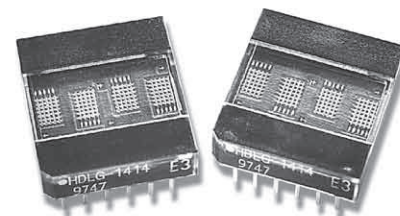


# HDLX-1414 Series

## Four-Character Smart Alphanumeric Displays



### Description

These Broadcom® 3.7-mm (0.145-in.) four-character 5 × 7 dot matrix displays are driven by an on-board CMOS IC. These displays are pin for pin compatible with the HPDL-1414. The IC stores and decodes 7-bit ASCII data and displays it in an easy to read 5 × 7 font. Multiplexing and LED drive circuitry are also included in the display, and fast setup and hold times allow it to interface easily with common microprocessors.

The address and data inputs can be directly connected to microprocessor address and data buses.

The HDLX-1414 offers a larger character set than the HPDL-1414. Lowercase letters and special symbols are now offered, made possible by the 5 × 7 dot matrix character layout.

The difference between the sunlight-viewable HDLS-1414 and the low-power HDLU-1414 lies in the brightness level. The sunlight-viewable version is internally set to provide high-intensity characters. The low-power version uses the same bright LED technology, but reduces the current through each LED to a much lower level, and maintains an intensity comparable to the HDLO-1414.

### Devices

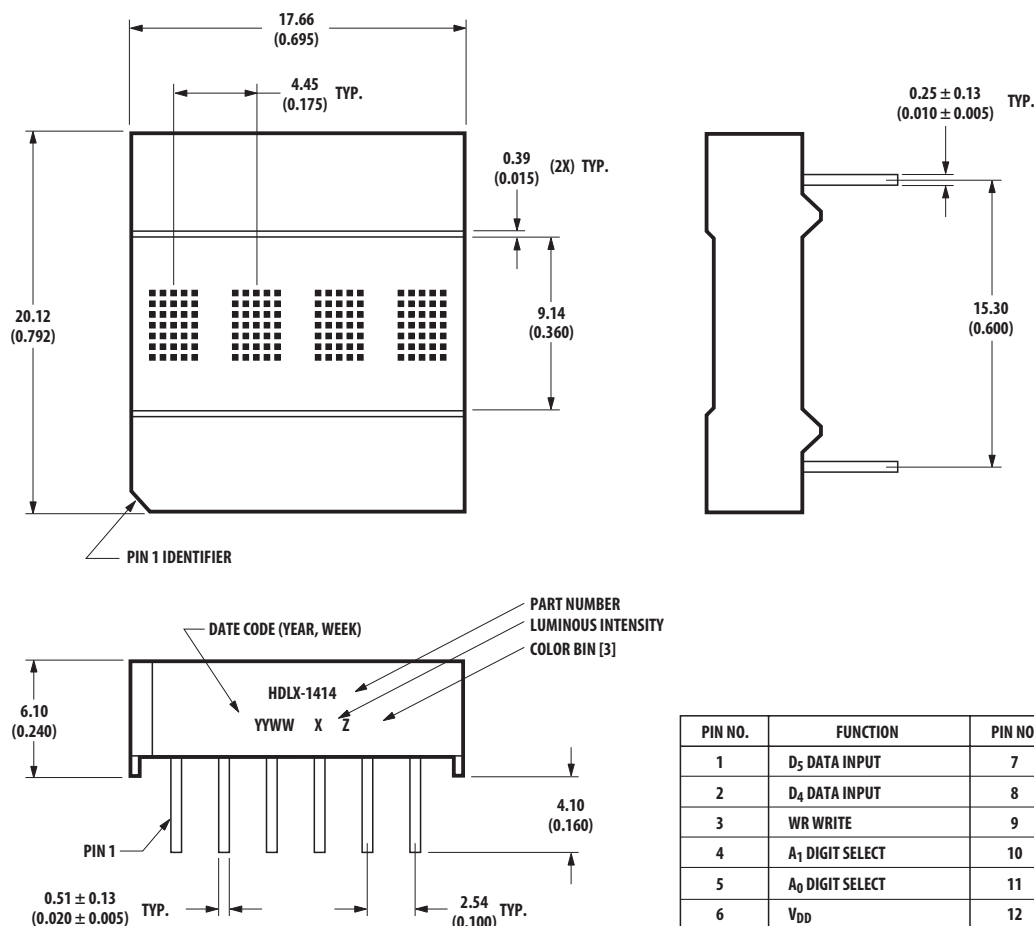
Deep Red	High Efficiency Red	Orange	Yellow	Green
HDLS-1414 (sunlight view.)	HDLO-1414	HDLA-1414	HDLY-1414	HDLG-1414
HDLU-1414 (low power)				

**ESD Warning:** Observe standard CMOS handling precautions with the HDLX-1414.

### Features

- Dot matrix replacement of HPDL-1414
- Smart alphanumeric display  
Built-in RAM, ASCII decoder, and LED drive circuitry
- 128 ASCII character set
- End stackable
- Categorized for luminous intensity; Yellow and Green categorized for color
- Low-power and sunlight-viewable AlInGaP Deep Red versions
- Wide viewing angle (50° typical)

## Package Dimensions



DIMENSIONS ARE IN MILLIMETERS (INCHES).





























































































































PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	D <sub>5</sub> DATA INPUT	7	GROUND
2	D <sub>4</sub> DATA INPUT	8	D <sub>0</sub> DATA INPUT
3	WR WRITE	9	D <sub>1</sub> DATA INPUT
4	A <sub>1</sub> DIGIT SELECT	10	D <sub>2</sub> DATA INPUT
5	A <sub>0</sub> DIGIT SELECT	11	D <sub>3</sub> DATA INPUT
6	V <sub>DD</sub>	12	D <sub>6</sub> DATA INPUT

## Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Units
Supply Voltage, VDD to Ground <sup>a</sup>		-0.5	—	7.0	V
Input Voltage, Any Pin to Ground		-0.5	—	+0.5	V to V <sub>DD</sub>
Free Air Operating Temperature Range	T <sub>A</sub>	-40	—	+85	°C
Storage Temperature	T <sub>S</sub>	-40	—	+100	°C
CMOS IC Junction Temperature		—	—	+150	°C
Relative Humidity (Noncondensing) at +65°C		—	85%	—	
Soldering Temperature (1.59 mm [0.063 in.] Below Body)					
Solder Dipping		260°C for 5s			
Wave Soldering		250°C for 3s			
ESD Classification, R = 1.5 kΩ, C = 100 pF		Class 1 (0 to 1999V)			

a. Maximum voltage is with no LEDs illuminated.

Character Set

ASCII CODE				D0	0	1	0	1	0	1	0	1	0	1	0	1	0	1		
				D1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
				D2	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
				D3	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
D6	D5	D4	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	0	0	0																	
0	0	1	1																	
0	1	0	2																	
0	1	1	3																	
1	0	0	4																	
1	0	1	5																	
1	1	0	6																	
1	1	1	7																	

NOTES: 1 = HIGH LEVEL  
0 = LOW LEVEL

## Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units
Supply Voltage	$V_{DD}$	4.5	5.0	5.5	V

## Electrical/Optical Characteristics over Operating Temperature Range

$4.5 < V_{DD} < 5.5V$  (unless otherwise specified).

Parameter	Symbol	Min.	-25°C <sup>a</sup>		Max.	Units	Test Conditions
			Typ.	Max.			
Blank Current	$I_{DD}(\text{blink})$	—	1.0	—	4.0	mA	All digits blanked
Input Current	$I_I$	-40	—	—	10	μA	$V_{IN} = 0V$ to $V_{DD}$ $V_{DD} = 5.0V$
Input Voltage High	$V_{IH}$	2.0	—	—	$V_{DD}$	V	
Input Voltage Low	$V_{IL}$	GND	—	—	0.8	V	
IDD 4 Digits 20 dots/character <sup>b, c</sup>	$I_{DD}(\#)$	—	110	130	160	mA	"#" ON in all four locations

a.  $V_{DD} = 5.0V$ .

b. Average  $I_{DD}$  measured at full brightness. Peak  $I_{DD} = 28/15 \times$  Average  $I_{DD}(\#)$ .

c.  $I_{DD}(\#)$  max. = 130 mA, 150°C IC junction temperature and  $V_{DD} = 5.5V$ .

## Optical Characteristics at 25°C<sup>1</sup>

$V_{DD} = 5.0V$  at full brightness.

### Deep Red HDLS-1414

Parameter	Symbol	Min.	Typ.	Units	Test Conditions
Average Luminous Intensity per Digit, Character Average	$I_V$	4.0	12.7	mcd	"*" illuminated in all four digits. 19 dots ON per digit.
Peak Wavelength	$\lambda_{PEAK}$	—	645	nm	
Dominant Wavelength <sup>a</sup>	$\lambda_D$	—	637	nm	

a. Dominant wavelength,  $\lambda_D$ , is derived from the CIE chromaticity diagram, and represents the single wavelength that defines the color of the device.

### Deep Red HDLU-1414

Parameter	Symbol	Min.	Typ.	Units	Test Conditions
Average Luminous Intensity per Digit, Character Average	$I_V$	1.2	3.1	mcd	"*" illuminated in all four digits. 19 dots ON per digit.
Peak Wavelength	$\lambda_{PEAK}$	—	645	nm	
Dominant Wavelength <sup>a</sup>	$\lambda_D$	—	637	nm	

a. Dominant wavelength,  $\lambda_D$ , is derived from the CIE chromaticity diagram, and represents the single wavelength that defines the color of the device.

### High Efficiency Red HDLO-1414

Parameter	Symbol	Min.	Typ.	Units	Test Conditions
Average Luminous Intensity per Digit, Character Average	$I_V$	1.2	3.5	mcd	"*" illuminated in all four digits. 19 dots ON per digit.
Peak Wavelength	$\lambda_{PEAK}$	—	635	nm	
Dominant Wavelength <sup>a</sup>	$\lambda_D$	—	626	nm	

a. Dominant wavelength,  $\lambda_D$ , is derived from the CIE chromaticity diagram, and represents the single wavelength that defines the color of the device.

### Orange HDLA-1414

Parameter	Symbol	Min.	Typ.	Units	Test Conditions
Average Luminous Intensity per Digit, Character Average	$I_V$	1.2	3.5	mcd	"*" illuminated in all four digits. 19 dots ON per digit.
Peak Wavelength	$\lambda_{PEAK}$	—	600	nm	
Dominant Wavelength <sup>a</sup>	$\lambda_D$	—	602	nm	

a. Dominant wavelength,  $\lambda_D$ , is derived from the CIE chromaticity diagram, and represents the single wavelength that defines the color of the device.

1. Refers to the initial case temperature of the device immediately prior to the light measurement.

## Yellow HDLY-1414

Parameter	Symbol	Min.	Typ.	Units	Test Conditions
Average Luminous Intensity per Digit, Character Average	$I_V$	1.2	3.7	mcd	“*” illuminated in all four digits. 19 dots ON per digit.
Peak Wavelength	$\lambda_{PEAK}$	—	583	nm	
Dominant Wavelength <sup>a</sup>	$\lambda_D$	—	585	nm	

a. Dominant wavelength,  $\lambda_D$ , is derived from the CIE chromaticity diagram, and represents the single wavelength that defines the color of the device.

## Green HDLG-1414

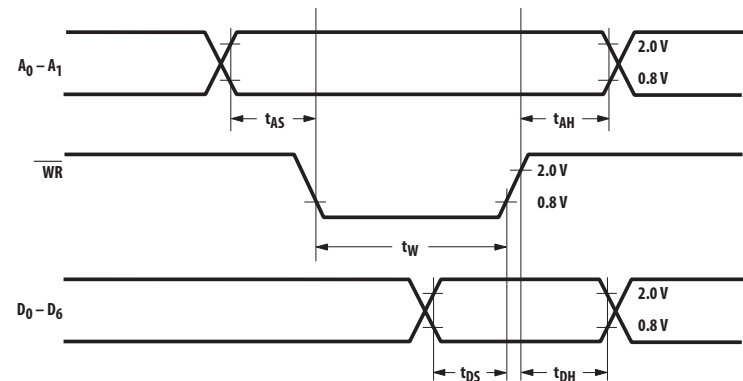
Parameter	Symbol	Min.	Typ.	Units	Test Conditions
Average Luminous Intensity per Digit, Character Average	$I_V$	1.2	5.6	mcd	“*” illuminated in all four digits. 19 dots ON per digit.
Peak Wavelength	$\lambda_{PEAK}$	—	568	nm	
Dominant Wavelength <sup>a</sup>	$\lambda_D$	—	574	nm	

a. Dominant wavelength,  $\lambda_D$ , is derived from the CIE chromaticity diagram, and represents the single wavelength that defines the color of the device.

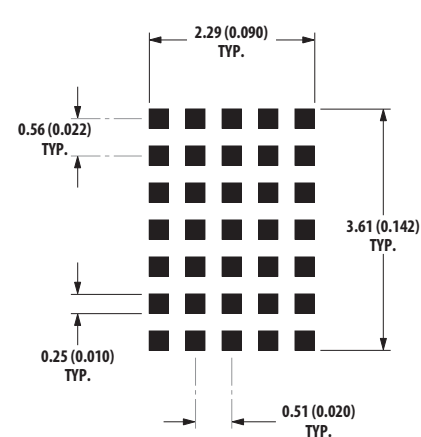
## AC Timing Characteristics over Operating Temperature Range at $V_{DD} = 4.5V$

Parameter	Symbol	Min.	Units
Address Setup	$t_{AS}$	10	ns
Address Hold	$t_{AH}$	40	ns
Data Setup	$t_{DS}$	50	ns
Data Hold	$t_{DH}$	40	ns
Write Time	$t_W$	75	ns

Timing Diagram



Enlarged Character Font



- NOTE:
1. Unless otherwise specified, the tolerance on all dimensions is  $\pm 0.254$  mm (0.010 in.).
  2. Dimensions are in millimeters (in.).

Electrical Description

Pin Function	Description
Write ( $\overline{WR}$ , Pin 3)	$\overline{WR}$ must be logic 0 to store data in the display.
Address Inputs ( $A_1$ and $A_0$ , Pins 4 and 5)	$A_0$ and $A_1$ select a specific location in the display memory. Address 00 accesses the far-right character, and address 11 accesses the far-left position.
$V_{DD}$ (Pin 6)	$V_{DD}$ is the positive power supply input.
Ground (GND, Pin 7)	Ground is the display ground.
Data Inputs ( $D_0$ to $D_6$ , Pins 1, 2, 8 to 12)	$D_0$ to $D_6$ are used to specify the input data for the display.

## Display Internal Block Diagram

Figure 1 shows the HDLX-1414 display internal block diagram. The CMOS IC consists of a  $4 \times 7$  Character RAM, a 128-character ASCII decoder and the refresh circuitry necessary to synchronize the decoding and driving of four  $5 \times 7$  dot matrix characters.

Four 7-bit ASCII words are stored in the character RAM. The IC reads the ASCII data and decodes it using the 128-character ASCII decoder. This decoder includes the 64-character set of the HPDL-1414, 32 lowercase ASCII symbols, and 32 foreign language symbols.

## Data Entry

Table 1 shows a truth table for the HDLX-1414 display. Address inputs  $A_0$  and  $A_1$  select the digit location in the display. When  $A_0$  and  $A_1$  are both logic low, data is loaded into the right-most character.

Data inputs D0 to D6 load information into the display. Data is latched into the given character address on the rising edge of the WVR signal. Data and Address inputs must be held stable during the write cycle to ensure that correct data is stored in the display.

## Mechanical and Electrical Considerations

The HDLX-1414 is a 12-pin DIP package that can be stacked to create a character array of any size. The display is designed to operate reliably in  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  ambient temperatures.

The HDLX-1414 is assembled by die-attaching and wire-bonding 140 LEDs and a CMOS IC to a high temperature printed circuit board. A polycarbonate lens is placed over the PCB, creating a protective air gap over the LED wire bonds. Backfill epoxy environmentally seals the display package. This package construction makes the display highly tolerant to temperature cycling and allows wave soldering.

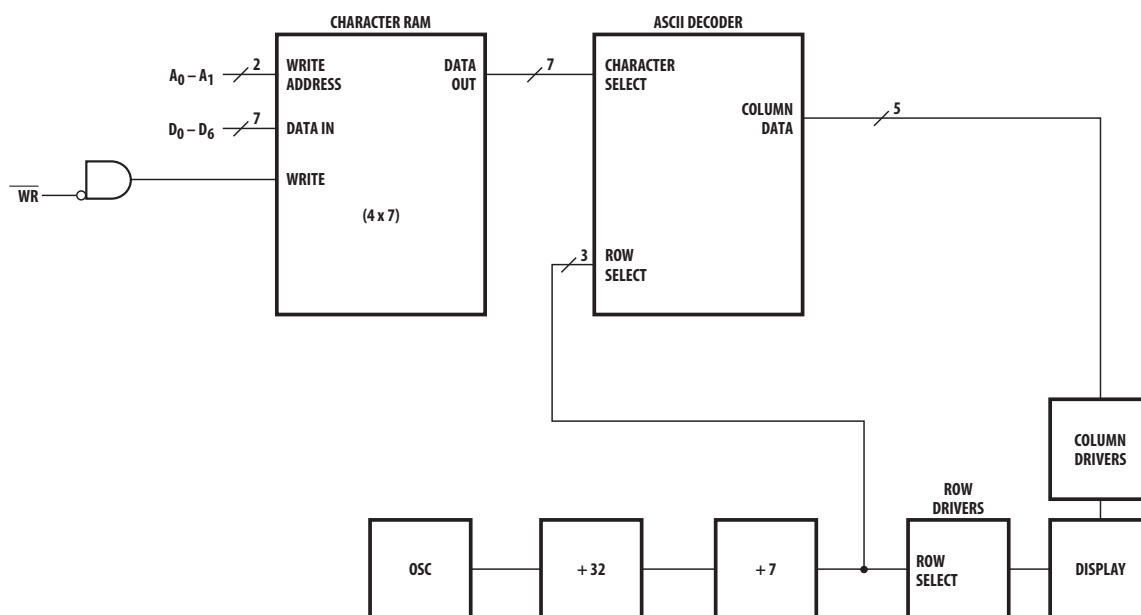
## ESD and Latchup Protection

The inputs to the CMOS IC are protected against static discharge and input current latchup. However, for best results, use standard CMOS handling precautions. Prior to use, store the HDLX-1414 in antistatic tubes or conductive material. During assembly, use a grounded conductive work area, and assembly personnel should wear conductive wrist straps. Avoid lab coats made of synthetic material because they are prone to static charge build-up. Input current latchup can be caused when the CMOS inputs are subjected either to a voltage below ground ( $V_{in} < \text{ground}$ ) or higher than  $V_{DD}$  ( $V_{in} > V_{DD}$ ) and when a high current is forced into the input. To prevent input current latchup and ESD damage, connect unused inputs either to ground or to  $V_{DD}$ . Do not apply voltages to the inputs until  $V_{DD}$  has been turned on, and eliminate high transient input voltages.

Table 1: Display Truth Table

WVR	A1	A0	D6	D5	D4	D3	D2	D1	D0	Function
1	X	X	X	X	X	X	X	X	X	No Change
0	0	0	Digit 0 ASCII Data (Right-Most Character)							Write to Character RAM
0	0	1	Digit 1 ASCII Data							
0	1	0	Digit 2 ASCII Data							
0	1	1	Digit 3 ASCII Data (Left-Most Character)							
0 = Logic 0; 1 = Logic 1; X = Do Not Care.										



**Figure 1: Display Internal Block Diagram**

## Soldering Instructions

The HDLX-1414 is compatible with hand- and wave-solder processes. Use a no-clean flux.

The polycarbonate lens on these displays is incompatible with some fluxes and cleaning solutions. Do not use with heated Terpene or solutions of propylene glycol monomethyl ether and monoethanolamine.

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

## Contrast Enhancement

The objective of contrast enhancement is to provide good readability in the end user's ambient lighting conditions. By using both luminance (brightness) and chrominance (color) contrast techniques, the ON dots of the display can be made to stand out against a dark background.

For further information on contrast enhancement, refer to Application Note 1015, *Contrast Enhancement Techniques for LED Displays*.

## Intensity Bin Limits for HDLS-1414

Bin	Intensity Range (mcd)	
	Min.	Max.
E	3.97	6.79
F	5.55	9.50
G	7.78	13.30
H	10.88	18.62
I	15.24	26.07
J	21.33	36.49

**NOTE:** Test conditions as specified in [Optical Characteristics at 25°C](#).

## Intensity Bin Limits for HDLX-1414

Bin	Intensity Range (mcd)	
	Min.	Max.
A	1.20	1.77
B	1.45	2.47
C	2.02	3.46
D	2.83	4.85
E	3.97	6.79
F	5.55	9.50
G	7.78	13.30

**NOTE:** Test conditions as specified in [Optical Characteristics at 25°C](#).

## Color Bin Limits

Color	Bin	Color Range (nm)	
		Min.	Max.
Green	1	576.0	580.0
	2	573.0	577.0
	3	570.0	574.0
	4	567.0	571.5
Yellow	3	581.5	585.0
	4	584.0	587.5
	5	586.5	590.0

**NOTE:** Test conditions as specified in [Optical Characteristics at 25°C](#).

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