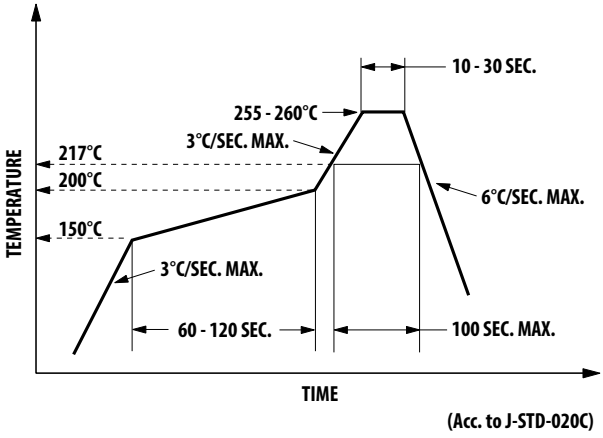
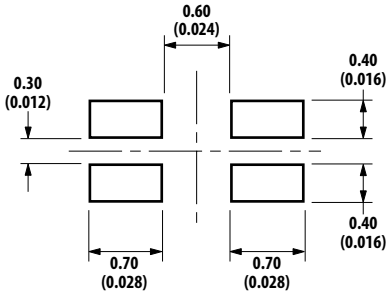



**Figure 8: Recommended Solder Pad Pattern**




**NOTE:** All dimensions are in millimeters (inches).

**Figure 9: Reeling Orientation**

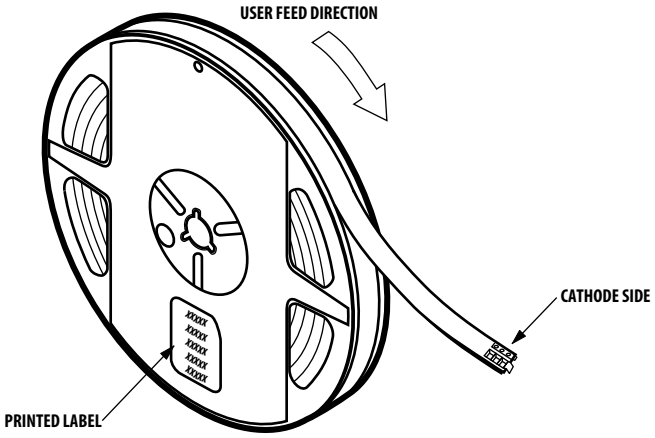
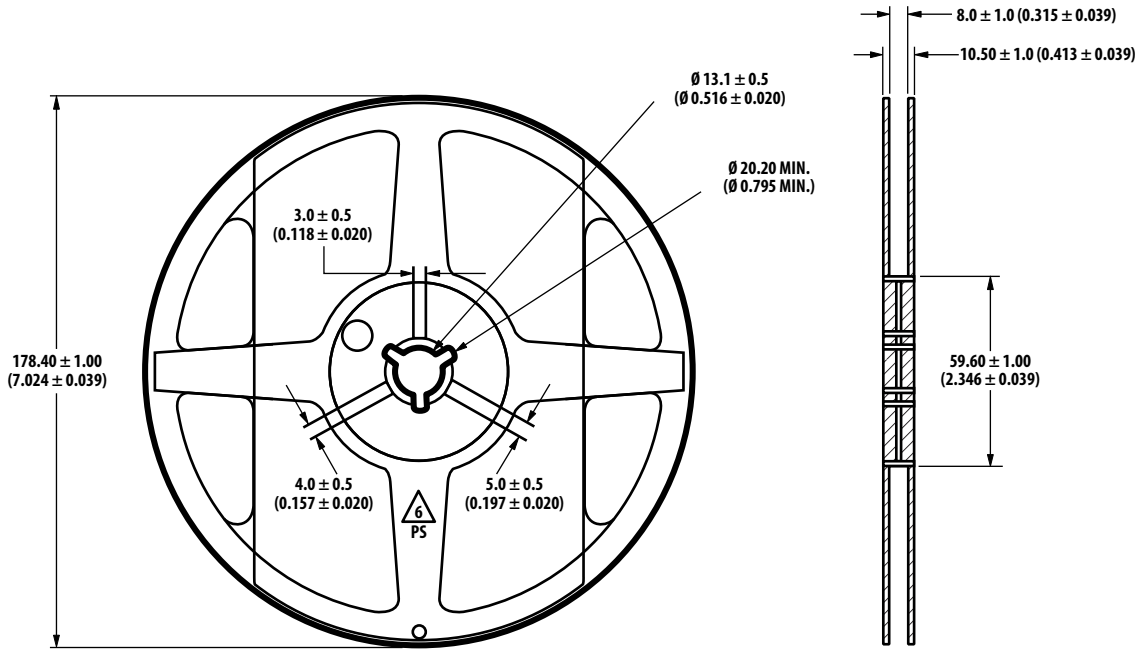



**Figure 10: Reel Dimensions**




**NOTE:** All dimensions are in millimeters (inches).

**Figure 11: Tape Dimensions**

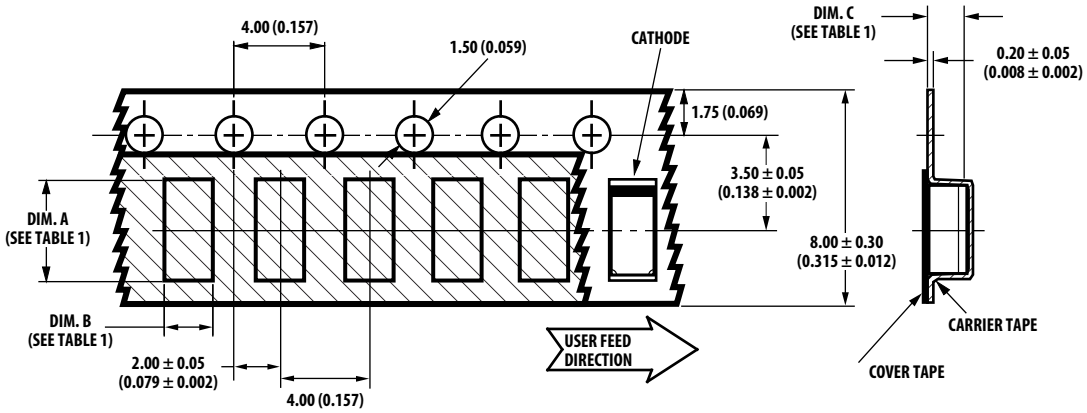
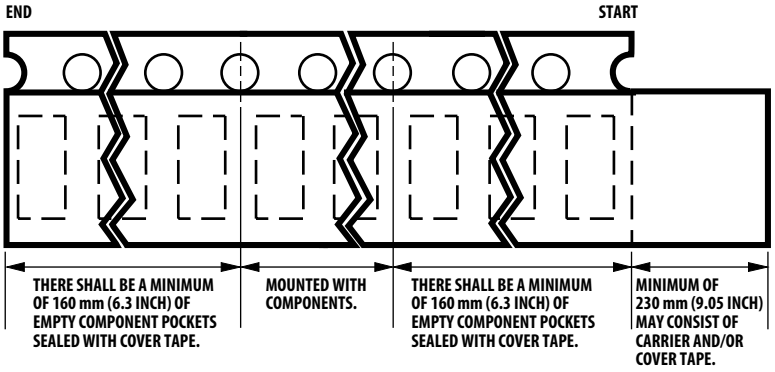



TABLE 1
DIMENSIONS IN MILLIMETERS (INCHES)

| PART NUMBER | DIM. A ± 0.10 (± 0.004) | DIM. B ± 0.10 (± 0.004) | DIM. C ± 0.10 (± 0.004) |
|---|---|---|---|
| HSMF-C16x | 1.75 (0.069) | 0.95 (0.037) | 0.60 (0.024) |

**Figure 12: Tape Leader and Trailer Dimensions**



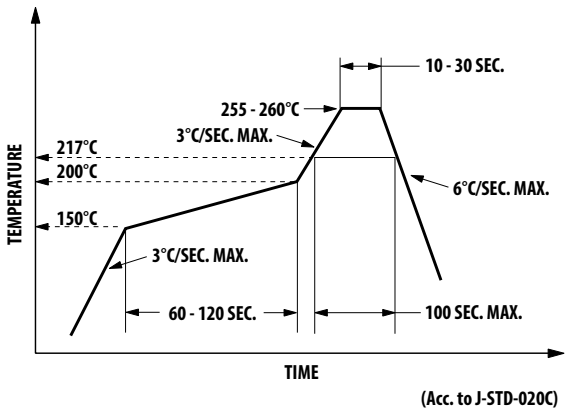

**NOTE:** All dimensions are in millimeters (inches).
Tolerance is ±0.1 mm (±0.004 in.) unless otherwise specified.

# 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 = 310°C maximum.
  - Soldering duration = 2 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**




## Handling Precautions

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, 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 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 672 hours.

**Baking is required if the following conditions exist:**

- 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 LEDs' floor life exceeded 672 hours.

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

Baking can only be done once.

## 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 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 can 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.
- If the LED is intended to be used along with LEDs of other colors to achieve color mixing, Broadcom does not guarantee the consistency of the resultant color. Contact your Broadcom sales representative for these applications.
- 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 temperatures, 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, 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.