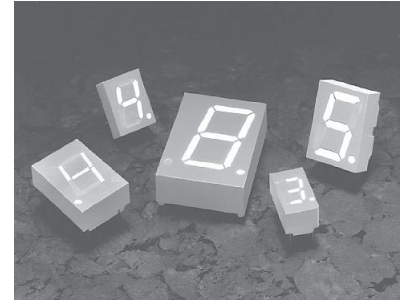


HDSP-335x, HDSP-555x, HDSP-751x, HDSP-A10x, HDSP-A80x, HDSP-A90x, HDSP-E10x, HDSP-F10x, HDSP-H10x, HDSP-K12x, HDSP-N10x Series

Low-Current Seven-Segment Displays



Description

This Broadcom[®] family of low-current seven-segment displays is designed for applications requiring low power consumption. They are tested and selected for their excellent low-current characteristics to ensure that the segments are matched at low currents. Drive currents as low as 1 mA per segment are available.

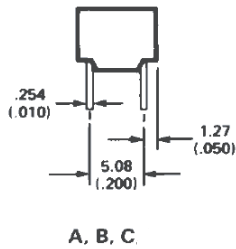
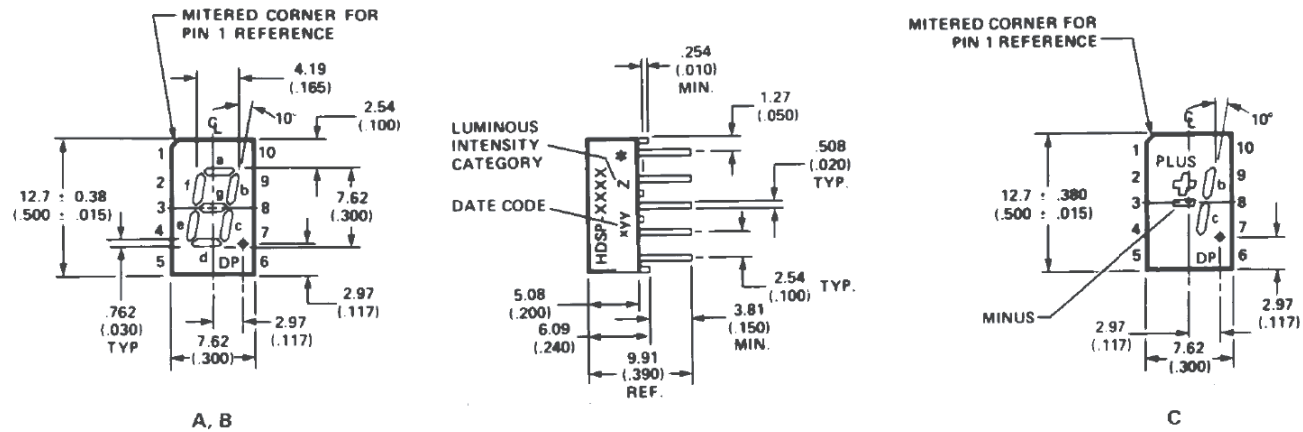
Pin-for-pin equivalent displays are also available in a standard current or high light ambient design. The standard current displays are available in all colors and are ideal for most applications. The high light ambient displays are ideal for sunlight ambients or long string lengths. For additional information, see the 7.6-mm Micro Bright Seven-Segment Displays, 10-mm Seven-Segment Displays, 7.6-mm/10.9-mm Seven-Segment Displays, 14.2-mm Seven-Segment Displays (AV02-1107EN), 20-mm Seven-Segment Displays, or High Light Ambient Seven-Segment Displays data sheets.

Features

- Low power consumption
- Industry-standard size
- Industry-standard pinout
- Choice of character size: 7.6 mm (0.30 in), 10 mm (0.40 in), 10.9 mm (0.43 in), 14.2 mm (0.56 in), 20 mm (0.80 in)
- Choice of colors: AllnGaP deep red, AllnGaP red, AllnGaP yellow, AllnGaP green
- Excellent appearance
 - Evenly lighted segments
 - $\pm 50^\circ$ viewing angle
- Design flexibility
 - Common anode or common cathode
 - Single and dual digits
 - Left-hand and right-hand decimal points
 - ± 1 right-hand decimal overflow character
- Categorized for luminous intensity
 - Yellow and green categorized for color
 - Use of like categories yields a uniform display
- Excellent for long digit string multiplexing

Package Drawings

Figure 1: Package Dimensions, A to C



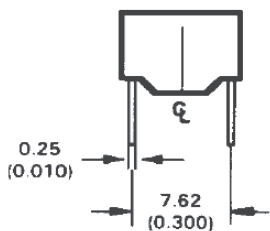
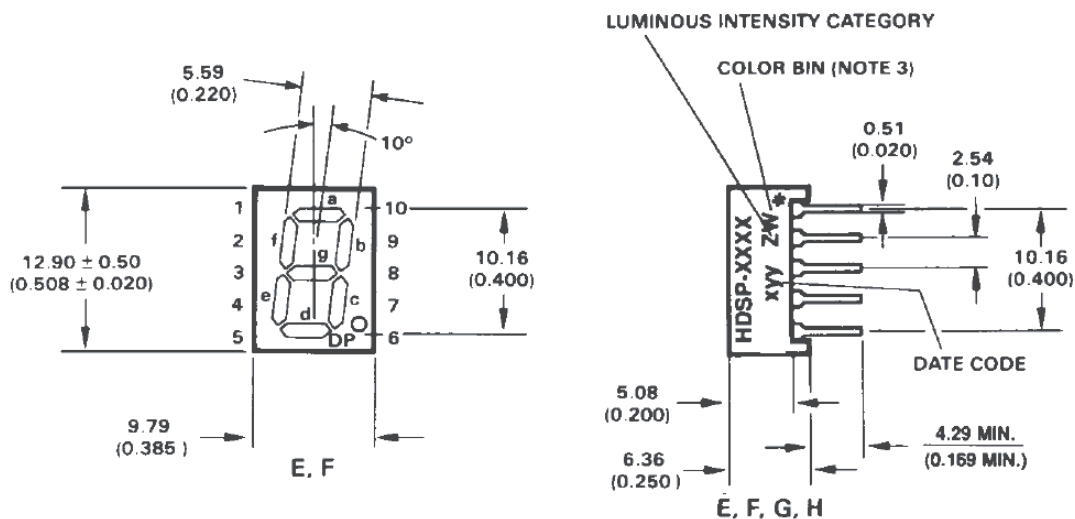
* Side View of package indicates Country of Origin

| Pin | FUNCTION | | |
|-----|----------------------|------------------------|----------------------|
| | A | B | C |
| 1 | ANODE ^[3] | CATHODE ^[4] | ANODE ^[3] |
| 2 | CATHODE f | ANODE f | CATHODE PLUS |
| 3 | CATHODE g | ANODE g | CATHODE MINUS |
| 4 | CATHODE e | ANODE e | NC |
| 5 | CATHODE d | ANODE d | NC |
| 6 | ANODE ^[3] | CATHODE ^[4] | ANODE ^[3] |
| 7 | CATHODE DP | ANODE DP | CATHODE DP |
| 8 | CATHODE c | ANODE c | CATHODE c |
| 9 | CATHODE b | ANODE b | CATHODE b |
| 10 | CATHODE a | ANODE a | NC |

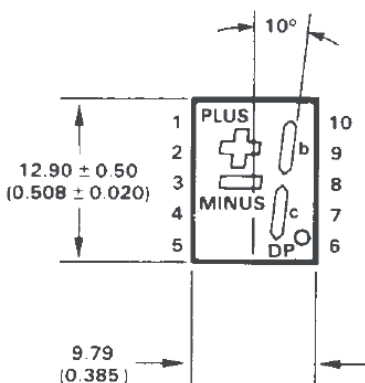
Notes:

1. All dimensions in millimeters (inches).
2. All untoleranced dimensions are for reference only.
3. Redundant anodes.
4. Redundant cathodes.

Figure 2: Package Dimensions, E to H



E, F, G, H



G, H

* Side View of package indicates Country of Origin

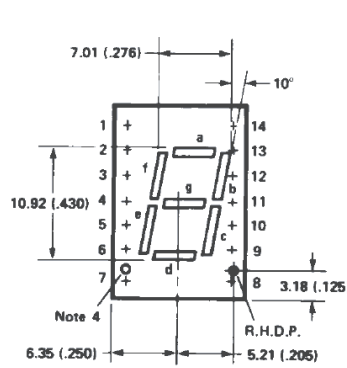
| Pin | FUNCTION | | | |
|-----|----------------------|------------------------|----------------------|------------------------|
| | E | F | G | H |
| 1 | ANODE ^[3] | CATHODE ^[4] | ANODE ^[3] | CATHODE ^[4] |
| 2 | CATHODE f | ANODE f | CATHODE PLUS | ANODE PLUS |
| 3 | CATHODE g | ANODE g | CATHODE MINUS | ANODE MINUS |
| 4 | CATHODE e | ANODE e | NC | NC |
| 5 | CATHODE d | ANODE d | NC | NC |
| 6 | ANODE ^[3] | CATHODE ^[4] | ANODE ^[3] | CATHODE ^[4] |
| 7 | CATHODE DP | ANODE DP | CATHODE DP | ANODE DP |
| 8 | CATHODE c | ANODE c | CATHODE c | ANODE c |
| 9 | CATHODE b | ANODE b | CATHODE b | ANODE b |
| 10 | CATHODE a | ANODE a | NC | NC |

Notes:

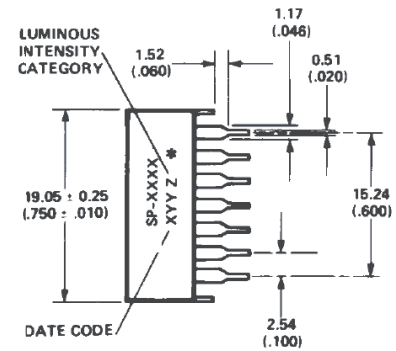
1. All dimensions in millimeters (inches).
2. All untoleranced dimensions are for reference only.
3. Redundant anodes.
4. Redundant cathodes.

Figure 3: Package Dimensions, J to K

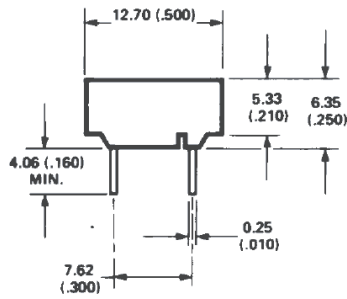
| Pin | FUNCTION | |
|-----|--------------|--------------|
| | J | K |
| 1 | CATHODE a | ANODE a |
| 2 | CATHODE f | ANODE f |
| 3 | ANODE [3] | CATHODE [6] |
| 4 | NO PIN | NO PIN |
| 5 | NO PIN | NO PIN |
| 6 | NO CONN. [5] | NO CONN. [5] |
| 7 | CATHODE e | ANODE e |
| 8 | CATHODE d | ANODE d |
| 9 | CATHODE dp | ANODE dp |
| 10 | CATHODE c | ANODE c |
| 11 | CATHODE g | ANODE g |
| 12 | NO PIN | NO PIN |
| 13 | CATHODE b | ANODE b |
| 14 | ANODE [3] | CATHODE [6] |



J, K
 FRONT VIEW



SIDE VIEW

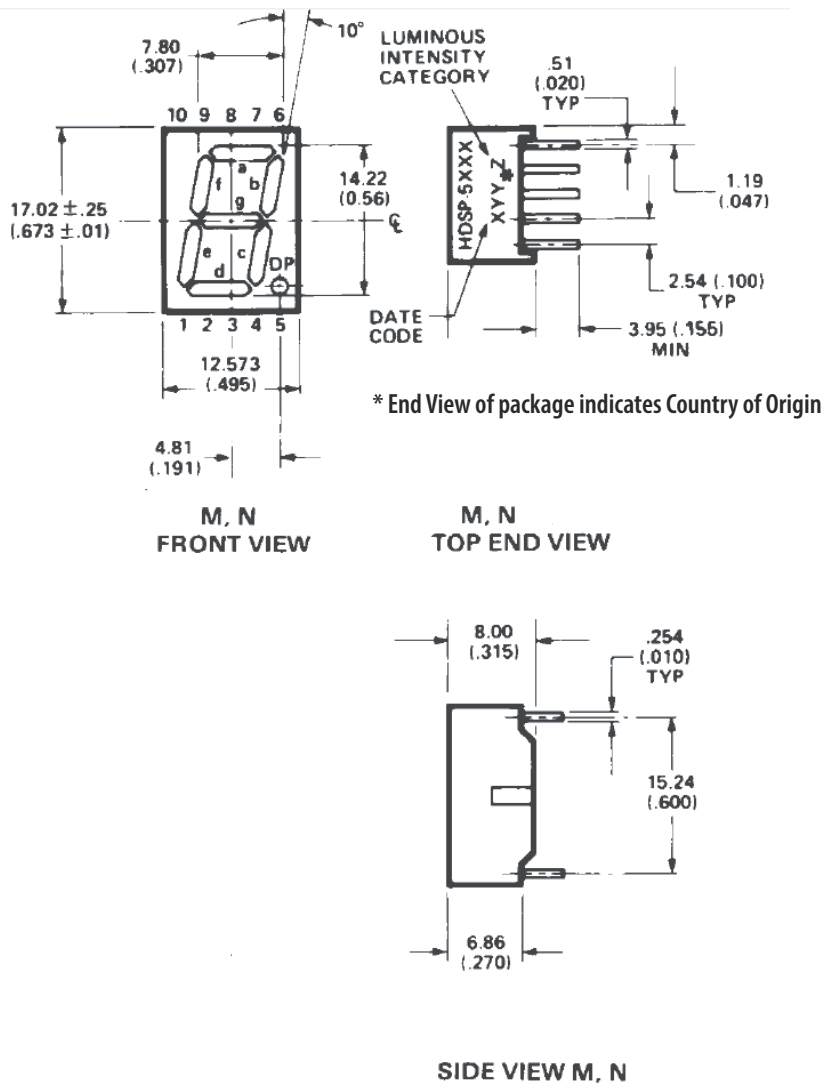


*Side View of package indicates Country of Origin

Notes:

1. All dimensions in millimeters (inches).
2. All untoleranced dimensions are for reference only.
3. Redundant anodes.
4. Unused dp position.
5. See internal circuit diagram.
6. Redundant cathodes.
7. See part number table for L.H.D.P. and R.H.D.P. designation.

Figure 4: Package Dimensions, M to N

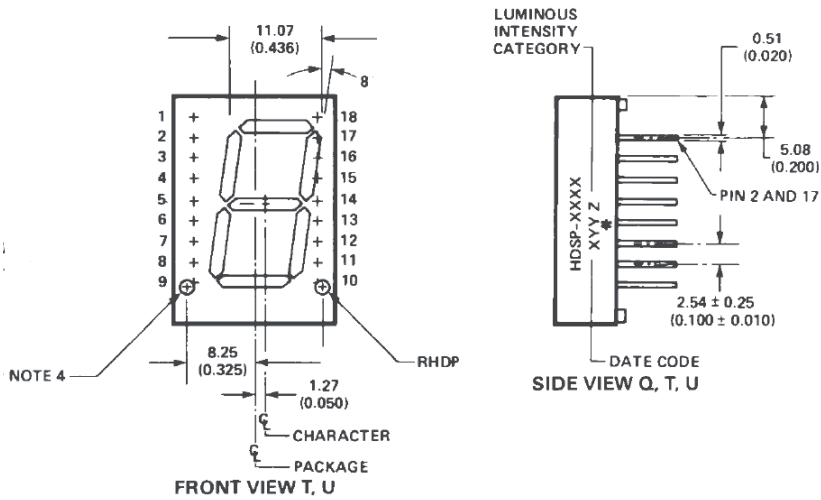


| Pin | FUNCTION | |
|-----|----------------------|------------------------|
| | M | N |
| 1 | CATHODE e | ANODE e |
| 2 | CATHODE d | ANODE d |
| 3 | ANODE ^[3] | CATHODE ^[4] |
| 4 | CATHODE c | ANODE c |
| 5 | CATHODE DP | ANODE DP |
| 6 | CATHODE b | ANODE b |
| 7 | CATHODE a | ANODE a |
| 8 | ANODE ^[3] | CATHODE ^[4] |
| 9 | CATHODE f | ANODE f |
| 10 | CATHODE g | ANODE g |

Notes:

1. All dimensions in millimeters (inches).
2. All untoleranced dimensions are for reference only.
3. Redundant anodes.
4. Redundant cathodes.

Figure 5: Package Dimensions, T to U



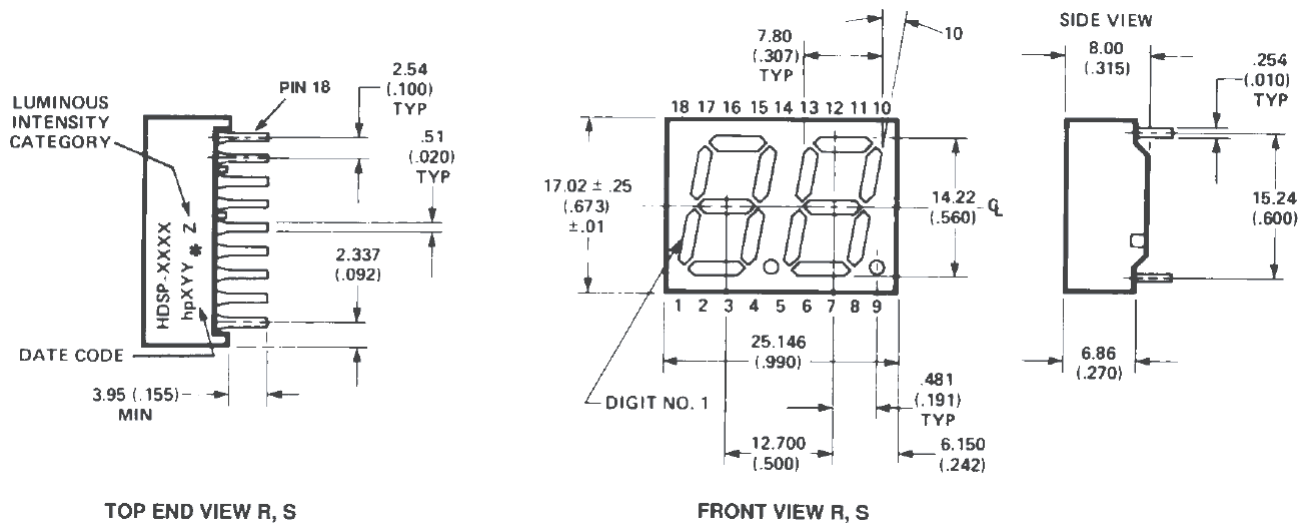
* The Side View of package indicates Country of Origin

| Pin | FUNCTION | |
|-----|----------------------|------------------------|
| | T | U |
| 1 | NO PIN | NO PIN |
| 2 | CATHODE a | ANODE a |
| 3 | CATHODE f | ANODE f |
| 4 | ANODE ^[3] | CATHODE ^[6] |
| 5 | CATHODE e | ANODE e |
| 6 | ANODE ^[3] | CATHODE ^[6] |
| 7 | NO CONNECT | NO CONNECT |
| 8 | NO PIN | NO PIN |
| 9 | NO PIN | NO PIN |
| 10 | CATHODE dp | ANODE dp |
| 11 | CATHODE d | ANODE d |
| 12 | ANODE ^[3] | CATHODE ^[6] |
| 13 | CATHODE c | ANODE c |
| 14 | CATHODE g | ANODE g |
| 15 | CATHODE b | ANODE b |
| 16 | NO PIN | NO PIN |
| 17 | ANODE ^[3] | CATHODE ^[6] |
| 18 | NO PIN | NO PIN |

Notes:

1. All dimensions in millimeters (inches).
2. All untoleranced dimensions are for reference only.
3. Redundant anodes.
4. Unused dp position.
5. See internal circuit diagram.
6. Redundant cathodes.

Figure 6: Package Dimensions, R to S



* The Side View of package indicates Country of Origin

| Pin | FUNCTION | |
|-----|-------------------|---------------------|
| | R | S |
| 1 | E CATHODE NO. 1 | E ANODE NO. 1 |
| 2 | D CATHODE NO. 1 | D ANODE NO. 1 |
| 3 | C CATHODE NO. 1 | C ANODE NO. 1 |
| 4 | DP CATHODE NO. 1 | DP ANODE NO. 1 |
| 5 | E CATHODE NO. 2 | E ANODE NO. 2 |
| 6 | D CATHODE NO. 2 | D ANODE NO. 2 |
| 7 | G CATHODE NO. 2 | G ANODE NO. 2 |
| 8 | C CATHODE NO. 2 | C ANODE NO. 2 |
| 9 | DP CATHODE NO. 2 | DP ANODE NO. 2 |
| 10 | B CATHODE NO. 2 | B ANODE NO. 2 |
| 11 | A CATHODE NO. 2 | A ANODE NO. 2 |
| 12 | F CATHODE NO. 2 | F ANODE NO. 2 |
| 13 | DIGIT NO. 2 ANODE | DIGIT NO. 2 CATHODE |
| 14 | DIGIT NO. 1 ANODE | DIGIT NO. 1 CATHODE |
| 15 | B CATHODE NO. 1 | B ANODE NO. 1 |
| 16 | A CATHODE NO. 1 | A ANODE NO. 1 |
| 17 | G CATHODE NO. 1 | G ANODE NO. 1 |
| 18 | F CATHODE NO. 1 | F ANODE NO. 1 |

Notes:

1. All dimensions in millimeters (inches).
2. All untoleranced dimensions are for reference only.
3. Where applicable.

Internal Circuit Diagram

Figure 7: Internal Circuit Diagram

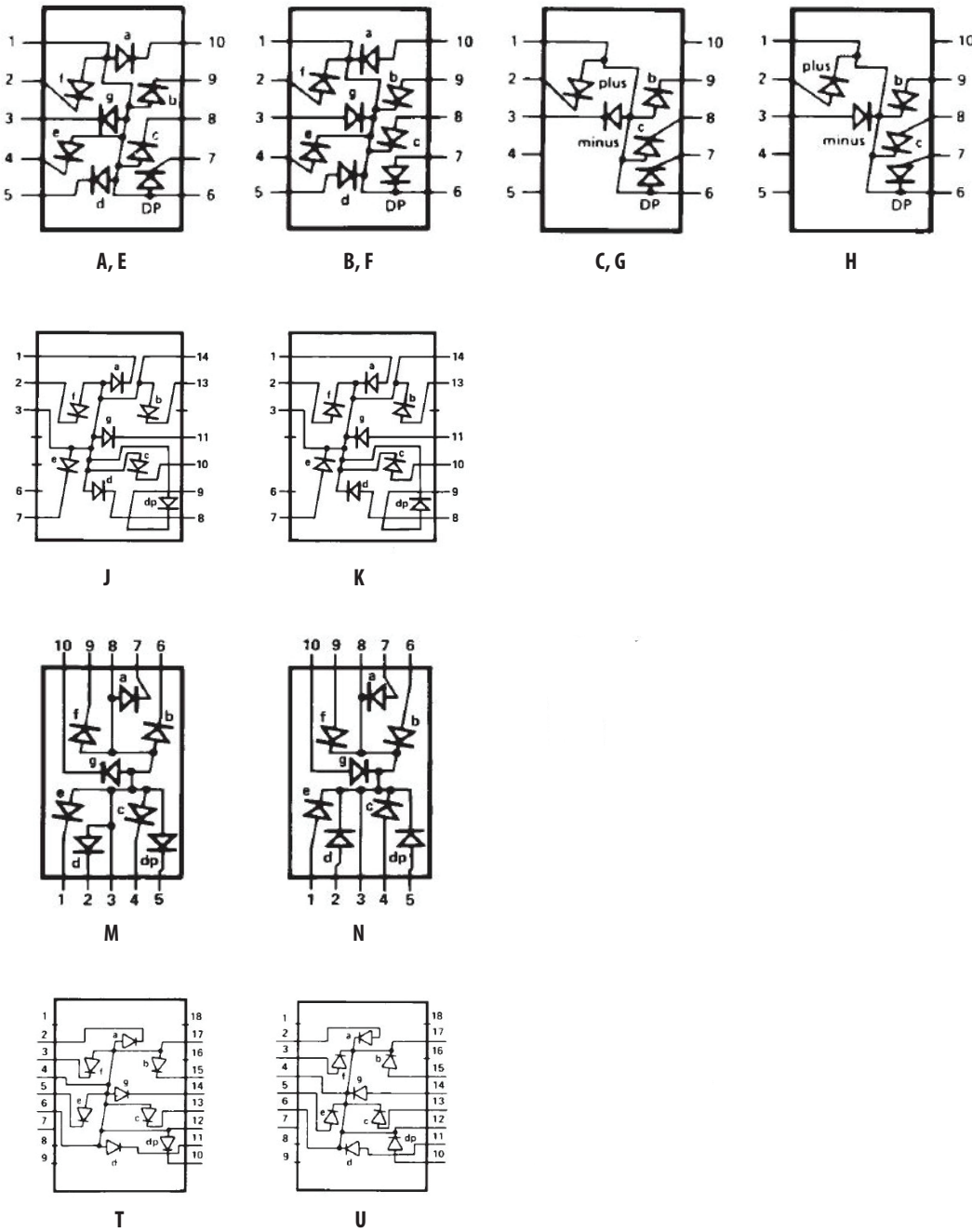
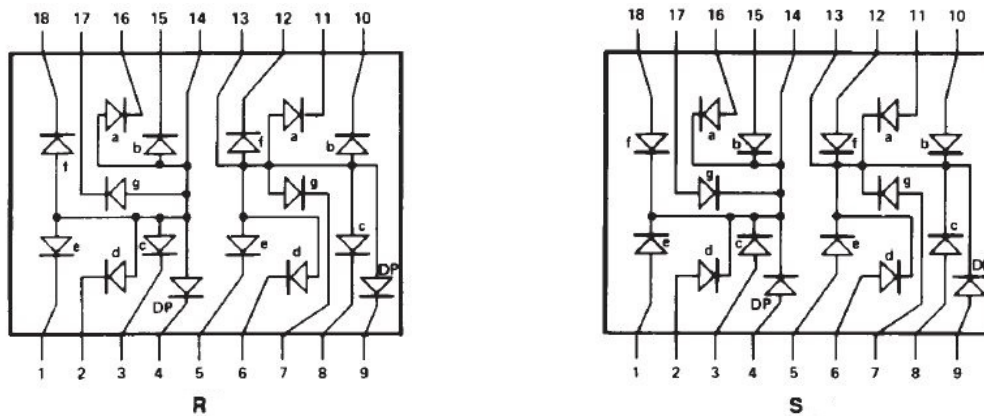


Figure 8: Internal Circuit Diagram, R to S



Device Selection Guide

| AllnGaP Deep Red | AllnGaP Red | AllnGaP Yellow | AllnGaP Green | Description | Package Drawing |
|------------------|-------------|----------------|---------------|--|-----------------|
| HDSP-A101 | HDSP-7511 | HDSP-A801 | HDSP-A901 | 7.6-mm Common Anode Right-Hand Decimal | A |
| HDSP-A103 | HDSP-7513 | HDSP-A803 | HDSP-A903 | 7.6-mm Common Cathode Right-Hand Decimal | B |
| HDSP-A107 | HDSP-7517 | | | 7.6-mm Common Anode ± 1 Right-Hand Decimal Overflow | C |
| HDSP-F101 | | | | 10-mm Common Anode Right-Hand Decimal | E |
| HDSP-F103 | | | | 10-mm Common Cathode Right-Hand Decimal | F |
| HDSP-F107 | | | | 10-mm Common Anode ± 1 Right-Hand Decimal Overflow | G |
| HDSP-F108 | | | | 10-mm Common Cathode ± 1 Right-Hand Decimal Overflow | H |
| HDSP-E101 | HDSP-3351 | | | 10.9-mm Common Anode Right-Hand Decimal | J |
| HDSP-E103 | HDSP-3353 | | | 10.9-mm Common Cathode Right-Hand Decimal | K |
| HDSP-H101 | HDSP-5551 | | | 14.2-mm Common Anode Right-Hand Decimal | M |
| HDSP-H103 | HDSP-5553 | | | 14.2-mm Common Cathode Right-Hand Decimal | N |
| HDSP-K121 | | | | 14.2-mm Two Digit Common Anode Right-Hand Decimal | R |
| HDSP-K123 | | | | 14.2-mm Two Digit Common Cathode Right-Hand Decimal | S |
| HDSP-N101 | | | | 20-mm Common Anode Right-Hand Decimal | T |
| HDSP-N103 | | | | 20-mm Common Cathode Right-Hand Decimal | U |

Absolute Maximum Ratings

| Parameter | Deep Red HDSP-A10x/E10x/ H10x/K12x/N10x/ F10x Series | Red HDSP-751x/ 335x/555x Series | Yellow HDSP-A80x Series | Green HDSP-A90x Series | Unit |
|--|---|--|-------------------------------|------------------------------|------|
| Power Dissipation per Segment or DP | 37.5 | 37.5 | 37.5 | 37.5 | mW |
| Peak Forward Current per Segment or DP ^a | 90 | 90 | 60 | 90 | mA |
| DC Forward Current per Segment or DP ^b | 15 | 15 | 15 | 15 | mA |
| Operating Temperature Range | -20 to +100 | -40 to +100 | -40 to +100 | -40 to +100 | °C |
| Storage Temperature Range | -55 to +100 | | | | °C |
| Reverse Voltage per Segment or DP ^c | 3.0 | | | | V |
| Wave Soldering Temperature for 3 Seconds (1.60 mm [0.063 in.] below seating body) | 250 | | | | °C |

a. Duty factor = 10%, frequency = 1 kHz, $T_A = 25^\circ\text{C}$.

b. Derate linearly as shown in [Figure 12](#) (deep red), [Figure 16](#) (red), [Figure 20](#) (green), and [Figure 24](#) (yellow).

c. Reverse voltage is for LED testing purposes and not recommended to be used as an application condition.

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

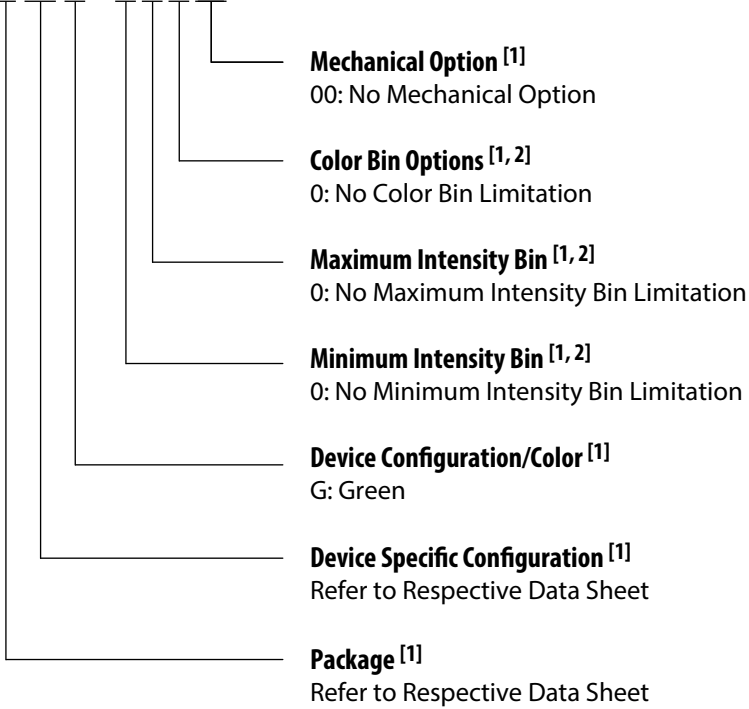
| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions |
|---|-------------|-------|-------|------|------|-------------------------|
| Deep Red, Device Series HDSP-A10x/E10x/H10x/K12x/N10x/F10x | | | | | | |
| Luminous Intensity/Segment (Digital Average) ^{a, b} | I_V | | | | mcd | $I_F = 1 \text{ mA}$ |
| HDSP-A10x | | 0.315 | 0.900 | — | | |
| HDSP-F10x | | 0.330 | 1.200 | — | | |
| HDSP-E10x | | 0.390 | 1.100 | — | | |
| HDSP-H10x, HDSP-K12x | | 0.400 | 1.150 | — | | |
| HDSP-N10x | | 0.270 | 1.100 | — | | |
| Forward Voltage/Segment or DP ^c | V_F | — | 2.1 | 2.5 | V | $I_F = 20 \text{ mA}$ |
| Peak Wavelength | λ_p | — | 656 | — | nm | |
| Dominant Wavelength ^d | λ_d | — | 639 | — | nm | |
| Reverse Voltage/Segment or DP ^e | V_R | 3.0 | — | — | V | $I_R = 100 \mu\text{A}$ |
| Red, Device Series HDSP-751x/335x/555x | | | | | | |
| Luminous Intensity/Segment (Digital Average) ^{a, b} | I_V | | | | mcd | |
| HDSP-751x | | 0.315 | 1.800 | — | | $I_F = 2 \text{ mA}$ |
| HDSP-335x | | 0.391 | 2.000 | — | | $I_F = 2 \text{ mA}$ |
| HDSP-555x | | 0.415 | 2.200 | — | | $I_F = 2 \text{ mA}$ |
| Forward Voltage/Segment or DP ^c | V_F | — | 2.05 | 2.5 | V | $I_F = 20 \text{ mA}$ |
| Peak Wavelength | λ_p | — | 631 | — | nm | |
| Dominant Wavelength ^d | λ_d | — | 622 | — | nm | |
| Reverse Voltage/Segment or DP ^e | V_R | 3.0 | — | — | V | $I_R = 100 \mu\text{A}$ |

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions |
|--|-------------|-------|------|-------|------|-------------------------|
| Yellow, Device Series HDSP-A80x | | | | | | |
| Luminous Intensity/Segment (Digital Average) ^{a, b} | I_V | 0.625 | 2.60 | — | mcd | $I_F = 4 \text{ mA}$ |
| Forward Voltage/Segment or DP ^c | V_F | — | 2.0 | 2.5 | V | $I_F = 20 \text{ mA}$ |
| Peak Wavelength | λ_p | — | 591 | — | nm | |
| Dominant Wavelength ^d | λ_d | 581.5 | 588 | 592.5 | nm | |
| Reverse Voltage/Segment or DP ^e | V_R | 3.0 | — | — | V | $I_R = 100 \mu\text{A}$ |
| High Performance Green, Device Series HDSP-A90x | | | | | | |
| Luminous Intensity/Segment (Digital Average) ^{a, b} | I_V | 0.425 | 2.60 | — | mcd | $I_F = 4 \text{ mA}$ |
| Forward Voltage/Segment or DP ^c | V_F | — | 2.1 | 2.5 | V | $I_F = 20 \text{ mA}$ |
| Peak Wavelength | λ_p | — | 572 | — | nm | |
| Dominant Wavelength ^d | λ_d | — | 571 | 577 | nm | |
| Reverse Voltage/Segment or DP ^e | V_R | 3.0 | — | — | 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. Forward voltage tolerance is $\pm 0.1\text{V}$.
- d. The dominant wavelength, λ_d , is derived from the CIE Chromaticity Diagram and represents the color of the device.
- e. Typical specification for reference only. Do not exceed absolute maximum ratings, and long-term reverse bias is not recommended.

Part Numbering System

5082 - X XX X - X X X XX
HDSP - X XX X - X X X XX



1. For codes not listed in the figure, refer to the respective data sheet or contact your nearest Broadcom representative for details.
2. Bin options refer to shippable bins for a part number. Color and Intensity Bins are typically restricted to 1 bin per tube (exceptions may apply). Refer to respective data sheet for specific bin limit information.

Intensity Bin Limits (mcd)

Deep Red

Table 1: HDSP-A10x Series

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| E | 0.315 | 0.520 |
| F | 0.428 | 0.759 |
| G | 0.621 | 1.16 |
| H | 0.945 | 1.71 |
| I | 1.40 | 2.56 |
| J | 2.10 | 3.84 |
| K | 3.14 | 5.75 |
| L | 4.70 | 8.55 |

Table 2: HDSP-E10x/HDSP-F10x Series

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| D | 0.391 | 0.650 |
| E | 0.532 | 0.923 |
| F | 0.755 | 1.39 |
| G | 1.13 | 2.08 |
| H | 1.70 | 3.14 |

Table 3: HDSP-H10x/HDSP-K12x Series

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| C | 0.415 | 0.690 |
| D | 0.565 | 0.990 |
| E | 0.810 | 1.50 |
| F | 1.20 | 2.20 |
| G | 1.80 | 3.30 |
| H | 2.73 | 5.00 |
| I | 4.09 | 7.50 |

Table 4: HDSP-N10x Series

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| A | 0.270 | 0.400 |
| B | 0.325 | 0.500 |
| C | 0.415 | 0.690 |
| D | 0.565 | 0.990 |
| E | 0.810 | 1.50 |
| F | 1.20 | 2.20 |
| G | 1.80 | 3.30 |
| H | 2.73 | 5.00 |
| I | 4.09 | 7.50 |

Red

Table 5: HDSP-751x Series

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| E | 0.315 | 0.520 |
| F | 0.428 | 0.759 |
| G | 0.621 | 1.16 |
| H | 0.95 | 1.75 |
| I | 1.43 | 2.64 |
| J | 2.16 | 3.97 |

Table 6: HDSP-335x Series

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| D | 0.391 | 0.650 |
| E | 0.532 | 0.923 |
| F | 0.755 | 1.39 |
| G | 1.13 | 2.08 |
| H | 1.70 | 3.14 |
| I | 2.57 | 4.70 |

Table 7: HDSP-555x

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| C | 0.415 | 0.690 |
| D | 0.565 | 0.990 |
| E | 0.810 | 1.50 |
| F | 1.20 | 2.20 |
| G | 1.80 | 3.30 |
| H | 2.73 | 5.00 |
| I | 4.09 | 7.50 |

Yellow

Table 8: HDSP-A80x

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| D | 0.250 | 0.385 |
| E | 0.315 | 0.520 |
| F | 0.425 | 0.760 |
| G | 0.625 | 1.14 |
| H | 0.940 | 1.70 |
| I | 1.40 | 2.56 |
| J | 2.10 | 3.84 |
| K | 3.14 | 5.76 |
| L | 4.71 | 8.64 |
| M | 7.07 | 13.00 |
| N | 10.60 | 19.40 |
| O | 15.90 | 29.20 |
| P | 23.90 | 43.80 |
| Q | 35.80 | 65.60 |

Green

Table 9: HDSP-A90x

| IV Bin Category | Min. | Max. |
|-----------------|-------|-------|
| E | 0.315 | 0.520 |
| F | 0.425 | 0.760 |
| G | 0.625 | 1.14 |
| H | 0.940 | 1.70 |
| I | 1.40 | 2.56 |
| J | 2.10 | 3.84 |
| K | 3.14 | 5.76 |
| L | 4.71 | 8.64 |
| M | 7.07 | 13.00 |
| N | 10.60 | 19.40 |
| O | 15.90 | 29.20 |
| P | 23.90 | 43.80 |
| Q | 35.80 | 65.60 |

Color Categories

| Color | Bin | Dominant Wavelength (nm) | |
|--------|-----|--------------------------|--------|
| | | Min. | Max. |
| Yellow | 1 | 581.50 | 585.00 |
| | 3 | 584.00 | 587.50 |
| | 2 | 586.50 | 590.00 |
| | 4 | 589.00 | 592.50 |
| Green | 2 | 573.00 | 577.00 |
| | 3 | 570.00 | 574.00 |
| | 4 | 567.00 | 571.00 |
| | 5 | 564.00 | 568.00 |

NOTE: All categories are established for classification of products. Products may not be available in all categories. Contact your Broadcom representatives for further clarification or information.

Deep Red Graphs

Figure 9: Relative Intensity vs. Wavelength

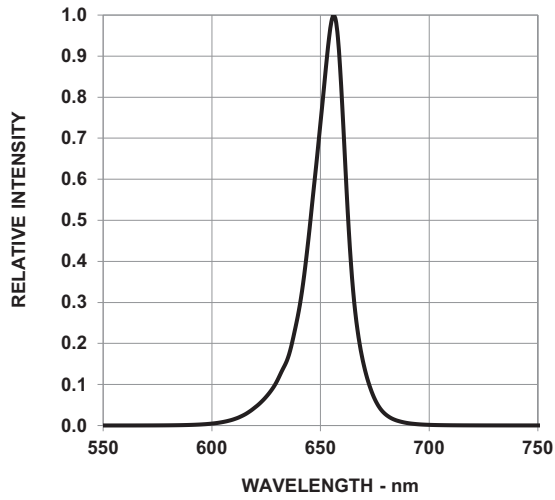


Figure 10: Forward Current vs. Forward Voltage

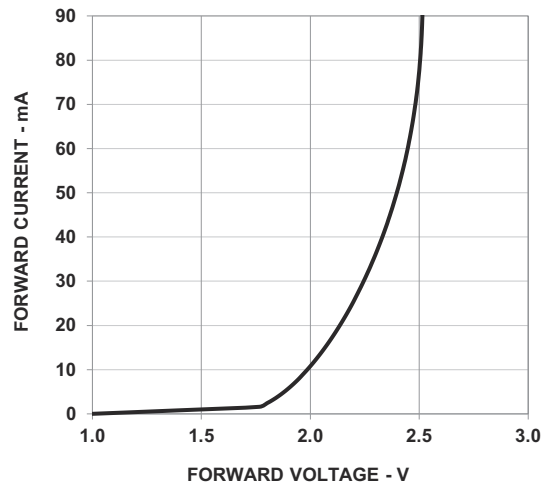


Figure 11: Relative Luminous Intensity vs. Forward Current

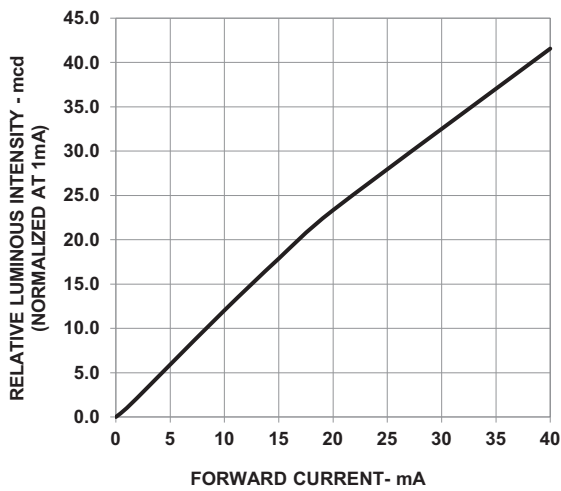
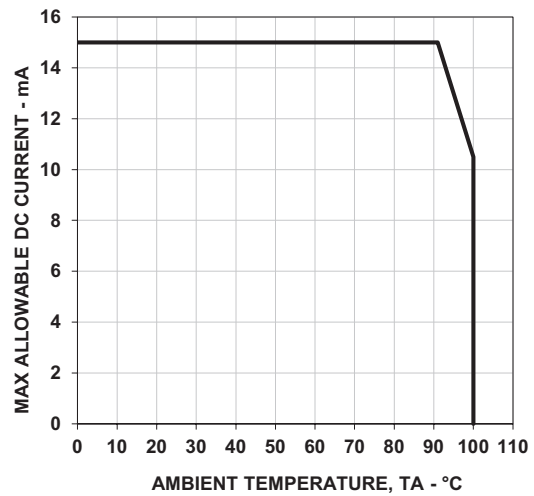


Figure 12: Maximum Forward Current vs. Ambient Temperature



Red Graphs

Figure 13: Relative Intensity vs. Wavelength

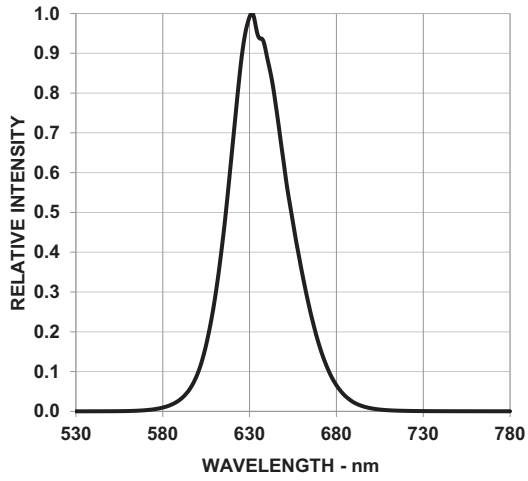


Figure 14: Forward Current vs. Forward Voltage

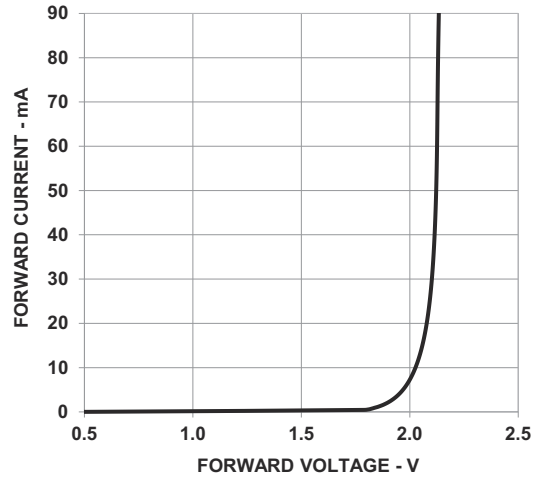


Figure 15: Relative Luminous Intensity vs. Forward Current

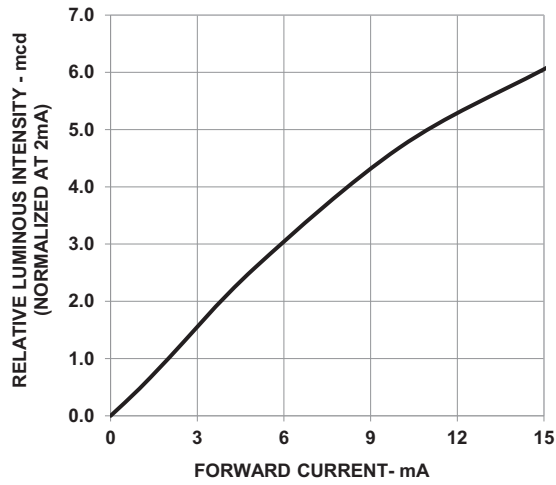
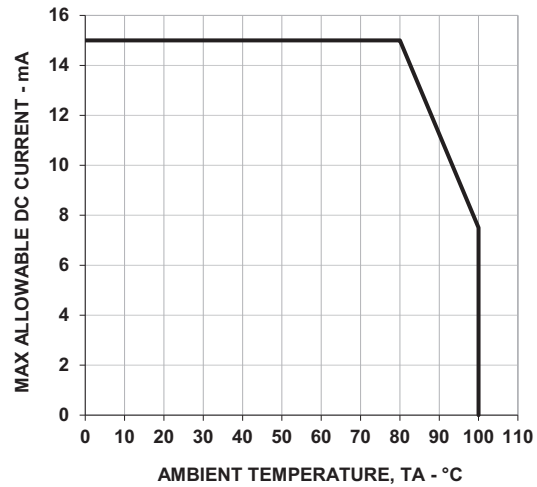


Figure 16: Maximum Forward Current vs. Ambient Temperature



Green Graphs

Figure 17: Relative Intensity vs. Wavelength

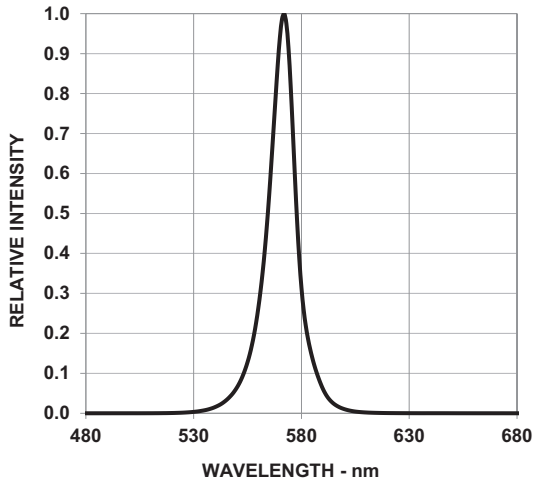


Figure 18: Forward Current vs. Forward Voltage

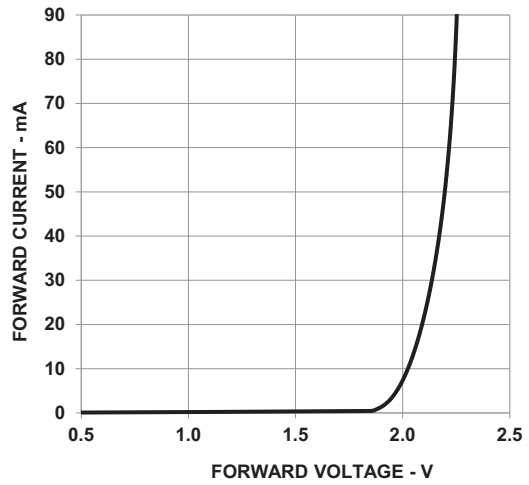


Figure 19: Relative Luminous Intensity vs. Forward Current

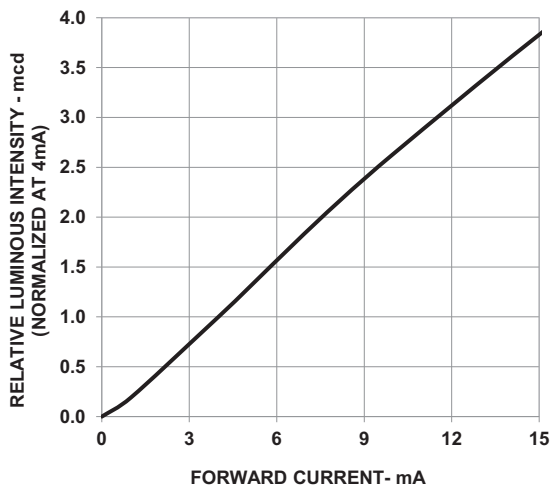
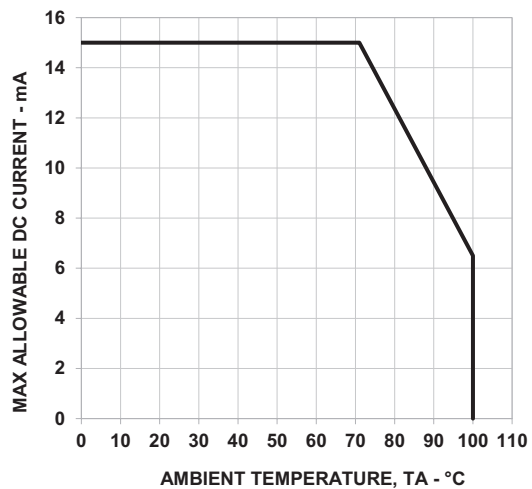


Figure 20: Maximum Forward Current vs. Ambient Temperature



Yellow Graphs

Figure 21: Relative Intensity vs. Wavelength

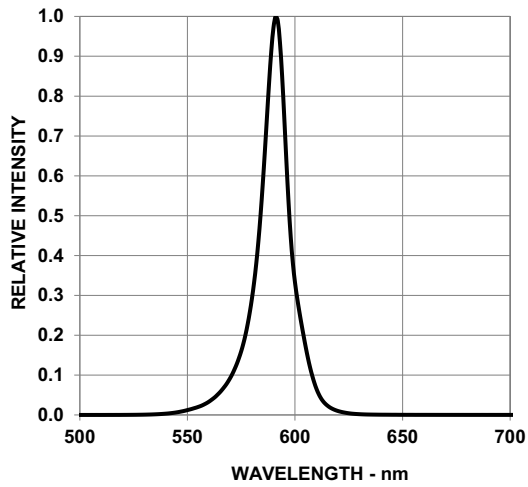


Figure 22: Forward Current vs. Forward Voltage

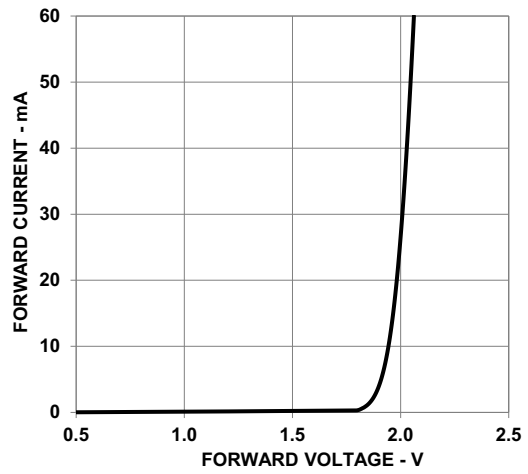


Figure 23: Relative Luminous Intensity vs. Forward Current

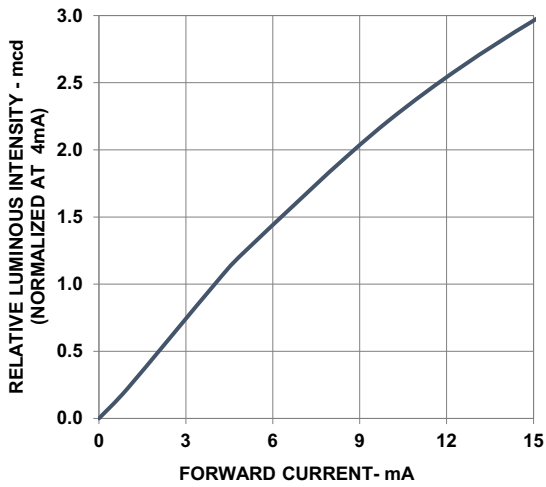
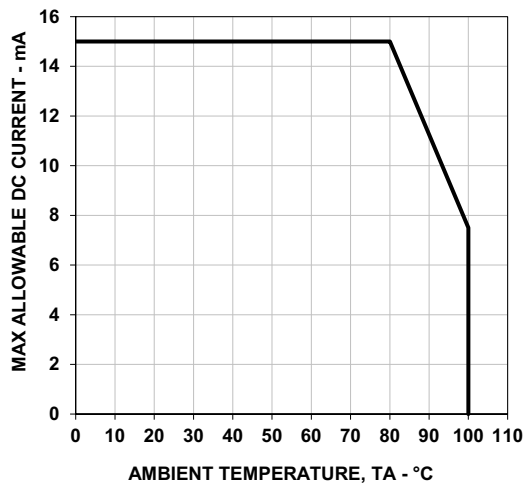


Figure 24: Maximum Forward Current vs. Ambient Temperature



Precautionary Notes

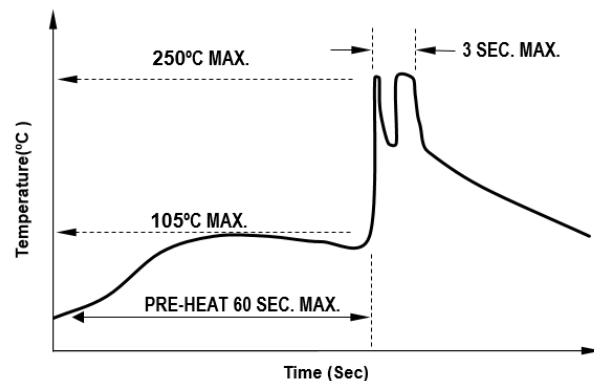
Soldering and Handling Precautions

- 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 is always conforming 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 a PCB. PCBs with different sizes and designs (component density) will have different heat capacities 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.
- Any alignment fixture used during wave soldering must be loosely fitted and must not apply stress on the LEDs. Use non-metal material because it will absorb 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 is 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.
- 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) are not recommended for cleaning the LED displays. All of these various solvents attack or dissolve the encapsulating epoxies used to form the package of plastic LED parts.

- For the purpose of cleaning, wash with DI water only. The cleaning process should take place at room temperature only. Clear any water or moisture from the LED display immediately after washing.
- Use of *No clean* solder paste is recommended for soldering.

Figure 25: Recommended Wave Soldering Profile



NOTE: Figure 25 refers to measurements with thermocouple mounted at the bottom of the PCB.

Application Precautions

- The drive current of the LED must not exceed the maximum allowable limit across temperatures 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 (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 change 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 outdoor environment, protect the LED against damages caused by rain, water, dust, oil, corrosive gases, external mechanical stresses, and so on.

Eye Safety Precautions

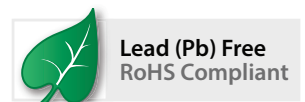
LEDs may pose optical hazards when in operation. Do not look directly at operating LEDs because it might be harmful to the eyes. For safety reasons, use appropriate shielding or personal protective equipment.

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