

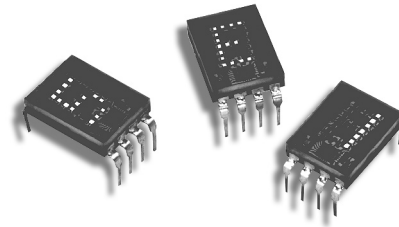
# HDSP-078x, HDSP-079x, HDSP-088x, HDSP-098x

## Glass/Ceramic Numeric and Hexadecimal Displays

### for Industrial Applications



## Data Sheet



### Description

These standard solid state displays have a 7.4 mm (0.29 inch) dot matrix character and an on-board IC with data memory latch/decoder and LED drivers in a glass/ceramic package.

The hermetic HDSP-078x,-079x/-088x displays utilize a solder glass frit seal. The HDSP-098X displays utilize an epoxy glass-to-ceramic seal.

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.

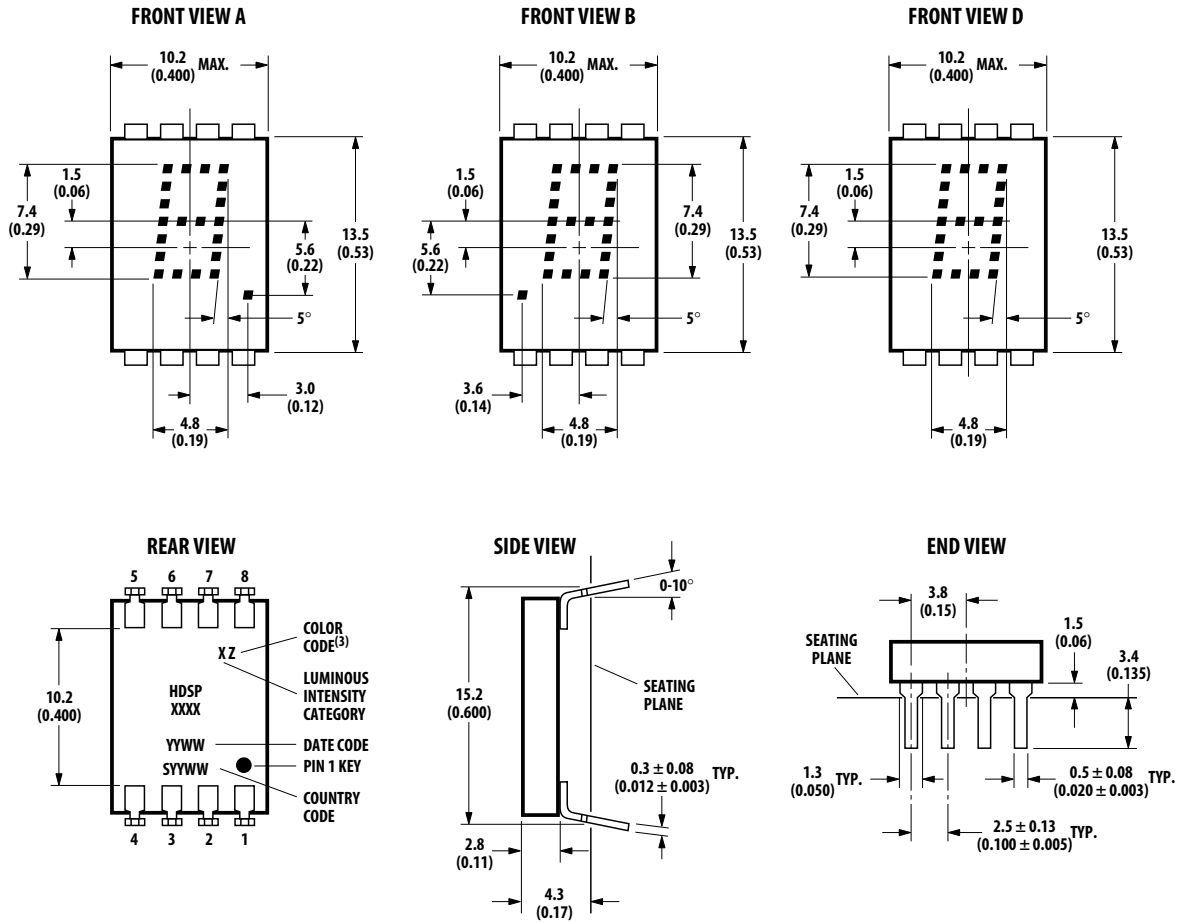
### Features

- Three character options  
Numeric, hexadecimal, over range
- Three colors;  
High Efficiency Red, Yellow, High Performance Green
- 4x7 dot matrix character
- Two high efficiency red options  
Low power, high brightness
- Performance guaranteed over temperature
- High temperature stabilized
- Memory latch/decoder/driver  
TTL compatible
- Categorized for luminous intensity

### Devices

| Part Number |                                        |                        | Front View |
|-------------|----------------------------------------|------------------------|------------|
| HDSP-       | Color                                  | Description            |            |
| 0781        | High-Efficiency Red<br>Low Power       | Numeric, Right Hand DP | A          |
| 0782        |                                        | Numeric, Left Hand DP  | B          |
| 0783        |                                        | Over Range $\pm 1$     | C          |
| 0784        |                                        | Hexadecimal            | D          |
| 0791        | High-Efficiency Red<br>High Brightness | Numeric, Right Hand DP | A          |
| 0792        |                                        | Numeric, Left Hand DP  | B          |
| 0794        |                                        | Hexadecimal            | D          |
| 0881        | Yellow                                 | Numeric, Right Hand DP | A          |
| 0883        |                                        | Over Range $\pm 1$     | C          |
| 0884        |                                        | Hexadecimal            | D          |
| 0981        | High-Performance<br>Green              | Numeric, Right Hand DP | A          |
| 0983        |                                        | Over Range $\pm 1$     | C          |
| 0984        |                                        | Hexadecimal            | D          |

## 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. UNLESS OTHERWISE SPECIFIED, THE TOLERANCE ON ALL DIMENSIONS IS  $\pm 0.38$  mm ( $\pm 0.015$  INCH).
3. DIGIT CENTER LINE IS  $\pm 0.25$  mm ( $\pm 0.01$  INCH) FROM PACKAGE CENTER LINE.
4. COLOR CODE FOR HDSP-088X/-098X SERIES.

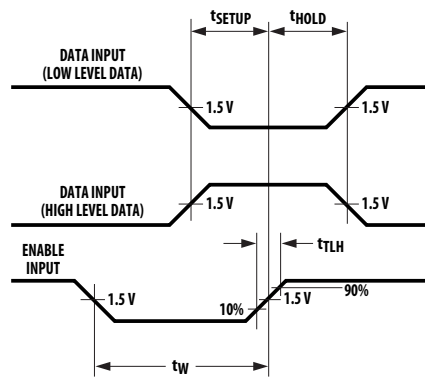


Figure 1. Timing diagram.

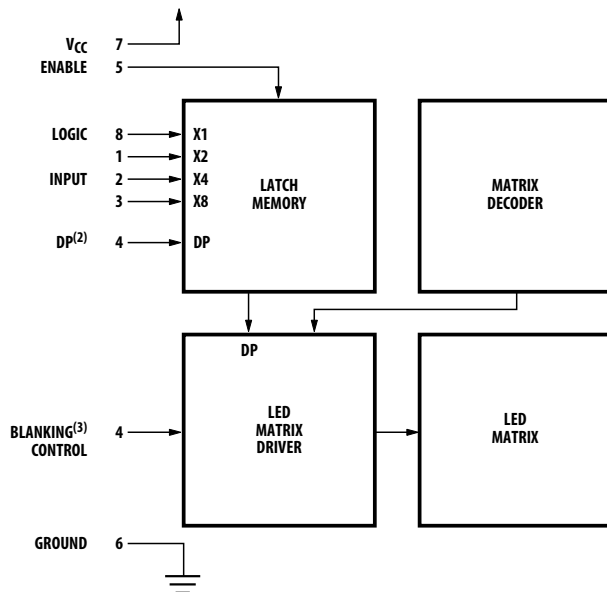


Figure 2. Block diagram.

| 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                            | $T_S$              | -65  | +125     | °C   |
| HDSP-078x/-079x/-088x                                   |                    | -55  | +100     |      |
| Operating Temperature, Ambient <sup>[1]</sup>           | $T_A$              | -55  | +100     | °C   |
| Supply Voltage <sup>[2]</sup>                           | $V_{CC}$           | -0.5 | +7.0     | V    |
| Voltage Applied to Input Logic, dp and Enable Pins      | $V_I, V_{DP}, V_E$ | -0.5 | $V_{CC}$ | V    |
| Voltage Applied to Blanking Input <sup>[2]</sup>        | $V_R$              | -0.5 | $V_{CC}$ | V    |
| Soldering Temperature [1.59 mm (0.063 inch) Below Body] |                    |      |          |      |
| Solder Dipping, max 5 seconds                           |                    |      | 260      | °C   |
| Wave Soldering, max. 3 seconds                          |                    |      | 250      |      |

**Recommended Operating Conditions**

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

**Optical Characteristics at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5.0\text{ V}$** 

| Device           | Description                                                 | Symbol           | Min. | Typ. | Max. | Unit           |
|------------------|-------------------------------------------------------------|------------------|------|------|------|----------------|
| HDSP-078x Series | Luminous Intensity per LED (Digit Average) <sup>[3,4]</sup> | $I_V$            | 65   | 140  |      | $\mu\text{cd}$ |
|                  | Peak Wavelength                                             | $\lambda_{PEAK}$ |      | 635  |      | nm             |
|                  | Dominant Wavelength <sup>[5]</sup>                          | $\lambda_d$      |      | 626  |      | nm             |
| HDSP-079x Series | Luminous Intensity per LED (Digit Average) <sup>[3,4]</sup> | $I_V$            | 260  | 620  |      | $\mu\text{cd}$ |
|                  | Peak Wavelength                                             | $I_{PEAK}$       |      | 635  |      | nm             |
|                  | Dominant Wavelength <sup>[5]</sup>                          | $\lambda_d$      |      | 626  |      | nm             |
| HDSP-088x Series | Luminous Intensity per LED (Digit Average) <sup>[3,4]</sup> | $\lambda_V$      | 215  | 490  |      | $\mu\text{cd}$ |
|                  | Peak Wavelength                                             | $\lambda_{PEAK}$ |      | 583  |      | nm             |
|                  | Dominant Wavelength <sup>[5,6]</sup>                        | $\lambda_d$      |      | 585  |      | nm             |
| HDSP-098x Series | Luminous Intensity per LED (Digit Average) <sup>[3,4]</sup> | $I_V$            | 298  | 1100 |      | $\mu\text{cd}$ |
|                  | Peak Wavelength                                             | $\lambda_{PEAK}$ |      | 568  |      | nm             |
|                  | Dominant Wavelength                                         | $\lambda_d$      |      | 574  |      | nm             |

**Notes:**

1. The nominal thermal resistance of a display mounted in a socket that is soldered onto a printed circuit board is  $R_{\theta JA} = 50^\circ\text{C/W/device}$ . The device package thermal resistance is  $R_{\theta J-PIN} = 15^\circ\text{C/W/device}$ . The thermal resistance device pin-to-ambient through the PC board should not exceed  $35^\circ\text{C/W/device}$  for operation up to  $T_A = +100^\circ\text{C}$ .
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  $25^\circ\text{C}$ .

## Electrical/Optical Characteristics

$T_A = -55^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$

| Description                                         | Symbol                                           | Test Conditions                                                         | Min. | Typ. <sup>[7]</sup> | Max.               | Unit          |
|-----------------------------------------------------|--------------------------------------------------|-------------------------------------------------------------------------|------|---------------------|--------------------|---------------|
| Supply Current                                      | HDSP-078x Series<br>HDSP-079x/-088x/-098x Series | $I_{CC}$<br>$V_{CC} = 5.5\text{ V}$<br>Characters "5." or "B" displayed |      | 78                  | 105                | mA            |
|                                                     |                                                  |                                                                         |      | 120                 | 175                |               |
| Power Dissipation                                   | HDSP-078x Series<br>HDSP-079x/-088x/-098x Series | $P_T$<br>$V_{CC} = 5.5\text{ V}$<br>Characters "5." or "B" displayed    |      | 390                 | 573                | mW            |
|                                                     |                                                  |                                                                         |      | 690                 | 963                |               |
| Logic, Enable and Blanking Low-Level Input Voltage  | $V_{IL}$                                         | $V_{CC} = 4.5\text{ V}$                                                 |      |                     | 0.8                | V             |
| Logic, Enable High-Level Input Voltage              | $V_{IH}$                                         |                                                                         | 2.0  |                     |                    | V             |
| Blanking High-Voltage; Display Blanked              | $V_{BH}$                                         |                                                                         | 2.3  |                     |                    | V             |
| Logic and Enable Low-Level Input Current            | $I_{IL}$                                         | $V_{CC} = 5.5\text{ V}$                                                 |      |                     | -1.6               | mA            |
| Blanking Low-Level Input Current                    | $I_{BL}$                                         | $V_{IL} = 0.4\text{ V}$                                                 |      |                     | -10                | $\mu\text{A}$ |
| Logic, Enable and Blanking High-Level Input Current | $I_{IH}$                                         | $V_{CC} = 5.5\text{ V}$<br>$V_{IH} = 2.4\text{ V}$                      |      |                     | +40                | $\mu\text{A}$ |
| Weight                                              |                                                  |                                                                         |      | 1.0                 |                    | gm            |
| Leak Rate                                           |                                                  |                                                                         |      |                     | $5 \times 10^{-8}$ | cc/sec        |

### Notes:

4. The luminous intensity at a specific operating ambient temperature,  $I_V(T_A)$ , 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-078 Series  | -0.0131/ $^{\circ}\text{C}$ |
| HDSP-079x Series |                             |
| HDSP-088x Series | -0.0112/ $^{\circ}\text{C}$ |
| HDSP-098x Series | -0.0104/ $^{\circ}\text{C}$ |

5. The dominant wavelength,  $\lambda_d$ , is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
6. The HDSP-088X and HDSP-098X 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  $V_{CC} = 5.0\text{ V}$  and  $T_A = 25^{\circ}\text{C}$ .

## Operational Considerations

### Electrical

These devices use a modified 4x7 dot matrix of light emitting diodes to display decimal/hexadecimal numeric information. The high efficiency red and yellow displays use GaAsP/GaP LEDs and the high performance green displays use GaP/GaP LEDs. 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  $T_A = 25^{\circ}\text{C}$ .

The ESD susceptibility of the IC devices is Class A of MIL-STD-883 or Class 2 of DOD-STD-1686 and DOD-HDBK-263.

## Mechanical

These displays are hermetically sealed for use in environments that require a high reliability device. These displays are designed and tested to meet a helium leak rate of  $5 \times 10^{-8}$  cc/sec.

These displays may be mounted by soldering directly to a printed circuit board or insertion into a socket. The lead-to-lead pin spacing is 2.54 mm (0.100 inch) and the lead row spacing is 15.24 mm (0.600 inch). These displays may be end stacked with 2.54 mm (0.100 inch) spacing between outside pins of adjacent displays. Sockets such as Augat 324-AG2D (3 digits) or Augat 508-AG8D (one digit, right angle mounting) may be used.

The primary thermal path for power dissipation is through the device leads. Therefore, to insure reliable operation up to an ambient temperature of +100°C, it is important to maintain a base-to-ambient thermal resistance of less than 35°C watt/device as measured on top of display pin 3.

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

## Preconditioning

These displays are 100% preconditioned by 24 hour storage at 125°C, at 100°C for the HDSP-098x Series.

## 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 on contrast enhancement, see Application Note 1015, *Contrast Enhancement for LED Displays*.

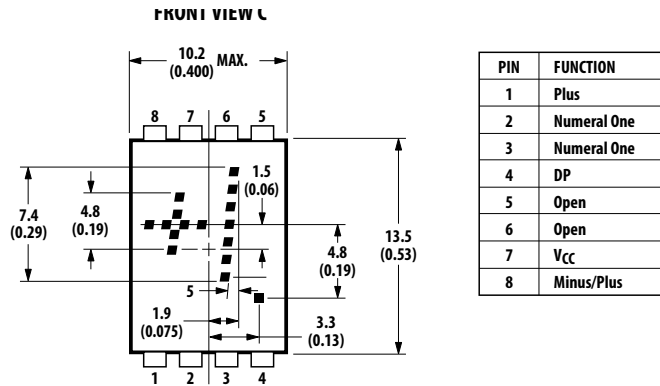
## Over Range Display

The over range devices display “±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.

## Absolute Maximum Ratings

| Description                    | Symbol         | Min | Max  | Unit |
|--------------------------------|----------------|-----|------|------|
| Storage Temperature, Ambient   | T <sub>S</sub> | –65 | +125 | °C   |
| Operating Temperature, Ambient | T <sub>A</sub> | –55 | +100 | °C   |
| Forward Current, Each LED      | I <sub>F</sub> |     | 10   | mA   |
| Reverse Voltage, Each LED      | V <sub>R</sub> |     | 5    | V    |

## Package Dimensions



NOTE: DIMENSIONS IN MILLIMETERS AND (INCHES).

| 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.'

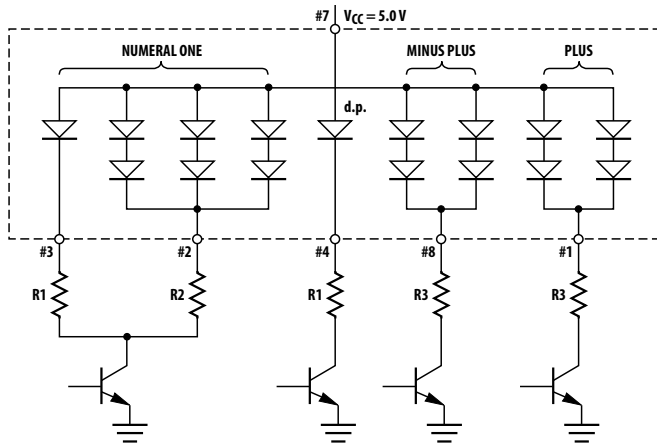


Figure 3. Typical driving circuit.

## Luminous Intensity per LED

(Digit Average) at T<sub>A</sub> = 25°C

| Device    | Test Conditions         | Min. | Typ. | Units |
|-----------|-------------------------|------|------|-------|
| HDSP-0783 | I <sub>F</sub> = 2.8 mA | 65   | 140  | μcd   |
|           | I <sub>F</sub> = 8 mA   |      | 620  | μcd   |
| HDSP-0883 | I <sub>F</sub> = 8 mA   | 215  | 490  | μcd   |
| HDSP-0983 | I <sub>F</sub> = 8 mA   | 298  | 1100 | μcd   |

## Recommended Operating Conditions

V<sub>CC</sub> = 5.0 V

| Device    |                 | Forward Current<br>Per LED, mA | Resistor Value |                |                |
|-----------|-----------------|--------------------------------|----------------|----------------|----------------|
|           |                 |                                | R <sub>1</sub> | R <sub>2</sub> | R <sub>3</sub> |
| HDSP-0783 | Low Power       | 2.8                            | 1300           | 200            | 300            |
|           | High Brightness | 8                              | 360            | 47             | 68             |
| HDSP-0883 |                 | 8                              | 360            | 36             | 56             |
| HDSP-0983 |                 | 8                              | 360            | 30             | 43             |

## Electrical Characteristics

$T_A = -55^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$

| Device    | Description                              | Symbol | Test Conditions        | Min. | Typ. | Max. | Unit |
|-----------|------------------------------------------|--------|------------------------|------|------|------|------|
| HDSP-0783 | Power Dissipation (All LEDs Illuminated) | $P_T$  | $I_F = 2.8 \text{ mA}$ |      | 72   |      | mW   |
|           |                                          |        | $I_F = 8 \text{ mA}$   |      | 224  | 282  |      |
|           | Forward Voltage per LED                  | $V_F$  | $I_F = 2.8 \text{ mA}$ |      | 1.6  |      | V    |
|           |                                          |        | $I_F = 8 \text{ mA}$   |      | 1.75 | 2.2  |      |
| HDSP-0883 | Power Dissipation (All LEDs Illuminated) | $P_T$  | $I_F = 8 \text{ mA}$   |      | 237  | 282  | mW   |
|           | Forward Voltage per LED                  | $V_F$  |                        |      | 1.90 | 2.2  | V    |
| HDSP-0983 | Power Dissipation (All LEDs Illuminated) | $P_T$  | $I_F = 8 \text{ mA}$   |      | 243  | 282  | mW   |
|           | Forward Voltage per LED                  | $V_F$  |                        |      | 1.85 | 2.2  | V    |

### Intensity Bin Limits for HDSP-078x Series

| Bin Category | Min. (mcd) | Max. (mcd) | Condition                                    |
|--------------|------------|------------|----------------------------------------------|
| A            | 0.065      | 0.102      | Luminous Intensity per LED. $V_{DD}$ @ 5.0 V |
| B            | 0.085      | 0.138      |                                              |
| C            | 0.114      | 0.200      |                                              |
| D            | 0.165      | 0.300      |                                              |
| E            | 0.260      | 0.488      |                                              |
| F            | 0.403      | 0.756      |                                              |
| G            | 0.625      | 1.172      |                                              |

### Intensity Bin Limits for HDSP-079x Series

| Bin Category | Min. (mcd) | Max. (mcd) | Condition                                    |
|--------------|------------|------------|----------------------------------------------|
| E            | 0.260      | 0.488      | Luminous Intensity per LED. $V_{DD}$ @ 5.0 V |
| F            | 0.403      | 0.756      |                                              |
| G            | 0.625      | 1.172      |                                              |
| H            | 0.969      | 1.820      |                                              |

### Intensity Bin Limits for HDSP-088x Series

| Bin Category | Min. (mcd) | Max. (mcd) | Condition                                    |
|--------------|------------|------------|----------------------------------------------|
| A            | 0.22       | 0.34       | Luminous Intensity per LED. $V_{DD}$ @ 5.0 V |
| B            | 0.28       | 0.46       |                                              |
| C            | 0.38       | 0.66       |                                              |
| D            | 0.55       | 0.99       |                                              |
| E            | 0.82       | 1.54       |                                              |
| F            | 1.27       | 2.39       |                                              |

### Intensity Bin Limits for HDSP-098x Series

| Bin Category | Min. (mcd) | Max. (mcd) | Condition                                    |
|--------------|------------|------------|----------------------------------------------|
| C            | 0.30       | 0.52       | Luminous Intensity per LED. $V_{DD}$ @ 5.0 V |
| D            | 0.43       | 0.79       |                                              |
| E            | 0.65       | 1.18       |                                              |
| F            | 0.97       | 1.76       |                                              |
| G            | 1.45       | 2.63       |                                              |

### Color Bin Limits

(Dominant Wavelength)

| Color  | Bin | Intensity Range (nm) |        |
|--------|-----|----------------------|--------|
|        |     | Min.                 | Max.   |
| Yellow | 1   | 581.50               | 585.00 |
|        | 2   | 584.00               | 587.50 |
|        | 3   | 586.50               | 590.00 |
| Green  | 1   | 570.00               | 574.00 |
|        | 2   | 573.00               | 577.00 |
|        | 3   | 576.00               | 580.00 |

#### Note:

Bin categories are established for classification of products. Products may not be available in all bin categories. Please consult your local Avago Technologies representative.

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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- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
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- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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