


**HEWLETT  
PACKARD**

## HERMETIC, NUMERIC AND HEXADECIMAL DISPLAYS FOR MILITARY APPLICATIONS

### HIGH EFFICIENCY RED

Low Power

HDSP-078X/078XTXV/078XTXVB

High Brightness

HDSP-079X/079XTXV/079XTXVB

YELLOW

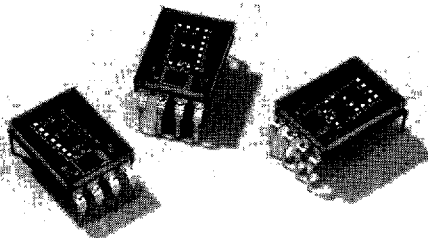
HDSP-088X/088XTXV/088XTXVB

High Performance GREEN

HDSP-098X/098XTXV/098XTXVB

## Features

- CONFORM TO MIL-D-87157, QUALITY LEVEL A TEST TABLES
- TRUE HERMETIC PACKAGE FOR HIGH EFFICIENCY RED AND YELLOW<sup>[1]</sup>
- TXV AND TXVB VERSIONS AVAILABLE
- THREE CHARACTER OPTIONS  
Numeric, Hexadecimal, Over Range
- THREE COLORS  
High Efficiency Red, Yellow,  
High Performance Green
- 4 x 7 DOT MATRIX CHARACTER
- HIGH EFFICIENCY RED, YELLOW, AND HIGH PERFORMANCE GREEN
- TWO HIGH EFFICIENCY RED OPTIONS  
Low Power, High Brightness
- PERFORMANCE GUARANTEED OVER TEMPERATURE
- HIGH TEMPERATURE STABILIZED
- GOLD PLATED LEADS
- MEMORY LATCH/DECODER/DRIVER  
TTL Compatible
- CATEGORIZED FOR LUMINOUS INTENSITY



The hermetic HDSP-078X,-079X/-088X displays utilize a solder glass frit seal. The HDSP-098X displays utilize an epoxy glass-to-ceramic seal. All packages conform to the hermeticity requirements of MIL-D-87157, the general specification for LED displays. These displays are designed for use in military and aerospace applications.

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 "±1" and right hand decimal point and is typically driven via external switching transistors.

### Note:

- 1 The HDSP-098X high performance green displays are epoxy sealed and conform to MIL-D-87157 hermeticity requirements.

## Description

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

## Devices

| Part Number<br>HDSP-                                                                             | Color                                  | Description                                                                     | Front View       |
|--------------------------------------------------------------------------------------------------|----------------------------------------|---------------------------------------------------------------------------------|------------------|
| 0781/0781TXV/0781TXVB<br>0782/0782TXV/0782TXVB<br>0783/0783TXV/0783TXVB<br>0784/0784TXV/0784TXVB | High-Efficiency Red<br>Low Power       | Numeric, Right Hand DP<br>Numeric, Left Hand DP<br>Over Range ±1<br>Hexadecimal | A<br>B<br>C<br>D |
| 0791/0791TXV/0791TXVB<br>0792/0792TXV/0792TXVB<br>0783/0783TXV/0783TXVB<br>0794/0794TXV/0794TXVB | High-Efficiency Red<br>High Brightness | Numeric, Right Hand DP<br>Numeric, Left Hand DP<br>Over Range ±1<br>Hexadecimal | A<br>B<br>C<br>D |
| 0881/0881TXV/0881TXVB<br>0882/0882TXV/0882TXVB<br>0883/0883TXV/0883TXVB<br>0884/0884TXV/0884TXVB | Yellow                                 | Numeric, Right Hand DP<br>Numeric, Left Hand DP<br>Over Range ±1<br>Hexadecimal | A<br>B<br>C<br>D |
| 0981/0981TXV/0981TXVB<br>0982/0982TXV/0982TXVB<br>0983/0983TXV/0983TXVB<br>0984/0984TXV/0984TXVB | High Performance<br>Green              | Numeric, Right Hand DP<br>Numeric, Left Hand DP<br>Over Range ±1<br>Hexadecimal | A<br>B<br>C<br>D |

 HERMETIC  
DISPLAYS

# Package Dimensions

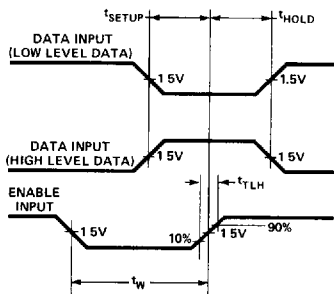
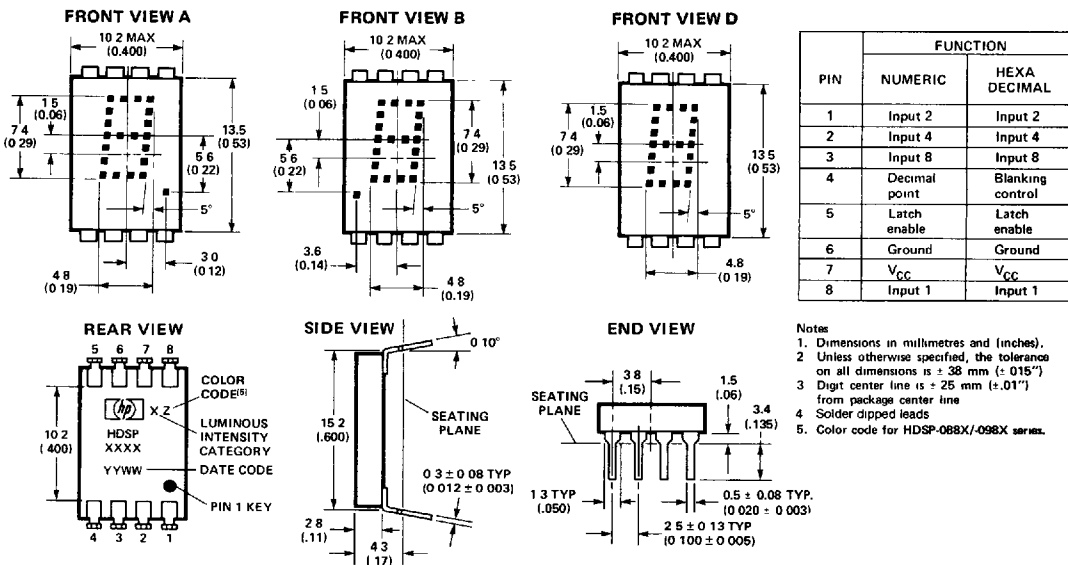


Figure 1. Timing Diagram

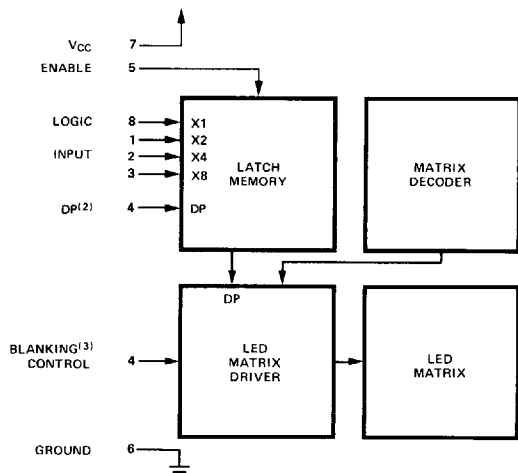


Figure 2. Logic Block Diagram

| TRUTH TABLE               |                |                |                |                                |
|---------------------------|----------------|----------------|----------------|--------------------------------|
| BCD DATA <sup>(1)</sup>   |                |                |                |                                |
| X <sub>8</sub>            | X <sub>4</sub> | X <sub>2</sub> | X <sub>1</sub> |                                |
| L                         | L              | L              | L              |                                |
| L                         | L              | L              | H              |                                |
| L                         | L              | H              | L              | ...                            |
| L                         | L              | H              | H              |                                |
| L                         | H              | L              | L              |                                |
| L                         | H              | L              | H              |                                |
| L                         | H              | H              | L              |                                |
| L                         | H              | H              | H              |                                |
| H                         | L              | L              | L              |                                |
| H                         | L              | L              | H              |                                |
| H                         | L              | H              | L              |                                |
| H                         | L              | H              | H              | (BLANK)                        |
| H                         | H              | L              | L              | (BLANK)                        |
| H                         | H              | L              | H              |                                |
| H                         | H              | H              | L              | (BLANK)                        |
| H                         | H              | H              | H              | (BLANK)                        |
| 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<br>HDSP-078X/-079X/-088X                                         | $T_S$              | -65  | +125     | °C   |
| HDSP-098X                                                                                     |                    | -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    |
| Maximum solder temperature at 1.59 mm (0.062 inch)<br>below seating plane: $t \leq 5$ seconds |                    |      | 260      | °C   |

## 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<br>of enable line | $t_{SETUP}$ | 50   |      |      | nsec |
| Time data must be held after positive transition<br>of enable line  | $t_{HOLD}$  | 50   |      |      | nsec |
| Enable pulse rise time                                              | $t_{IH}$    |      |      | 10   | 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<br>Series | Luminous Intensity per LED<br>(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<br>Series | Luminous Intensity per LED<br>(Digit Average) <sup>[3,4]</sup> | $I_V$            | 260  | 620  |      | $\mu\text{cd}$ |
|                     | Peak Wavelength                                                | $\lambda_{PEAK}$ |      | 635  |      | nm             |
|                     | Dominant Wavelength <sup>[5]</sup>                             | $\lambda_d$      |      | 626  |      | nm             |
| HDSP-088X<br>Series | Luminous Intensity per LED<br>(Digit Average) <sup>[3,4]</sup> | $I_V$            | 215  | 490  |      | $\mu\text{cd}$ |
|                     | Peak Wavelength                                                | $\lambda_{PEAK}$ |      | 583  |      | nm             |
|                     | Dominant Wavelength <sup>[5,6]</sup>                           | $\lambda_d$      |      | 585  |      | nm             |
| HDSP-098X<br>Series | Luminous Intensity per LED<br>(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

- 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 at  $T_A = +100^\circ\text{C}$ .
- Voltage values are with respect to device ground, pin 6.
- 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 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                                         | I <sub>CC</sub> | V <sub>CC</sub> = 5.5 V<br>Characters "5" or "B"<br>displayed |      | 78                  | 105                  | mA      |
| HDSP-078X Series<br>HDSP-079X/-088X/<br>-098X Series   |                 |                                                               |      | 120                 | 175                  |         |
| Power Dissipation                                      | P <sub>T</sub>  | V <sub>CC</sub> = 5.5 V<br>Characters "5" or "B"<br>displayed |      | 390                 | 573                  | mW      |
| HDSP-078X Series<br>HDSP-079X/-088X/<br>-098X Series   |                 |                                                               |      | 690                 | 963                  |         |
| Logic, Enable and Blanking<br>Low-Level Input Voltage  | V <sub>IL</sub> | V <sub>CC</sub> = 4.5 V                                       |      |                     | 0.8                  | V       |
| Logic, Enable High-Level<br>Input Voltage              | V <sub>IH</sub> |                                                               | 2.0  |                     |                      | V       |
| Blanking High Voltage;<br>Display Blanked              | V <sub>BH</sub> |                                                               | 2.3  |                     |                      | V       |
| Logic and Enable<br>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<br>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                                              |                 |                                                               |      |                     | 5 x 10 <sup>-8</sup> | 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-078X Series<br>HDSP-079X Series | -0.0131/ $^\circ\text{C}$ |
| 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 is that 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 side of the display package.
7. All typical values at V<sub>CC</sub> = 5.0 V and T<sub>A</sub> = 25 $^\circ\text{C}$ .

## Operational Considerations

### ELECTRICAL

These devices use a modified 4 x 7 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 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<sub>A</sub> = 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 x 10<sup>-8</sup> 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 $^\circ\text{C}$ , it is important to maintain a base-to-ambient thermal resistance of less than 35 $^\circ\text{C}$  watt/device as measured on top of display pin 3.

Post solder cleaning may be accomplished using water, Freon/alcohol mixtures formulated for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixtures formulated for room temperature cleaning. Suggested solvents: Freon TF, Freon TE, Genesolv DI-15, Genesolv DE-15.

## 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. The following filters are suggested:

| Display Color          | Ambient Lighting                             |                                                                       |                                                                                                                                   |
|------------------------|----------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|                        | Dim                                          | Moderate                                                              | Bright                                                                                                                            |
| HDSP-088X<br>Yellow    | Panelgraphic Yellow 27<br>Chequers Amber 107 | Polaroid HNCP 37<br>3M Light Control Film<br><br>Panelgraphic Gray 10 | Polaroid Gray HNCP10<br>HOYA Yellowish-Orange<br>HLF-608-3Y<br>Marks Gray<br>MCP-0301-8-10                                        |
| HDSP-078X/-079X<br>HER | Panelgraphic Ruby Red 60<br>Chequers Red 112 | Chequers Grey 105                                                     | Polaroid Gray HNCP10<br>HOYA Reddish-Orange<br>HLF-608-5R<br>Marks Gray<br>MCP-0301-8-10<br>Marks Reddish-Orange<br>MCP-0201-2-22 |
| HDSP-098X<br>HP Green  | Panelgraphic Green 48<br>Chequers Green 107  |                                                                       | Polaroid Gray HNCP10<br>HOYA Yellow-Green<br>HLF-608-1G<br>Marks Yellow-Green<br>MCP-0101-5-12                                    |

## 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

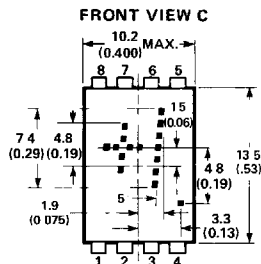
| Description                    | Symbol         | Min. | Max. | Unit |
|--------------------------------|----------------|------|------|------|
| Storage Temperature, Ambient   | T <sub>S</sub> | -65  | +125 | °C   |
| Operating Temperature, Ambient | T <sub>A</sub> | -55  | +100 | °C   |
| Forward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

| 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'

## 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      |

Note:

- 1 Dimensions in millimetres and (inches)

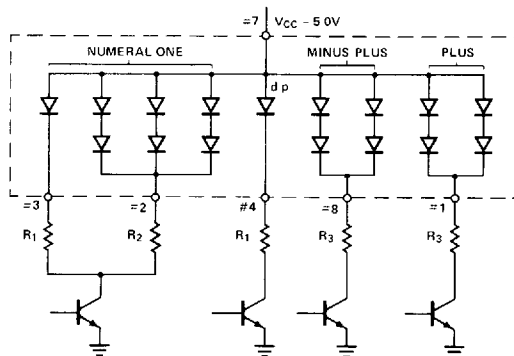


Figure 3. Typical Driving Circuit

# Luminous Intensity Per LED

(Digit Average) at  $T_A = 25^\circ\text{C}$ 

| Device    | Test Conditions       | Min. | Typ. | Units          |
|-----------|-----------------------|------|------|----------------|
| HDSP-0783 | $I_F = 2.8\text{ mA}$ | 65   | 140  | $\mu\text{cd}$ |
|           | $I_F = 8\text{ mA}$   |      | 620  | $\mu\text{cd}$ |
| HDSP-0883 | $I_F = 8\text{ mA}$   | 215  | 490  | $\mu\text{cd}$ |
| HDSP-0983 | $I_F = 8\text{ mA}$   | 298  | 1100 | $\mu\text{cd}$ |

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

| Device    | Forward Current 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            |
|           | High Brightness             | 8              | 360            | 47             |
| HDSP-0883 |                             | 8              | 360            | 36             |
| HDSP-0983 |                             | 8              | 360            | 30             |

# Electrical Characteristics ( $T_A = -55^\circ\text{C}$ to $+100^\circ\text{C}$ )

| Device    | Description                              | Symbol | Test Condition        | Min. | Typ. | Max. | Units |
|-----------|------------------------------------------|--------|-----------------------|------|------|------|-------|
| 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     |

# High Reliability Testing

Two standard reliability testing programs are available. The TXVB program is in conformance with Quality Level A Test Tables of MIL-D-87157 for hermetically sealed displays with 100% screening tests. A TXVB product is tested to Tables I, II, IIIa, and IVa. A second program is an HP modification to the full conformance program and offers the 100% screening portion of Level A, Table I, and Group A, Table II.

## PART MARKING SYSTEM

| Standard Product | With Table I and II | With Tables I, II, IIIa and IVa |
|------------------|---------------------|---------------------------------|
| HDSP-078X        | HDSP-078XTXV        | HDSP-078XTXVB                   |
| HDSP-079X        | HDSP-079XTXV        | HDSP-079XTXVB                   |
| HDSP-088X        | HDSP-088XTXV        | HDSP-088XTXVB                   |
| HDSP-098X        | HDSP-098XTXV        | HDSP-098XTXVB                   |

## 100% Screening

TABLE I. QUALITY LEVEL A OF MIL-D-87157

| Test Screen                                        | MIL-STD-750 Method | Conditions                                                                                                                                   |
|----------------------------------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Precap Visual                                   | 2072               | Interpreted by HP Procedure 5956-7572-52                                                                                                     |
| 2. High Temperature Storage                        | 1032               | $T_A = 125^\circ\text{C}$ , Time = 24 hours <sup>[4]</sup>                                                                                   |
| 3. Temperature Cycling                             | 1051               | Condition B, 10 Cycles, 15 Min. Dwell                                                                                                        |
| 4. Constant Acceleration                           | 2006               | 10,000 G at Y <sub>1</sub> orientation                                                                                                       |
| 5. Fine Leak                                       | 1071               | Condition H                                                                                                                                  |
| 6. Gross Leak                                      | 1071               | Condition C or K <sup>[5]</sup>                                                                                                              |
| 7. Interim Electrical/Optical Tests <sup>[2]</sup> | —                  | $I_V$ , $I_{CC}$ , $I_{BL}$ , $I_{BH}$ , $I_{EL}$ , $I_{EH}$ , $I_{IL}$ , and $I_{IH}$<br>$T_A = 25^\circ\text{C}$                           |
| 8. Burn-In <sup>[1, 3]</sup>                       | 1015               | Condition B at $V_{CC} = 5\text{V}$ and cycle through logic at 1 character per second.<br>$T_A = 100^\circ\text{C}$ , $t = 160\text{ hours}$ |
| 9. Final Electrical Test <sup>[2]</sup>            | —                  | Same as Step 7                                                                                                                               |
| 10. Delta Determinations                           | —                  | $\Delta I_V = -20\%$ , $\Delta I_{CC} = \pm 10\text{ mA}$ , $\Delta I_{IH} = \pm 10\mu\text{A}$<br>and $\Delta I_{EH} = \pm 13\mu\text{A}$   |
| 11. External Visual <sup>[1]</sup>                 | 2009               |                                                                                                                                              |

## Notes:

1 MIL-STD-883 Test Method applies

2 Limits and conditions are per the electrical/optical characteristics

3 Burn-in for the over range display shall use Condition B at a nominal  $I_F = 8\text{ mA}$  per LED, with all LEDs illuminated for  $T = 160\text{ hours}$  minimum4  $T_A = +100^\circ\text{C}$  for HDSP-098X Series.5. Fluid temperature =  $+100^\circ\text{C}$  for HDSP-098X Series.

**TABLE II**  
**GROUP A ELECTRICAL TESTS — MIL-D-87157**

| Test                                                                        | Parameters                                                                                                                                                                                | LTPD |
|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Subgroup 1</b><br>DC Electrical Tests at 25°C <sup>[1]</sup>             | I <sub>V</sub> , I <sub>CC</sub> , I <sub>BL</sub> , I <sub>BH</sub> , I <sub>EL</sub> , I <sub>EH</sub> , I <sub>L</sub> , and I <sub>H</sub> and visual function, T <sub>A</sub> = 25°C | 5    |
| <b>Subgroup 2</b><br>DC Electrical Tests at High Temperature <sup>[1]</sup> | Same as Subgroup 1, except delete I <sub>V</sub> and visual function T <sub>A</sub> = +100°C                                                                                              | 7    |
| <b>Subgroup 3</b><br>DC Electrical Tests at Low Temperature <sup>[1]</sup>  | Same as Subgroup 1, except delete I <sub>V</sub> and visual function T <sub>A</sub> = -55°C                                                                                               | 7    |
| <b>Subgroup 4, 5, and 6 not applicable</b>                                  |                                                                                                                                                                                           |      |
| <b>Subgroup 7</b><br>Optical and Functional Tests at 25°C                   | Satisfied by Subgroup 1                                                                                                                                                                   | 5    |
| <b>Subgroup 8</b><br>External Visual                                        | MIL-STD-883, Method 2009                                                                                                                                                                  | 7    |

**Notes:**

1 Limits and conditions are per the electrical/optical characteristics.

**TABLE IIIa**  
**GROUP B, CLASS A AND B OF MIL-D-87157**

| Test                                                               | MIL-STD-750 Method  | Conditions                                                                                                                                                                           | Sample Size              |
|--------------------------------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>Subgroup 1</b><br>Resistance to Solvents                        | 1022                |                                                                                                                                                                                      | 4 Devices/<br>0 Failures |
| Internal Visual and Design Verification <sup>[1]</sup>             | 2075 <sup>[7]</sup> |                                                                                                                                                                                      | 1 Device/<br>0 Failures  |
| <b>Subgroup 2<sup>[2,3]</sup></b><br>Solderability                 | 2026                | T <sub>A</sub> = 245°C for 5 seconds                                                                                                                                                 | LTPD = 15                |
| <b>Subgroup 3</b><br>Thermal Shock (Temp Cycle)                    | 1051                | Condition B1, 15 min Dwell                                                                                                                                                           | LTPD = 15                |
| Moisture Resistance <sup>[4]</sup>                                 | 1021                |                                                                                                                                                                                      |                          |
| Fine Leak                                                          | 1071                | Condition H                                                                                                                                                                          |                          |
| Gross Leak                                                         | 1071                | Condition C or K <sup>[9]</sup>                                                                                                                                                      |                          |
| Electrical/Optical Endpoints <sup>[5]</sup>                        | —                   | I <sub>V</sub> , I <sub>CC</sub> , I <sub>BL</sub> , I <sub>BH</sub> , I <sub>EL</sub> , I <sub>EH</sub> , I <sub>L</sub> , I <sub>H</sub> and visual function T <sub>A</sub> = 25°C |                          |
| <b>Subgroup 4</b><br>Operating Life Test (340 hrs.) <sup>[6]</sup> | 1027                | T <sub>A</sub> = +100°C at V <sub>CC</sub> = 5.0V and cycling through logic at 1 character per second                                                                                | LTPD = 10                |
| Electrical/Optical Endpoints <sup>[5]</sup>                        | —                   | Same as Subgroup 3                                                                                                                                                                   |                          |
| <b>Subgroup 5</b><br>Non-operating (Storage) Life Test (340 hrs.)  | 1032                | T <sub>A</sub> = +125°C <sup>[7,8]</sup>                                                                                                                                             | LTPD = 10                |
| Electrical/Optical Endpoints <sup>[5]</sup>                        | —                   | Same as Subgroup 3                                                                                                                                                                   |                          |

**Notes:**

- Visual inspection performed through the display window
- Whenever electrical/optical tests are not required as endpoints, electrical rejects may be used
- The LTPD applies to the number of leads inspected except in no case shall less than 3 displays be used to provide the number of leads required
- Initial conditioning is a 15° inward bend, one cycle
- Limits and conditions are per the electrical/optical characteristics
- Burn-in for the over range display shall use Condition B at a nominal I<sub>F</sub> ± 8 mA with '+' illuminated for t = 160 hours.
- Equivalent to MIL-STD-883, Method 2014
- T<sub>A</sub> = +100°C for HDSP-098X Series.
- Fluid temperature = +100°C for HDSP-098X Series.

**TABLE IVa**  
**GROUP C, CLASS A AND B OF MIL-D-87157**

| Test                                                    | MIL-STD-750 Method | Conditions                                                                                                                                                                               | Sample Size              |
|---------------------------------------------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b>Subgroup 1</b><br>Physical Dimensions                | 2066               |                                                                                                                                                                                          | 2 Devices/<br>0 Failures |
| <b>Subgroup 2</b> <sup>[2,7,9]</sup><br>Lead Integrity  | 2004               | Condition B2                                                                                                                                                                             | LTPD = 15                |
| Fine Leak                                               | 1071               | Condition H                                                                                                                                                                              |                          |
| Gross Leak                                              | 1071               | Condition C or K <sup>[10]</sup>                                                                                                                                                         |                          |
| <b>Subgroup 3</b><br>Shock                              | 2016               | 1500G, Time = 0.5 ms, 5 blows in each orientation X <sub>1</sub> , Y <sub>1</sub> , Z <sub>1</sub>                                                                                       | LTPD = 15                |
| Vibration, Variable Frequency                           | 2056               |                                                                                                                                                                                          |                          |
| Constant Acceleration                                   | 2006               | 10,000G at Y <sub>1</sub> orientation                                                                                                                                                    |                          |
| External Visual <sup>[4]</sup>                          | 1010 or 1011       |                                                                                                                                                                                          |                          |
| Electrical/Optical Endpoints <sup>[8]</sup>             | —                  | I <sub>V</sub> , I <sub>CC</sub> , I <sub>BL</sub> , I <sub>BH</sub> , I <sub>EL</sub> , I <sub>EH</sub> , I <sub>IL</sub> , I <sub>IH</sub> and visual Function, T <sub>A</sub> = 25° C |                          |
| <b>Subgroup 4</b> <sup>[1,3]</sup><br>Salt Atmosphere   | 1041               |                                                                                                                                                                                          | LTPD = 15                |
| External Visual <sup>[4]</sup>                          | 1010 or 1011       |                                                                                                                                                                                          |                          |
| <b>Subgroup 5</b><br>Bond Strength <sup>[5]</sup>       | 2037               | Condition A                                                                                                                                                                              | LTPD = 20<br>(C = 0)     |
| <b>Subgroup 6</b><br>Operating Life Test <sup>[6]</sup> | 1026               | T <sub>A</sub> = +100° C                                                                                                                                                                 | λ = 10                   |
| Electrical/Optical Endpoints <sup>[8]</sup>             | —                  | Same as Subgroup 3                                                                                                                                                                       |                          |

**Notes:**

- Whenever electrical/optical tests are not required as endpoints, electrical rejects may be used.
- The LTPD applies to the number of leads inspected except in no case shall less than three displays be used to provide the number of leads required.
- Solderability samples shall not be used.
- Visual requirements shall be as specified in MIL-STD-883, Methods 1010 or 1011.
- Displays may be selected prior to seal.
- If a given inspection lot undergoing Group B inspection has been selected to satisfy Group C inspection requirements, the 340 hour life tests may be continued on test to 1000 hours in order to satisfy the Group C Life Test requirements. In such cases, either the 340 hour endpoint measurements shall be made a basis for Group B lot acceptance or the 1000 hour endpoint measurement shall be used as the basis for both Group B and Group C acceptance.
- MIL-STD-883 test method applies.
- Limits and conditions are per the electrical/optical characteristics.
- Initial conditioning is a 15° inward bend, 3 cycles.
- Fluid temperature = +100° C for HDSP-098X Series.

T-90-20

MOTION SENSING  
AND CONTROL

## Motion Control ICS – HCTL-XXXX Series

| Package Outline Drawing | Part No.              | Package | Description                                                                                                   | Page No. |
|-------------------------|-----------------------|---------|---------------------------------------------------------------------------------------------------------------|----------|
|                         | HCTL-1100             | PDIP    | CMOS General Purpose Motion Control IC                                                                        | 1-104    |
|                         | HCTL-1100 OPT PLC     | PLCC    | CMOS General Purpose Motion Control IC                                                                        |          |
|                         | HCTL-2000             | PDIP    | CMOS Quadrature Decoder/Counter IC, 12-bit Counter                                                            | 1-86     |
|                         | HCTL-2016             | PDIP    | CMOS Quadrature Decoder/Counter IC, 16-bit Counter                                                            |          |
|                         | New HCTL-2016 OPT PLC | PLCC    | CMOS Quadrature Decoder/Counter IC, 16-bit Counter                                                            | 1-102    |
|                         | HCTL-2020             | PDIP    | CMOS Quadrature Decoder/Counter IC, 16-bit Counter, Quadrature Decoder Output Signals, Cascade Output Signals | 1-86     |
|                         | New HCTL-2020 OPT PLC | PLCC    | CMOS Quadrature Decoder/Counter IC, 16-bit Counter, Quadrature Decoder Output Signals, Cascade Output Signals |          |

**Accessories for Encoders and Encoder Modules**

| Package Outline Drawing                                                           | Part No.              | Description                                                                                                                                                                           | Page No.             |
|-----------------------------------------------------------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|  | HEDS-8902             | 4-wire connector with 15.5 cm (6.1 in.) flying leads. Locks into HEDS-5500 and HEDS-5600 2 channel encoders. Also fits HEDS-9000, HEDS-9100, and HEDS-9200 2 channel encoder modules. | 1-61<br>1-22<br>1-28 |
|  | HEDS-8903             | 5-wire connector with 15.5 cm (6.1 in.) flying leads. Locks into HEDS-5540 and HEDS-5640 three channel encoders. Also fits HEDS-9040 and HEDS-9140 three channel encoder modules.     | 1-61<br>1-32         |
|                                                                                   | HEDS-8905             | Alignment Tool for HEDS-9140                                                                                                                                                          | 1-32                 |
|                                                                                   | HEDS-8906             | Alignment Tool for HEDS-9040                                                                                                                                                          | 1-32                 |
|                                                                                   | HEDS-8901             | Gap Setting shown for film codewheels                                                                                                                                                 | 1-51                 |
|                                                                                   | HEDS-8932             | Gap Setting shown for glass codewheels                                                                                                                                                | 1-51                 |
|                                                                                   | HEDS-8910<br>OPT 0 □□ | Alignment Tool for HEDS-5540/5545 and HEDS-5640/5645.<br>Order in appropriate shaft size.                                                                                             | 1-61                 |