

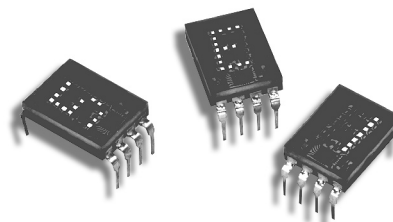
# HDSP-076x Series

Hexadecimal and Numeric Displays  
for Industrial Applications



## Data Sheet

HDSP-076x Series, HDSP-077x Series  
HDSP-086x Series, HDSP-096x Series



### Description

These solid state display devices are designed and tested for use in adverse industrial environments. The character height is 7.4 mm (0.29 inch). The numeric and hexadecimal devices incorporate an on-board IC that contains the data memory, decoder and display driver functions.

The numeric devices decode positive BCD logic into characters "0-9", a "-" sign, decimal point, and a test pattern. The hexadecimal devices decode positive BCD logic into 16 characters, "0-9, A-F". An input is provided on the hexadecimal devices to blank the display (all LEDs off) without losing the contents of the memory.

The over range device displays " $\pm 1$ " and right hand decimal point and is typically driven via external switching transistors.

### Features

- Three colors: High-efficiency red  
Yellow  
High performance green
- Two high-efficiency red options
  - Low power
  - High brightness
- Three character options
  - Numeric
  - Hexadecimal
  - Over range
- Performance guaranteed over temperature
- Memory latch/decoder/driver: TTL compatible
- 4 x 7 dot matrix character
- Categorized for luminous intensity
- Yellow and green categorized for color

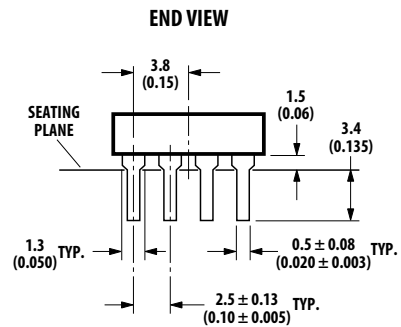
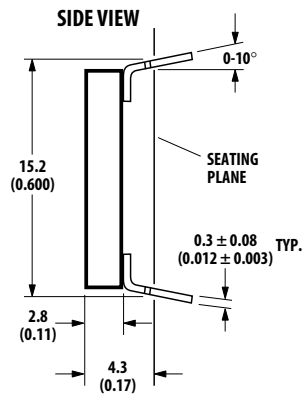
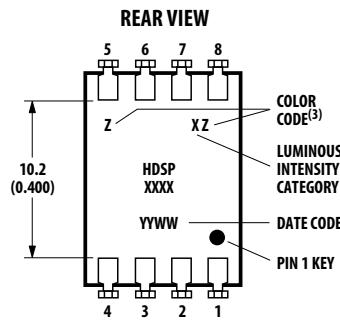
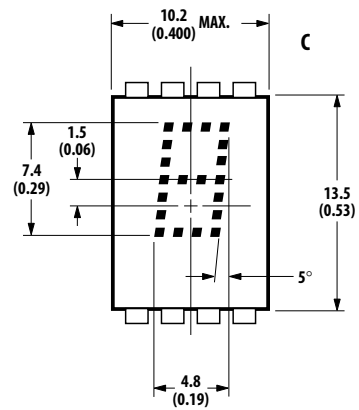
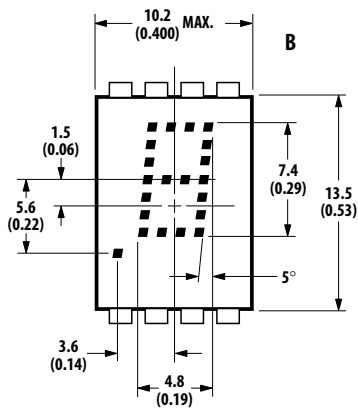
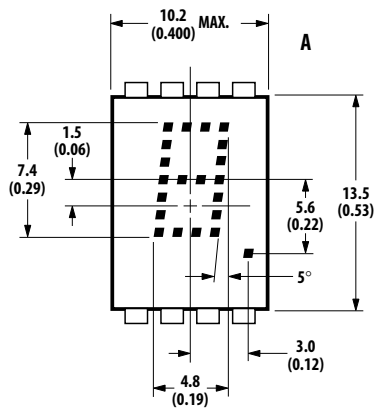
### Device Selection Guide

| Part Number | Color           | Description            | Front View |
|-------------|-----------------|------------------------|------------|
| 0760        | High-Efficiency | Numeric, Right Hand DP | A          |
| 0761        | Red             | Numeric, Left Hand DP  | B          |
| 0762        | Low Power       | Hexadecimal            | C          |
| 0763        |                 | Over Range $\pm 1$     | D          |
| 0770        | High-Efficiency | Numeric, Right Hand DP | A          |
| 0771        | Red             | Numeric, Left Hand DP  | B          |
| 0772        | High Brightness | Hexadecimal            | C          |
| 0860        | Yellow          | Numeric, Right Hand DP | A          |
| 0861        |                 | Numeric, Left Hand DP  | B          |
| 0862        |                 | Hexadecimal            | C          |
| 0863        |                 | Over Range $\pm 1$     | D          |
| 0960        | Green           | Numeric, Right Hand DP | A          |
| 0961        |                 | Numeric, Left Hand DP  | B          |
| 0962        |                 | Hexadecimal            | C          |
| 0963        |                 | Over Range $\pm 1$     | D          |

### Typical Applications

- Industrial equipment
- Computer peripherals
- Instrumentation
- Telecommunication equipment

## Package Dimensions



| PIN | FUNCTION        |                  |
|-----|-----------------|------------------|
|     | NUMERIC         | HEXADECIMAL      |
| 1   | Input 2         | Input 2          |
| 2   | Input 4         | Input 4          |
| 3   | Input 8         | Input 8          |
| 4   | Decimal Point   | Blanking Control |
| 5   | Latch Enable    | Latch Enable     |
| 6   | Ground          | Ground           |
| 7   | V <sub>CC</sub> | V <sub>CC</sub>  |
| 8   | Input 1         | Input 1          |

### NOTES:

1. DIMENSIONS IN MILLIMETERS AND (INCHES).
2. DIGIT CENTER LINE IS  $\pm 0.38$  mm ( $\pm 0.015$  INCH) FROM PACKAGE CENTER LINE.
3. UNLESS OTHERWISE SPECIFIED, THE TOLERANCE ON ALL DIMENSIONS IS  $\pm 0.38$  mm ( $\pm 0.015$  INCH).
4. HDSP-0860 AND HDSP-0960 SERIES.

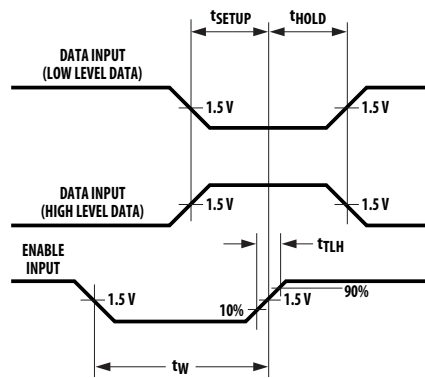


Figure 1. Timing diagram.

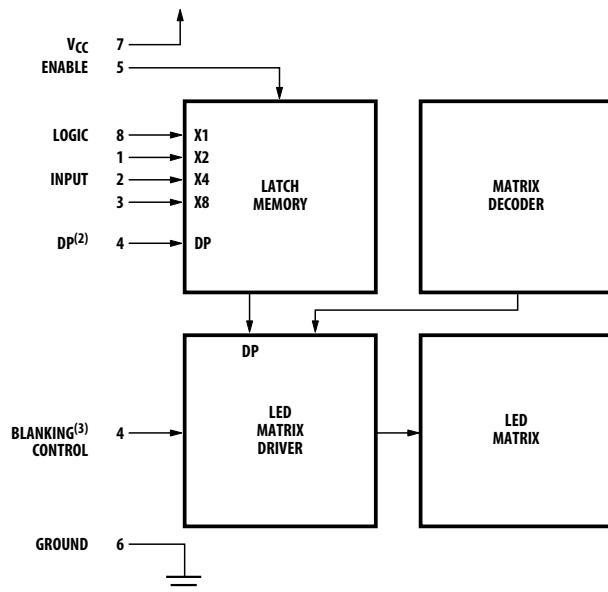


Figure 2. Logic block diagram.

| TRUTH TABLE                |                |                |                |             |                     |
|----------------------------|----------------|----------------|----------------|-------------|---------------------|
| BCD DATA <sup>[1]</sup>    |                |                |                | NUMERIC     | HEXADECIMAL         |
| X <sub>8</sub>             | X <sub>4</sub> | X <sub>2</sub> | X <sub>1</sub> |             |                     |
| L                          | L              | L              | L              | 0           | 0                   |
| L                          | L              | L              | H              | 1           | 1                   |
| L                          | L              | H              | L              | 2           | 2                   |
| L                          | L              | H              | H              | 3           | 3                   |
| L                          | H              | L              | L              | 4           | 4                   |
| L                          | H              | L              | H              | 5           | 5                   |
| L                          | H              | H              | L              | 6           | 6                   |
| L                          | H              | H              | H              | 7           | 7                   |
| H                          | L              | L              | L              | 8           | 8                   |
| H                          | L              | L              | H              | 9           | 9                   |
| H                          | L              | H              | L              | A           | A                   |
| H                          | L              | H              | H              | (BLANK)     | B                   |
| H                          | H              | L              | L              | (BLANK)     | C                   |
| H                          | H              | L              | H              | ...         | D                   |
| H                          | H              | H              | L              | (BLANK)     | E                   |
| H                          | H              | H              | H              | (BLANK)     | F                   |
| DECIMAL PT. <sup>[2]</sup> |                |                |                | ON          | V <sub>DP</sub> = L |
|                            |                |                |                | OFF         | V <sub>DP</sub> = H |
| ENABLE <sup>[1]</sup>      |                |                |                | LOAD DATA   | V <sub>E</sub> = L  |
|                            |                |                |                | LATCH DATA  | V <sub>E</sub> = H  |
| BLANKING <sup>[3]</sup>    |                |                |                | DISPLAY-ON  | V <sub>B</sub> = L  |
|                            |                |                |                | DISPLAY-OFF | V <sub>B</sub> = H  |

NOTES:

1. H = LOGIC HIGH; L = LOGIC LOW. WITH THE ENABLE INPUT AT LOGIC HIGH, CHANGES IN BCD INPUT LOGIC LEVELS HAVE NO EFFECT UPON DISPLAY MEMORY, DISPLAYED CHARACTER, OR DP.
2. THE DECIMAL POINT INPUT, DP, PERTAINS ONLY TO THE NUMERIC DISPLAYS.
3. THE BLANKING CONTROL INPUT, B, PERTAINS ONLY TO THE HEXADECIMAL DISPLAYS. BLANKING INPUT HAS NO EFFECT UPON DISPLAY MEMORY.

## Absolute Maximum Ratings

| Description                                             | Symbol                                            | Min. | Max.            | Unit |
|---------------------------------------------------------|---------------------------------------------------|------|-----------------|------|
| Storage Temperature, Ambient                            | T <sub>S</sub>                                    | -65  | +100            | °C   |
| Operating Temperature, Ambient <sup>[1]</sup>           | T <sub>A</sub>                                    | -55  | +85             | °C   |
| Supply Voltage <sup>[2]</sup>                           | V <sub>CC</sub>                                   | -0.5 | +7.0            | V    |
| Voltage Applied to Input Logic, dp and Enable Pins      | V <sub>I</sub> , V <sub>DP</sub> , V <sub>E</sub> | -0.5 | V <sub>CC</sub> | V    |
| Voltage Applied to Blanking Input <sup>[2]</sup>        | V <sub>B</sub>                                    | -0.5 | V <sub>CC</sub> | V    |
| Soldering Temperature [1.59 mm (0.063 inch) Below Body] |                                                   |      |                 |      |
| Solder Dipping, max. 5 Seconds                          |                                                   |      | 260             | °C   |
| Wave Soldering, max. 3 Seconds                          |                                                   |      | 250             | °C   |

## Recommended Operating Conditions

| Description                                                      | Symbol             | Min. | Nom. | Max. | Unit |
|------------------------------------------------------------------|--------------------|------|------|------|------|
| Supply Voltage <sup>[2]</sup>                                    | V <sub>CC</sub>    | 4.5  | 5.0  | 5.5  | V    |
| Operating Temperature, Ambient <sup>[1]</sup>                    | T <sub>A</sub>     | -55  |      | +85  | °C   |
| Enable Pulse Width                                               | t <sub>W</sub>     | 100  |      |      | nsec |
| Time Data Must Be Held Before Positive Transition of Enable Line | t <sub>SETUP</sub> | 50   |      |      | nsec |
| Time Data Must Be Held After Positive Transition of Enable Line  | t <sub>HOLD</sub>  | 50   |      |      | nsec |
| Enable Pulse Rise Time                                           | t <sub>TLH</sub>   |      |      | 1.0  | msec |

## Optical Characteristics at T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5.0 V

| Device           | Description                                                 | Symbol            | Min. | Typ. | Max. | Unit |
|------------------|-------------------------------------------------------------|-------------------|------|------|------|------|
| HDSP-0760 Series | Luminous Intensity per LED (Digit Average) <sup>[3,4]</sup> | I <sub>V</sub>    | 65   | 140  |      | μcd  |
|                  | Peak Wavelength                                             | λ <sub>PEAK</sub> |      | 635  |      | nm   |
|                  | Dominant Wavelength <sup>[5]</sup>                          | λ <sub>d</sub>    |      | 626  |      | nm   |
| HDSP-0770 Series | Luminous Intensity per LED (Digit Average) <sup>[3,4]</sup> | I <sub>V</sub>    | 260  | 620  |      | μcd  |
|                  | Peak Wavelength                                             | λ <sub>PEAK</sub> |      | 635  |      | nm   |
|                  | Dominant Wavelength <sup>[5]</sup>                          | λ <sub>d</sub>    |      | 626  |      | nm   |
| HDSP-0860 Series | Luminous Intensity per LED (Digit Average) <sup>[3,4]</sup> | I <sub>V</sub>    | 215  | 490  |      | μcd  |
|                  | Peak Wavelength                                             | λ <sub>PEAK</sub> |      | 583  |      | nm   |
|                  | Dominant Wavelength <sup>[5,6]</sup>                        | λ <sub>d</sub>    |      | 585  |      | nm   |
| HDSP-0960 Series | Luminous Intensity per LED (Digit Average) <sup>[3,4]</sup> | I <sub>V</sub>    | 298  | 1100 |      | μcd  |
|                  | Peak Wavelength                                             | λ <sub>PEAK</sub> |      | 568  |      | nm   |
|                  | Dominant Wavelength <sup>[5,6]</sup>                        | λ <sub>d</sub>    |      | 574  |      | nm   |

### Notes:

1. The nominal thermal resistance of a display mounted in a socket that is soldered onto a printed circuit board is R<sub>θJA</sub> = 50°C/W/device. The device package thermal resistance is R<sub>θJ-PIN</sub> = 15°C/W/device. The thermal resistance device pin-to-ambient through the PC board should not exceed 35°C/W/device for operation at T<sub>A</sub> = +85°C.
2. Voltage values are with respect to device ground, pin 6.
3. These displays are categorized for luminous intensity with the intensity category designated by a letter code located on the back of the display package. Case temperature of the device immediately prior to the light measurement is equal to 25°C.

# Electrical Characteristics; T<sub>A</sub> = -55°C to +85°C

| Description                                         | Symbol          | Test Conditions                                                  | Min. | Typ. <sup>[7]</sup> | Max.               | Unit   |
|-----------------------------------------------------|-----------------|------------------------------------------------------------------|------|---------------------|--------------------|--------|
| Supply Current<br>HDSP-0760 Series                  | I <sub>CC</sub> | V <sub>CC</sub> = 5.5 V<br>(Characters "5."<br>or "B" Displayed) |      | 78                  | 105                | mA     |
| HDSP-0770 Series                                    |                 |                                                                  |      | 120                 | 175                |        |
| HDSP-0860 Series                                    |                 |                                                                  |      |                     |                    |        |
| HDSP-0960 Series                                    |                 |                                                                  |      |                     |                    |        |
| Power Dissipation<br>HDSP-0760 Series               | P <sub>T</sub>  |                                                                  |      | 390                 | 573                | mW     |
| HDSP-0770 Series                                    |                 |                                                                  |      | 690                 | 963                |        |
| HDSP-0860 Series                                    |                 |                                                                  |      |                     |                    |        |
| HDSP-0960 Series                                    |                 |                                                                  |      |                     |                    |        |
| Logic, Enable and Blanking Low-Level Input Voltage  | V <sub>IL</sub> | V <sub>CC</sub> = 4.5 V                                          |      |                     | 0.8                | V      |
| Logic, Enable and Blanking High-Level Input Voltage | V <sub>IH</sub> |                                                                  | 2.0  |                     |                    | V      |
| Logic and Enable Low-Level Input Current            | I <sub>IL</sub> | V <sub>CC</sub> = 5.5 V                                          |      |                     | -1.6               | mA     |
| Blanking Low-Level Input Current                    | I <sub>BL</sub> | V <sub>IL</sub> = 0.4 V                                          |      |                     | -10                | μA     |
| Logic, Enable and Blanking High-Level Input Current | I <sub>IH</sub> | V <sub>CC</sub> = 5.5 V<br>V <sub>IH</sub> = 2.4 V               |      |                     | +40                | μA     |
| Weight                                              |                 |                                                                  |      | 1.0                 |                    | gm     |
| Leak Rate                                           |                 |                                                                  |      |                     | 5x10 <sup>-8</sup> | cc/sec |

## Notes:

4. The luminous intensity at a specific operating ambient temperature, I<sub>V</sub> (T<sub>A</sub>) may be approximated from the following exponential equation:  

$$I_V(T_A) = I_V(25^\circ\text{C}) e^{[k(T_A - 25^\circ\text{C})]}$$

| Device           | K          |
|------------------|------------|
| HDSP-0760 Series | -0.0131/°C |
| HDSP-0770 Series |            |
| HDSP-0860 Series | -0.0112/°C |
| HDSP-0960 Series | -0.0104/°C |

5. The dominant wavelength, λ<sub>d</sub>, is derived from the CIE Chromaticity Diagram and is that single wavelength which defines the color of the device.
6. The HDSP-0860 and HDSP-0960 series devices are categorized as to dominant wavelength with the category designated by a number on the back of the display package.
7. All typical values at V<sub>CC</sub> = 5.0 V and T<sub>A</sub> = 25°C.

## Operational Considerations

### Electrical

These devices use a modified 4x7 dot matrix light emitting diode to display decimal/hexadecimal numeric information. The high efficiency red and yellow LEDs are GaAsP epitaxial layer on a GaP transparent substrate. The green LEDs are GaP epitaxial layer on a GaP transparent substrate. The LEDs are driven by constant current drivers, BCD information is accepted by the display memory when the enable line is at logic low and the data is latched when the enable is at logic high. Using the enable pulse width and data setup and hold times listed in the Recommended Operating Conditions allows data to be clocked into an array of displays at a 6.7 MHz rate.

The decimal point input is active low true and this data is latched into the display memory in the same fashion as the BCD data. The decimal point LED is driven by the on-board IC.

The blanking control input on the hexadecimal displays blanks (turns off) the displayed information without disturbing the contents of display memory. The display is blanked at a minimum threshold level of 2.0 volts. When blanked, the display standby power is nominally 250 mW at  $T_A = 25^\circ\text{C}$ .

### Mechanical

The primary thermal path for power dissipation is through the device leads. Therefore, to insure reliable operation up to an ambient temperature of  $+85^\circ\text{C}$ , it is important to maintain a case-to-ambient thermal resistance of less than  $35^\circ\text{C watt/device}$  as measured on top of display pin 3.

For information on soldering and post solder cleaning see Application Note 1027, *Soldering LED Components*.

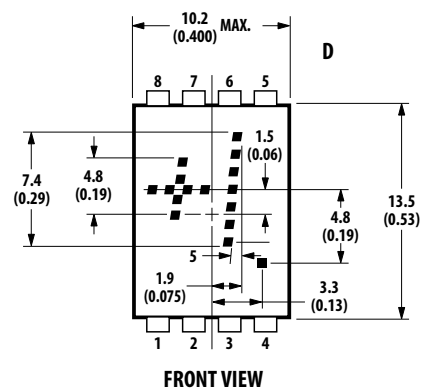
### Contrast Enhancement

These display devices are designed to provide an optimum ON/OFF contrast when placed behind an appropriate contrast enhancement filter. For further information, please refer to Application Note 1015, *Contrast Enhancement Techniques for LED Displays*.

### Over Range Display

The over range devices display " $\pm 1$ " and decimal point. The character height and package configuration are the same as the numeric and hexadecimal devices. Character selection is obtained via external switching transistors and current limiting resistors.

## Package Dimensions



| PIN | FUNCTION        |
|-----|-----------------|
| 1   | Plus            |
| 2   | Numeral One     |
| 3   | Numeral One     |
| 4   | DP              |
| 5   | Open            |
| 6   | Open            |
| 7   | V <sub>CC</sub> |
| 8   | Minus/Plus      |

| Character     | Pin |     |   |   |
|---------------|-----|-----|---|---|
|               | 1   | 2,3 | 4 | 8 |
| +             | 1   | X   | X | 1 |
| -             | 0   | X   | X | 1 |
| 1             | X   | 1   | X | X |
| Decimal Point | X   | X   | 1 | X |
| Blank         | 0   | 0   | 0 | 0 |

#### Notes:

- 0: Line switching transistor in Figure 7 cutoff.
- 1: Line switching transistor in Figure 7 saturated.
- X: 'don't care'

NOTE: DIMENSIONS IN MILLIMETERS AND (INCHES).

### Absolute Maximum Ratings

| Description                    | Symbol | Min. | Max. | Unit |
|--------------------------------|--------|------|------|------|
| Storage Temperature, Ambient   | $T_S$  | -65  | +100 | °C   |
| Operating Temperature, Ambient | $T_A$  | -55  | +85  | °C   |
| Forward Current, Each LED      | $I_F$  |      | 10   | mA   |
| Reverse Voltage, Each LED      | $V_R$  |      | 5    | V    |

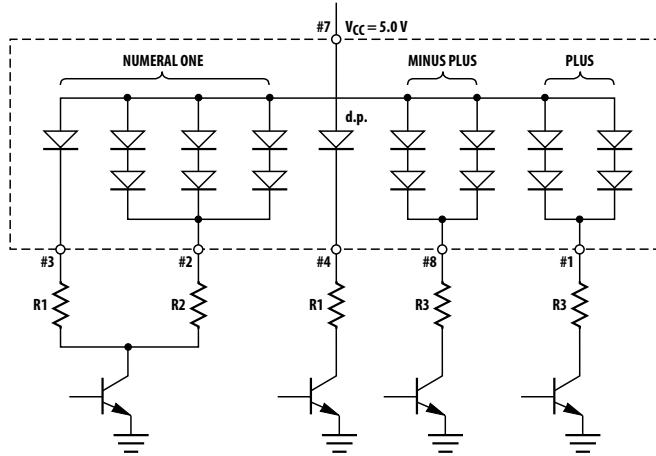


Figure 3. Typical driving circuit.

### Recommended Operating Conditions $V_{CC} = 5.0\text{ V}$

|                 | Forward Current Per Device LED, mA | Resistor Value |       |       |
|-----------------|------------------------------------|----------------|-------|-------|
|                 |                                    | $R_1$          | $R_2$ | $R_3$ |
| HDSP-0763       |                                    |                |       |       |
| Low Power       | 2.8                                | 1300           | 200   | 300   |
| High Brightness | 8                                  | 360            | 47    | 68    |
| HDSP-0863       | 8                                  | 360            | 36    | 56    |
| HDSP-0963       | 8                                  | 360            | 30    | 43    |

### Luminous Intensity per LED

(Digit Average)<sup>[3,4]</sup> at  $T_A = 25^\circ\text{C}$

| Device    | Test Conditions       | Min. | Typ. | Units          |
|-----------|-----------------------|------|------|----------------|
| HDSP-0763 | $I_F = 2.8\text{ mA}$ | 65   | 140  | $\mu\text{cd}$ |
|           | $I_F = 8\text{ mA}$   |      | 620  | $\mu\text{cd}$ |
| HDSP-0863 | $I_F = 8\text{ mA}$   | 215  | 490  | $\mu\text{cd}$ |
| HDSP-0963 | $I_F = 8\text{ mA}$   | 298  | 1100 | $\mu\text{cd}$ |

**Electrical Characteristics: T<sub>A</sub> = -55°C to +85°C**

| Device    | Description                              | Symbol         | Test Conditions         | Min. | Typ. | Max. | Unit |
|-----------|------------------------------------------|----------------|-------------------------|------|------|------|------|
| HDSP-0763 | Power Dissipation (All LEDs Illuminated) | P <sub>T</sub> | I <sub>F</sub> = 2.8 mA |      | 72   |      | mW   |
|           |                                          |                | I <sub>F</sub> = 8 mA   |      | 224  | 282  |      |
|           | Forward Voltage per LED                  | V <sub>F</sub> | I <sub>F</sub> = 2.8 mA |      | 1.6  |      | V    |
|           |                                          |                | I <sub>F</sub> = 8 mA   |      | 1.75 | 2.2  |      |
| HDSP-0863 | Power Dissipation (All LEDs Illuminated) | P <sub>T</sub> | I <sub>F</sub> = 8 mA   |      | 237  | 282  | mW   |
|           | Forward Voltage per LED                  | V <sub>F</sub> |                         |      | 1.90 | 2.2  | V    |
| HDSP-0963 | Power Dissipation (All LEDs Illuminated) | P <sub>T</sub> | I <sub>F</sub> = 8 mA   |      | 243  | 282  | mW   |
|           | Forward Voltage per LED                  | V <sub>F</sub> |                         |      | 1.85 | 2.2  | V    |

**Intensity Bin Limits for HDSP-0760 Series**

| Bin | Intensity Range (μcd) |         |
|-----|-----------------------|---------|
|     | Min.                  | Max.    |
| A   | 65.00                 | 102.14  |
| B   | 84.29                 | 137.86  |
| C   | 114.29                | 200.00  |
| D   | 165.71                | 300.00  |
| E   | 260.00                | 487.86  |
| F   | 402.86                | 755.71  |
| G   | 625.00                | 1171.43 |

**Note:**

Test conditions as specified in Optical Characteristic table.

**Intensity Bin Limits for HDSP-0860 Series**

| Bin | Intensity Range (μcd) |         |
|-----|-----------------------|---------|
|     | Min.                  | Max.    |
| A   | 215.00                | 337.86  |
| B   | 279.29                | 456.43  |
| C   | 377.14                | 662.14  |
| D   | 547.14                | 992.86  |
| E   | 820.71                | 1539.29 |
| F   | 1272.14               | 2385.71 |

**Note:**

Test conditions as specified in Optical Characteristic table.

**Color Bin Limits**

| Color  | Bin | Color Range (nm) |       |
|--------|-----|------------------|-------|
|        |     | Min.             | Max.  |
| Yellow | 1   | 581.5            | 585.0 |
|        | 2   | 584.0            | 587.5 |
|        | 3   | 586.5            | 590.0 |
| Green  | 1   | 570.0            | 574.0 |
|        | 2   | 573.0            | 577.0 |
|        | 3   | 576.0            | 580.0 |

**Note:**

Test conditions as specified in Optical Characteristic table.

**Intensity Bin Limits for HDSP-0770 Series**

| Bin | Intensity Range (μcd) |         |
|-----|-----------------------|---------|
|     | Min.                  | Max.    |
| E   | 260.00                | 487.64  |
| F   | 403.00                | 755.79  |
| G   | 624.64                | 1171.50 |
| H   | 969.00                | 1817.00 |

**Note:**

Test conditions as specified in Optical Characteristic table.

**Intensity Bin Limits for HDSP-0960 Series**

| Bin | Intensity Range (μcd) |         |
|-----|-----------------------|---------|
|     | Min.                  | Max.    |
| C   | 298.57                | 523.57  |
| D   | 432.86                | 785.00  |
| E   | 648.57                | 1175.00 |
| F   | 971.43                | 1757.86 |
| G   | 1452.86               | 2629.29 |

**Note:**

Test conditions as specified in Optical Characteristic table.

For product information and a complete list of distributors, please go to our website: [www.avagotech.com](http://www.avagotech.com)

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