HEWLETT PACKARD

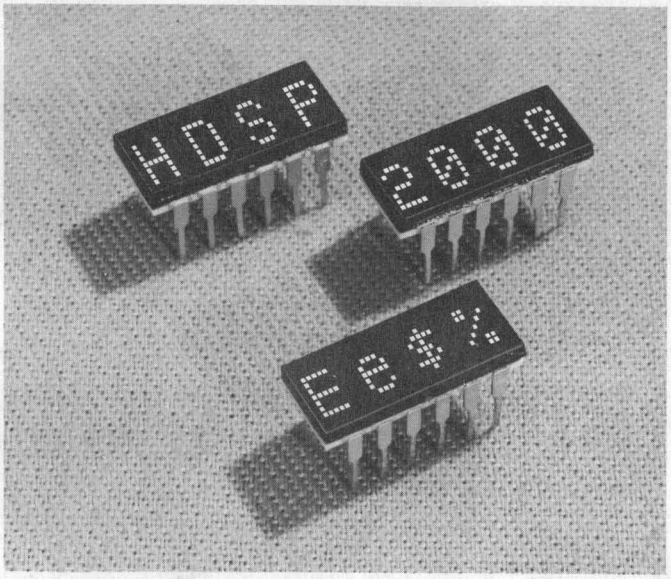
RED FOUR CHARACTER SOLID STATE ALPHANUMERIC DISPLAY

HDSP-2000

TECHNICAL DATA MARCH 1980

Features

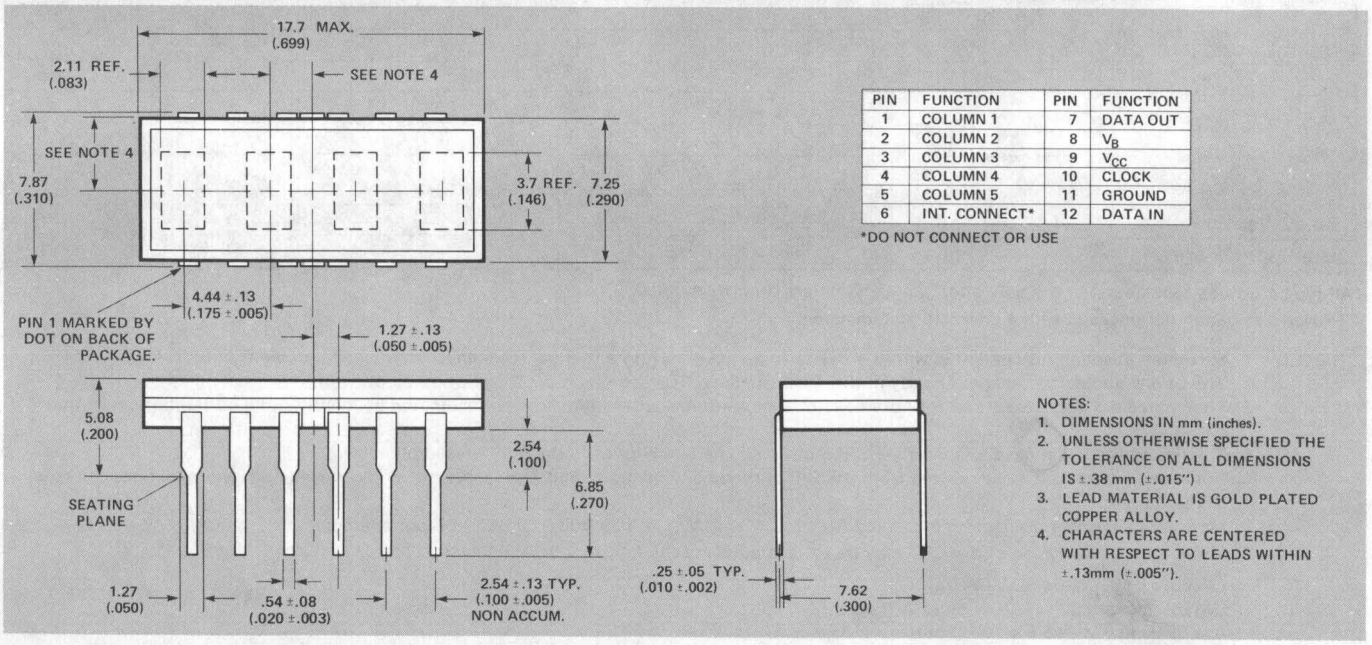
- **INTEGRATED SHIFT REGISTERS WITH CONSTANT CURRENT DRIVERS**
- **CERAMIC 7.62 mm (.3 in.) DIP**
  Integral Red Glass Contrast Filter
- **WIDE VIEWING ANGLE**
- **END STACKABLE 4 CHARACTER PACKAGE**
- **PIN ECONOMY**
  12 Pins for 4 Characters
- **TTL COMPATIBLE**
- **5x7 LED MATRIX DISPLAYS FULL ASCII CODE**
- **RUGGED, LONG OPERATING LIFE**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  Assures Ease of Package to Package Brightness Matching



Description

The HP HDSP-2000 display is a 3.8mm (0.15 inch) 5x7 LED array for display of alphanumeric information. The device is available in 4 character clusters and is packaged in a 12-pin dual-in-line type package. An on-board SIPO (serial-in-parallel-out) 7 bit shift register associated with each digit controls constant current LED row drivers. Full character display is achieved by external column strobing. The constant current LED drivers are externally programmable and typically capable of sinking 13.5mA peak per diode. Applications include interactive I/O terminals, point of sale equipment, portable telecommunications gear, and hand held equipment requiring alphanumeric displays.

Package Dimensions



PIN	FUNCTION	PIN	FUNCTION
1	COLUMN 1	7	DATA OUT
2	COLUMN 2	8	V_B
3	COLUMN 3	9	V_{CC}
4	COLUMN 4	10	CLOCK
5	COLUMN 5	11	GROUND
6	INT. CONNECT*	12	DATA IN

*DO NOT CONNECT OR USE

NOTES:
1. DIMENSIONS IN mm (inches).
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ±.38 mm (±.015").
3. LEAD MATERIAL IS GOLD PLATED COPPER ALLOY.
4. CHARACTERS ARE CENTERED WITH RESPECT TO LEADS WITHIN ±.13mm (±.005").

Absolute Maximum Ratings

Supply Voltage V_{CC} to Ground ..... −0.5V to 6.0V
Inputs, Data Out and V_B ..... −0.5V to V_{CC}
Column Input Voltage, V_{COL} ..... −0.5V to +6.0V
Free Air Operating Temperature Range, T_A[2] ..... −20°C to +70°C
Storage Temperature Range, T_S ..... -55°C to +100°C
Maximum Allowable Package Dissipation at $T_A = 25°C$[1,2,6] ..... 1.70 Watts
Maximum Solder Temperature 1.59mm (.063") Below Seating Plane t<5 secs ..... 260°C

Recommended Operating Conditions

Parameter	Symbol	Min.	Nom.	Max.	Units
Supply Voltage	V_{CC}	4.75	5.0	5.25	V
Data Out Current, Low State	I_{OL}			1.6	mA
Data Out Current, HighState	I_{OH}			−0.5	mA
Column Input Voltage, Column On	V_{COL}	2.6		V_{CC}	V
Setup Time	t_{setup}	70	45		ns
Hold Time	t_{hold}	30	0		ns
Width of Clock	$t_{w(Clock)}$	75			ns
Clock Frequency	f_{clock}	0		3	MHz
Clock Transition Time	t_{THL}			200	ns
Free Air Operating Temperature Range	T_A	−20		70	°C

Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified.)

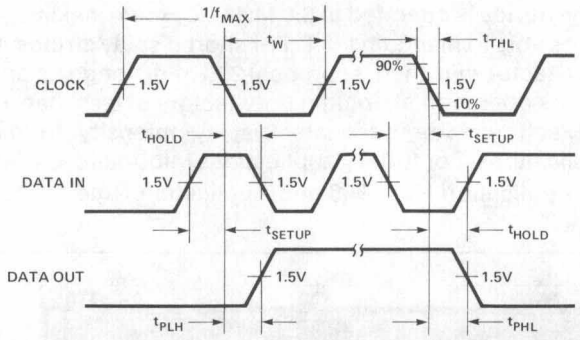
Description		Symbol	Test Conditions		Min.	Typ.*	Max.	Units
Supply Current		I_{CC}	V_{CC} = 5.25V, $V_{CLOCK} = V_{DATA}$ = 2.4V, All SR Stages = Logical 1	V_B = 0.4V		45	60	mA
				V_B = 2.4V		73	95	mA
Column Current at any Column Input		I_{COL}	V_{CC} = 5.25V, V_{COL} = 3.5V	V_B=0.4V			1.5	mA
Column Current at any Column Input		I_{COL}	All SR Stages = Logical 1	V_B=2.4V		335	410	mA
Peak Luminous Intensity per LED[3,7] (Character Average)		I_{vPEAK}	V_{CC} = 5.0V, V_{COL} = 3.5V, T_i = 25°C[4]	V_B=2.4V	105	200		µcd
V_B, Clock or Data Input Threshold High		V_{IH}	$V_{CC} = V_{COL}$ = 4.75V		2.0			V
V_B, Clock or Data Input Threshold Low		V_{IL}					0.8	V
Input Current Logical 1	V_B, Clock	I_{IH}	V_{CC} = 5.25V, V_{IH} = 2.4V			20	80	µA
	Data In	I_{IH}				10	40	µA
Input Current Logical 0	V_B,Clock	I_{IL}	V_{CC} = 5.25V, V_{IL} = 0.4V			-500	-800	µA
	Data In	I_{IL}				-250	-400	µA
Data Out Voltage		V_{OH}	V_{CC} = 4.75V, I_{OH} = −0.5mA, V_{COL} = 0V		2.4	3.4		V
		V_{OL}	V_{CC} = 4.75V, I_{OL} = 1.6mA, V_{COL} = 0V			0.2	0.4	V
Power Dissipation Per Package**		P_D	V_{CC} = 5.0V, V_{COL} = 2.6V, 15 LEDs on per character, V_B = 2.4V			0.66		W
Peak Wavelength		λ_{PEAK}				655		nm
Dominant Wavelength[5]		λ_d				639		nm

*All typical values specified at V_{CC} = 5.0V and T_A = 25°C unless otherwise noted.

**Power dissipation per package with 4 characters illuminated.

NOTES:
1. Maximum absolute dissipation is with the device in a socket having a thermal resistance from pins to ambient of 35°C/watt.
2. The device should be derated linearly above 25°C at 16mW/°C (see Electrical Description on page 3).
3. The characters are categorized for Luminous Intensity with the intensity category designated by a letter code on the bottom of the package.
4. T_i refers to the initial case temperature of the device immediately prior to the light measurement.
5. Dominant wavelength λ_d, is derived from the CIE chromaticity diagram, and represents the single wavelength which defines the color of the device.
6. Maximum allowable dissipation is derived from $V_{CC} = V_B = V_{COL}$ = 5.25 Volts, 20 LEDs on per character.
7. The luminous stearance of the LED may be calculated using the following relationships:

L_v (Lux) = I_v (Candela)/A (Metre)^2
L_v (Footlamberts) = πI_v (Candela)/A (Foot)^2
A = 5.3 x 10^{-8} M^2 = 5.8 x 10^{-7} (Foot)^2



Parameter	Condition	Min.	Typ.	Max.	Units
f_{clock} CLOCK Rate				3	MHz
t_{PLH}, t_{PHL} Propagation delay CLOCK to DATA OUT	C_L = 15pF R_L=2.4KΩ			125	ns

Figure 1. Switching Characteristics. (V_{CC} = 5V, T_A = -20°C to +70°C)

Mechanical and Thermal Considerations

The HDSP-2000 is available in a standard 12 lead ceramic-glass dual in-line package. It is designed for plugging into DIP sockets or soldering into PC boards. The packages may be horizontally or vertically stacked for character arrays of any desired size.

The -2000 can be operated over a wide range of temperature and supply voltages. Full power operation at T_A = 25°C (V_{CC} = V_B = V_{COL} = 5.25V) is possible by providing a total thermal resistance from the seating plane of the pins to ambient of 35°C/W/cluster maximum. For operation above T_A = 25°C, the maximum device dissipation should be derated above 25°C at 16mW/°C (see Figure 2). Power derating can be achieved by either decreasing V_{COL} or decreasing the average drive current through pulse width modulation of V_B.

The -2000 display has an integral contrast enhancement filter in the glass lens. Additional front panel contrast filters may by desirable in most actual display applications. Some suggested filters are Panelgraphic Ruby Red 60, SGL Homalite H100-1605 and Plexiglass 2423. Hewlett-Packard Application Note 964 treats this subject in greater detail.

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.

Electrical Description

The HDSP-2000 four character alphanumeric display has been designed to allow the user maximum flexibility in interface electronics design. Each four character display module features Data In and Data Out terminals arrayed for easy PC board interconnection such that display strings of up to 80 digits may be driven from a single character generator. Data Out represents the output of the 7th bit of digit number 4 shift register. Shift register clocking occurs on the high to low transition of the Clock input. The like columns of each character in a display cluster are tied to a single pin. Figure 5 is the block diagram for the HDSP-2000. High true data in the shift register enables the output current mirror driver stage associated with each row of LEDs in the 5x7 diode array.

The reference current for the current mirror is generated from the output voltage of the V_B input buffer applied across the resistor R. The TTL compatible V_B input may either be tied to V_{CC} for maximum display intensity or pulse width modulated to achieve intensity control and reduction in power consumption.

The normal mode of operation is depicted in the block diagram of Figure 6. In this circuit, binary input data for digit 4, column 1 is decoded by the 7 line output ROM and then loaded into the 7 on board shift register locations 1 through 7 through a parallel-in-serial-out shift register. Column 1 data for digits 3, 2 and 1 is similarly decoded and shifted into the display shift register locations. The column 1 input is now enabled for an appropriate period of time, T. A similar process is repeated for columns 2, 3, 4 and 5. If the time necessary to decode and load data into the shift register is t, then with 5 columns, each column of the display is operating at a duty factor of:

$$D.F. = \frac{T}{5(t+T)}$$

The time frame, t + T, allotted to each column of the display is generally chosen to provide the maximum duty factor consistent with the minimum refresh rate necessary

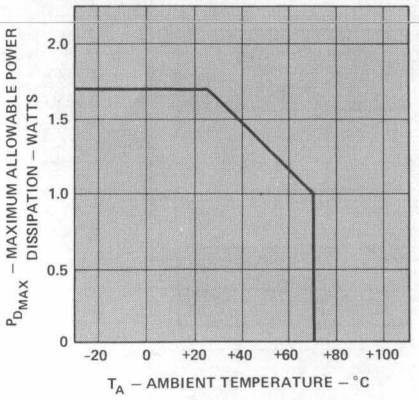


Figure 2. Maximum Allowable Power Dissipation vs. Temperature.

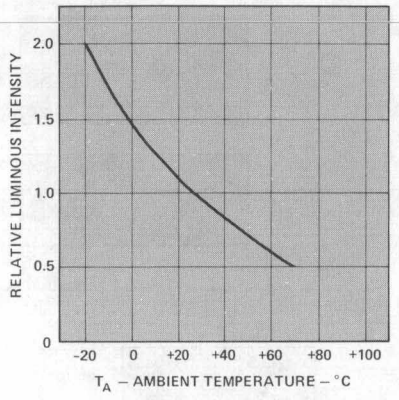


Figure 3. Relative Luminous Intensity vs. Temperature.

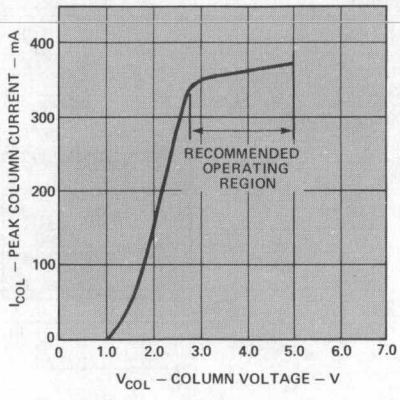


Figure 4. Peak Column Current vs. Column Voltage.

to achieve a flicker free display. For most strobed display systems, each column of the display should be refreshed (turned on) at a minimum rate of 100 times per second.

With 5 columns to be addressed, this refresh rate then gives a value for the time t + T of:

$1/[5 \times (100)] = 2$ msec.

If the device is operated at 3.0 MHz clock rate maximum, it is possible to maintain $t \ll T$. For short display strings, the duty factor will then approach 20%. For longer display strings operation at column duty factors of less than 10% will still provide adequate display intensity in most applications. For further applications information, refer to HP Application Note 966 and Application Note 1001.

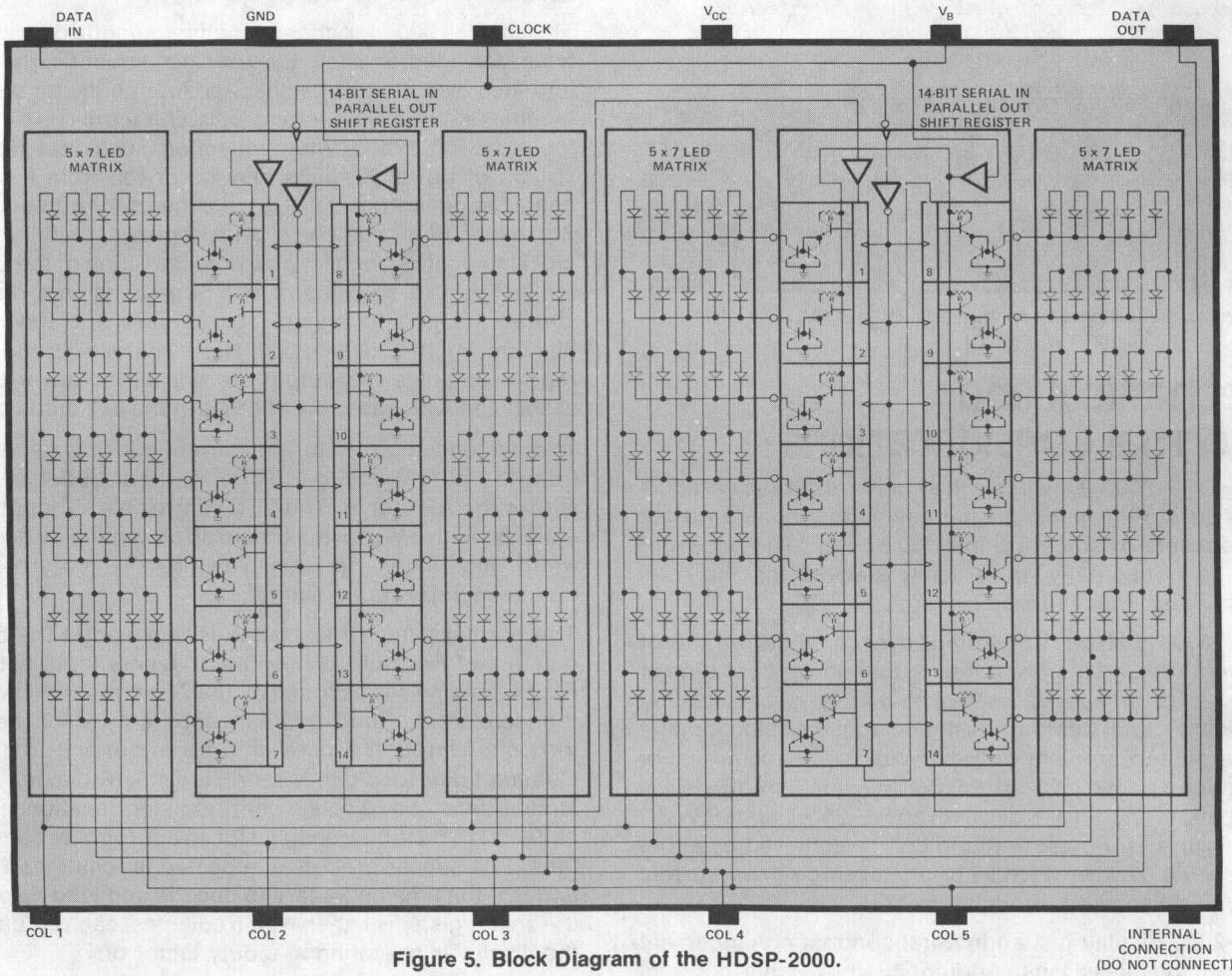


Figure 5. Block Diagram of the HDSP-2000.

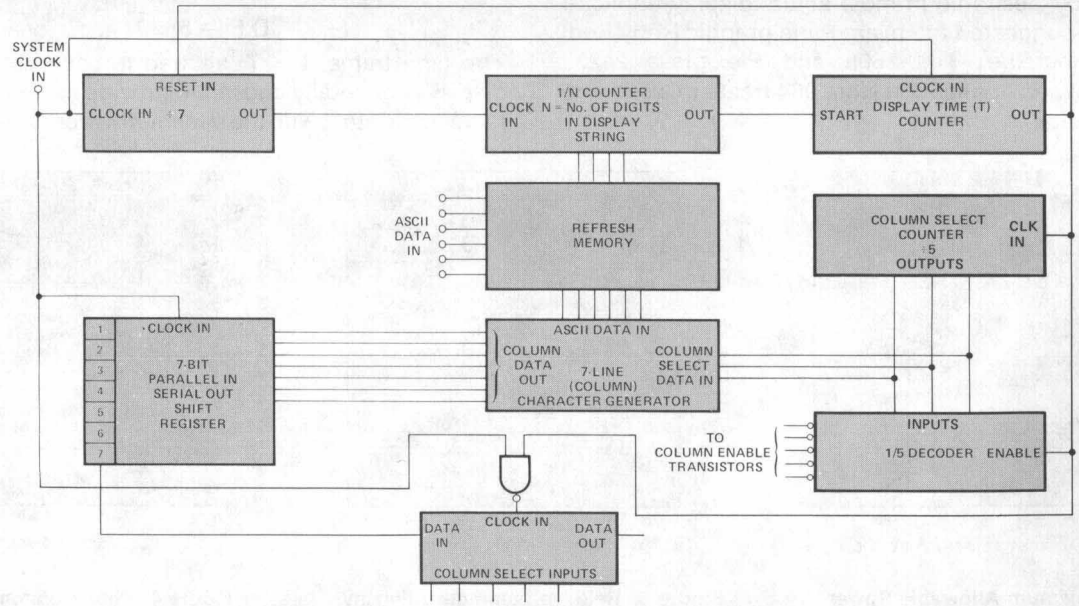


Figure 6. Block Diagram of a Basic Display System.

For more information call your local HP Sales Office or East (301) 948-6370 — Midwest (312) 255-9800 — South (404) 955-1500 — West (213) 970-7500. Or write: Hewlett-Packard Components, 640 Page Mill Road, Palo Alto, California 94304. In Europe, Hewlett-Packard GmbH, P.O. Box 250, Herrenberger Str. 110, D-7030 Boeblingen, West Germany. In Japan, YHP, 3-29-21, Takaido-Higashi, Suginami-Ku, Tokyo, 168.

Printed in U.S.A. Data Subject to Change (8/77) 5953-0428 (3/80)

HEWLETT PACKARD

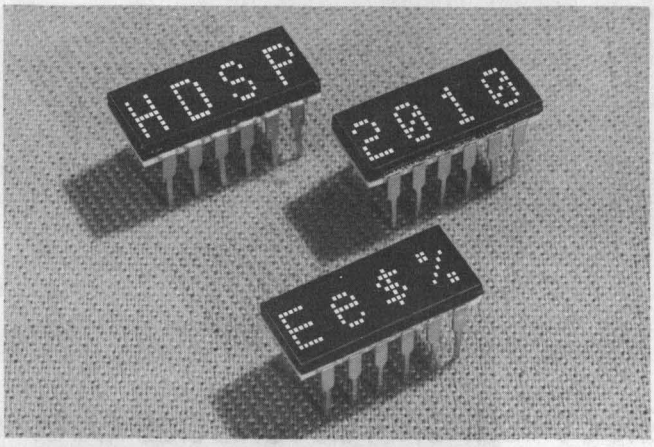
FOUR CHARACTER RED ALPHANUMERIC DISPLAY FOR EXTENDED TEMPERATURE APPLICATIONS

HDSP-2010

TENTATIVE DATA JANUARY 1980

Features

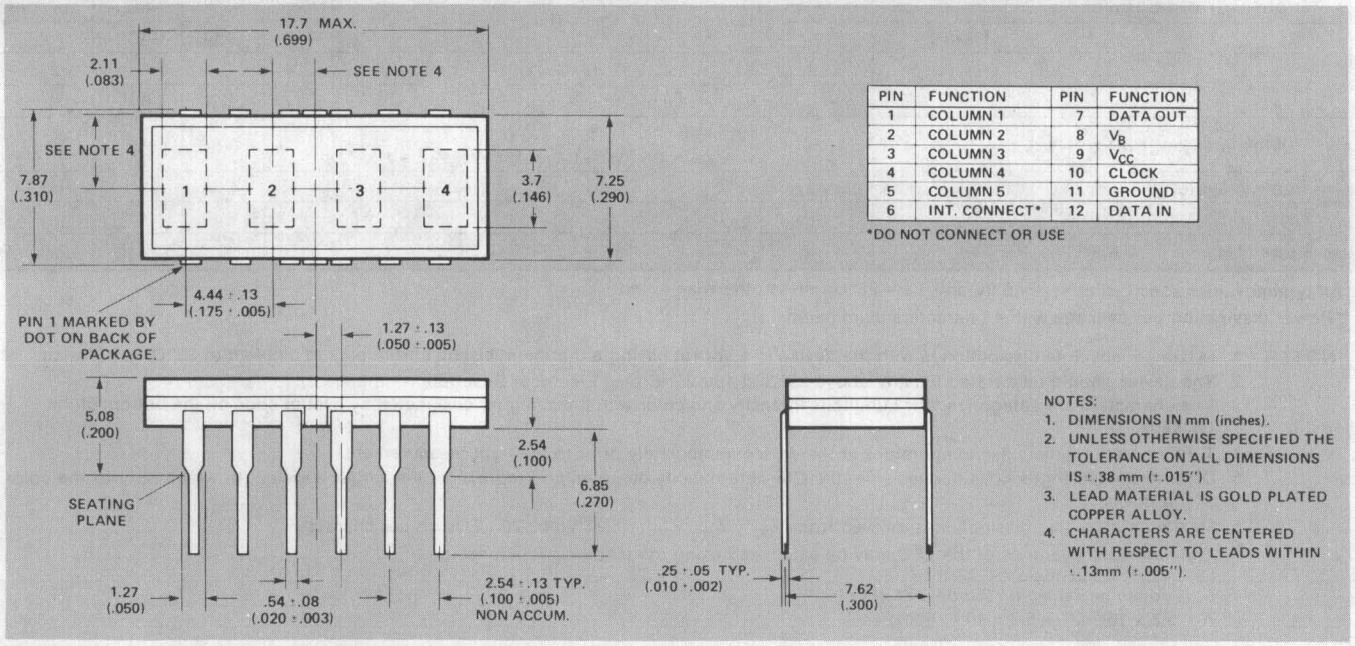
- **OPERATION GUARANTEED TO T_A = -40° C**
- **HERMETICITY GUARANTEED TXV Screening Available**
- **100% TEMPERATURE CYCLED -55° C to +100° C**
- **GOLD PLATED LEADS**
- **INTEGRATED SHIFT REGISTERS WITH CONSTANT CURRENT DRIVERS**
- **CERAMIC 7.62mm (.3 in.) DIP Integral Red Glass Contrast Filter**
- **WIDE VIEWING ANGLE**
- **END STACKABLE 4 CHARACTER PACKAGE**
- **PIN ECONOMY 12 Pins for 4 Characters**
- **TTL COMPATIBLE**
- **5 x 7 LED MATRIX DISPLAYS FULL ASCII CODE**
- **RUGGED, LONG OPERATING LIFE**
- **CATEGORIZED FOR LUMINOUS INTENSITY Assures Ease of Package to Package Brightness Matching**



Description

The HP HDSP-2010 display is designed for use in applications requiring high reliability. The character font is a 3.8mm (0.15 inch) 5 x 7 red LED array for displaying alphanumeric information. The device is available in 4 character clusters and is packaged in a 12-pin dual-in-line type package. An on-board SIPO (serial-in-parallel-out) 7-bit shift register associated with each digit controls constant current LED row drivers. Full character display is achieved by external column strobing. The constant current LED drivers are externally programmable and typically capable of sinking 13.5mA peak per diode. Applications include interactive I/O terminals, avionics, portable telecommunications gear, and hand held equipment requiring alphanumeric displays.

Package Dimensions



PIN	FUNCTION	PIN	FUNCTION
1	COLUMN 1	7	DATA OUT
2	COLUMN 2	8	V_B
3	COLUMN 3	9	V_{CC}
4	COLUMN 4	10	CLOCK
5	COLUMN 5	11	GROUND
6	INT. CONNECT*	12	DATA IN

*DO NOT CONNECT OR USE

NOTES:
1. DIMENSIONS IN mm (inches).
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ±.38 mm (±.015").
3. LEAD MATERIAL IS GOLD PLATED COPPER ALLOY.
4. CHARACTERS ARE CENTERED WITH RESPECT TO LEADS WITHIN ±.13mm (±.005").

Absolute Maximum Ratings

Supply Voltage V_{CC} to Ground ..... −0.5V to 6.0V
Inputs, Data Out and V_B ..... −0.5V to V_{CC}
Column Input Voltage, V_{COL} ..... −0.5V to +6.0V
Free Air Operating Temperature
Range, T_A[2] ..... −40° C to +70° C

Storage Temperature Range, T_S ..... -55° C to +100° C
Maximum Allowable Package Dissipation
at T_A = 25° C[1,2,6] ..... 1.70 Watts
Maximum Solder Temperature 1.59mm (.063")
Below Seating Plane t<5 secs ..... 260° C

Recommended Operating Conditions

Parameter	Symbol	Min.	Nom.	Max.	Units
Supply Voltage	V_{CC}	4.75	5.0	5.25	V
Data Out Current, Low State	I_{OL}			1.6	mA
Data Out Current, HighState	I_{OH}			−0.5	mA
Column Input Voltage, Column On	V_{COL}	2.6		V_{CC}	V
Setup Time	t_{setup}	70	45		ns
Hold Time	t_{hold}	30	0		ns
Width of Clock	$t_{w(Clock)}$	75			ns
Clock Frequency	f_{clock}	0		3	MHz
Clock Transition Time	t_{THL}			200	ns
Free Air Operating Temperature Range	T_A	-40		70	°C

Electrical Characteristics Over Operating Temperature Range

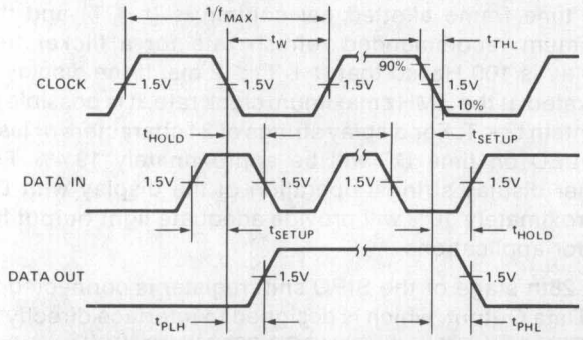
(Unless otherwise specified.)

Description		Symbol	Test Conditions		Min.	Typ.*	Max.	Units
Supply Current		I_{CC}	V_{CC} = 5.25V, V_{CLOCK} = V_{DATA} = 2.4V, All SR Stages = Logical 1	V_B = 4.0V		45	60	mA
				V_B = 2.4V		73	95	mA
Column Current at any Column Input		I_{COL}	V_{CC} = 5.25V, V_{COL} = 3.5V, All SR Stages = Logical 1	V_B = 0.4V			1.5	mA
Column Current at any Column Input		I_{COL}		V_B = 2.4V		350	435	mA
Peak Luminous Intensity per LED[3,7] (Character Average)		I_{vPEAK}	V_{CC} = 5.0V, V_{COL} = 3.5V, T_i = 25° C[4] V_B = 2.4V		105	200		μcd
V_B, Clock or Data Input Threshold High		V_{IH}	V_{CC} = V_{COL} = 4.75V		2.0			V
V_B, Data Input Threshold Low		V_{IL}					0.8	V
Clock Threshold Low		V_{IL}					0.6	V
Input Current Logical 1	V_B, Clock	I_{IH}	V_{CC} = 5.25V, V_{IH} = 2.4V			20	80	μA
	Data In	I_{IH}				10	40	μA
Input Current Logical 0	V_B, Clock	I_{IL}	V_{CC} = 5.25V, V_{IL} = 0.4V			-500	-800	μA
	Data In	I_{IL}				-250	-400	μA
Data Out Voltage		V_{OH}	V_{CC} = 4.75V, I_{OH} = -0.5mA, V_{COL} = 0V		2.4	3.4		V
		V_{OL}	V_{CC} = 4.75V, I_{OL} = 1.6mA, V_{COL} = 0V			0.2	0.4	V
Power Dissipation Per Package**		P_D	V_{CC} = 5.0V, V_{COL} = 2.6V, 15 LEDs on per character, V_B = 2.4V			0.66		W
Peak Wavelength		λ_{PEAK}				655		nm
Dominant Wavelength[5]		λ_d				640		nm
Leak Rate							5 x 10^{-7}	cc/s

*All typical values specified at V_{CC} = 5.0V and T_A = 25°C unless otherwise noted.

**Power dissipation per package with 4 characters illuminated.

NOTES:
1. Maximum absolute dissipation is with the device in a socket having a thermal resistance from pins to ambient of 35° C/watt/device.
2. The device should be derated linearly above 25° C at 16mW/° C (see Electrical Description on page 3).
3. The characters are categorized for Luminous Intensity and color with the category designated by a letter code on the bottom of the package.
4. T_i refers to the initial case temperature of the device immediately prior to the light measurement.
5. Dominant wavelength λ_d, is derived from the CIE chromaticity diagram, and represents the single wavelength which defines the color of the device.
6. Maximum allowable dissipation is derived from V_{CC} = V_B = V_{COL} = 5.25 Volts, 20 LEDs on per character.
7. The luminous stearance of the LED may be calculated using the following relationships:
   L_v (Lux) = I_v (Candela)/A (Metre)^2
   L_v (Footlamberts) = πI_v (Candela)/A (Foot)^2
   A = 5.3 x 10^{-8} M^2 = 5.8 x 10^{-7} (Foot)^2



Parameter	Condition	Min.	Typ.	Max.	Units
f_{clock} CLOCK Rate				3	MHz
t_{PLH}, t_{PHL} Propagation delay CLOCK to DATA OUT	C_L = 15pF R_L=2.4KΩ			125	ns

Figure 1. Switching Characteristics. (V_{CC} = 5V, T_A = -40°C to +70°C)

Mechanical and Thermal Considerations

The HDSP-2010 is available in a standard 12 lead ceramic-glass dual in-line package. It is designed for plugging into DIP sockets or soldering into PC boards. The packages may be horizontally or vertically stacked for character arrays of any desired size.

The HDSP-2010 can be operated over a wide range of temperature and supply voltages. Full power operation at T_A = 25°C (V_{CC} = V_B = V_{COL} = 5.25V) is possible by providing a total thermal resistance from the seating plane of the pins to ambient of 35°C/W/device maximum. For operation above T_A = 25°C, the maximum device dissipation should be derated above 25°C at 16mW/°C (see Figure 2). Power derating can be achieved by either decreasing V_{COL} or decreasing the average drive current through pulse width modulation of V_B.

The HDSP-2010 display has an integral red glass lens. A front panel contrast filter is desirable in most actual display applications. Some suggested filters are Panel graphic Ruby Red 60, SGL Homalite H100-1605 Red and 3M Light Control Film (louvered filters). OCLI Sungard optically coated glass filters offer superior contrast enhancement.

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.

Electrical Description

The HDSP-2010 display provides on-board storage of decoded column data and constant current sinking row drivers for each of 28 rows in the 4 character display. The device consists of four LED matrices and two integrated circuits that form a 28-bit serial input-parallel output (SIPO) shift register, see Figure 5. Each character is a 5 x 7 diode array arranged with the cathodes of each row connected to one constant current sinking output of the SIPO shift register. The anodes of each column are connected together, with the same column of each of the 4 characters connected together (i.e. column 1 of all four characters are connected to pin 1). Any LED within any character may be addressed by shifting data to the appropriate shift register location and applying a voltage to the appropriate column.

Associated with each shift register location is a constant current sinking LED driver, capable of sinking a nominal 13.5 mA. A logical 1 loaded into a shift register location enables the current source at that location. A voltage applied to the appropriate column input turns on the desired LED.

The display is column strobed on a 1 of 5 basis by loading 7 bits of row data per character for a selected column. The data is shifted through the SIPO shift register, one bit location for each high-to-low transition of the clock. When the HDSP-2010 display is operated with pin 1 in the lower left hand corner, the first bit that is loaded into the SIPO shift register will be the information for row 7 of the right most character. The 28th bit loaded into the SIPO shift register will be the information for row 1 of the left most character. When the 28 bits of row data for column 1 have been loaded into the SIPO shift register, the first column is energized for a time period, T, illuminating column 1 in all four characters. Column 1 is turned off and the process is repeated for columns 2 through 5.

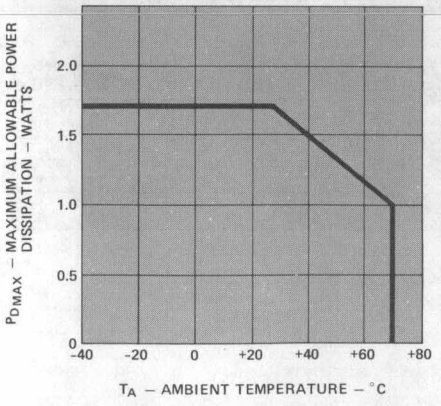


Figure 2. Maximum Allowable Power Dissipation vs. Temperature.

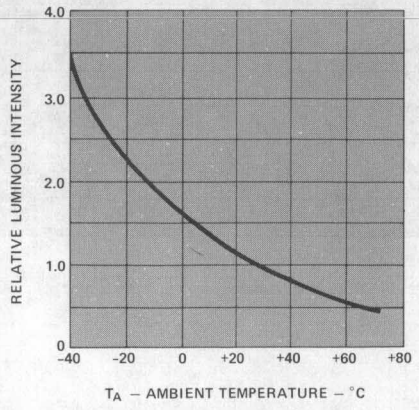


Figure 3. Relative Luminous Intensity vs. Temperature.

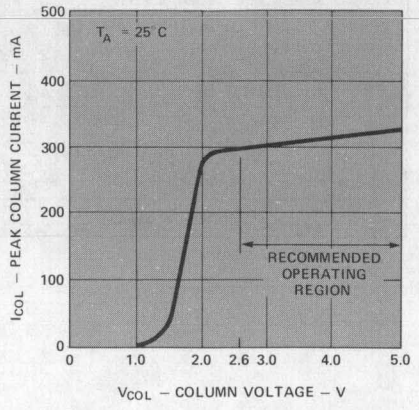


Figure 4. Peak Column Current vs. Column Voltage.

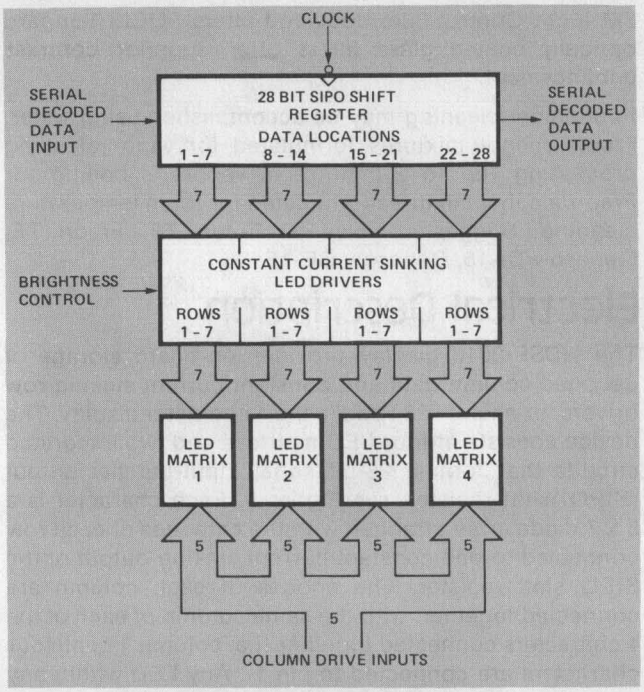


Figure 5. Block Diagram of the HDSP-2010 Display

Knowing the time period, t, to load the data into the display, the LED on time duty factor, DF, may be determined

$$DF = \frac{T}{5(t+T)}$$

The time frame allotted per column is $(t + T)$ and the minimum recommended refresh rate for a flicker free display is 100 Hz, so that $(t + T) \leq 2$ ms. If the display is operated at the 3 MHz maximum clock rate, it is possible to maintain $t << T$. For display strings of 24 characters or less, the LED on time DF will be approximately 19.4%. For longer display strings, operation of the display with DF approximately 10% will provide adequate light output for indoor applications.

The 28th stage of the SIPO shift register is connected to the Data Output, which is designed to interface directly to the Data Input of the next HDSP-2010 in the display string.

The V_B input may be used to control the apparent brightness of the display. A logic high applied to the V_B input enables the display to be turned ON, and a logic low blanks the display by disabling the constant current LED drivers. Therefore, the time average luminous intensity of the display can be varied by pulse width modulation of V_B. For application and drive circuit information refer to HP Application Notes 966 and 1001.

High Reliability Test Program

Hewlett-Packard provides standard high reliability test programs in order to facilitate the use of HP products in military programs. The TXV prefix identifies a part which has been preconditioned and screened per Table 1.

PART NUMBER SYSTEM

Standard Product	With TXV Screening
HDSP-2010	TXV-2010

TABLE 1. TXV Preconditioning and Screening — 100%

Examination or Test	MIL-STD-883 Methods	Conditions
1. Internal Visual Inspection	OED Procedure	
2. High Temperature Storage	1008	100° C, 24 Hrs.
3. Temperature Cycling	1010	-55° C to +100° C, 10 Cycles
4. Constant Acceleration	2001	2,000 G's, Y_1 Orientation
5. Fine Leak	1014	Condition A
6. Gross Leak	1014	Condition C, Inspect at 100° C
7. Electrical Test: (I_V, I_{CC}, I_{COL}, I_{IL}, I_{IH}, V_{OH}, V_{OL})		
8. Burn-In	1015	T_A = 70° C, t = 168 hrs. P_D = .9W Max
9. Electrical Test: (I_V, I_{CC}, I_{COL}, I_{IL}, I_{IH}, V_{OH}, V_{OL})		
10. External Visual	2009	