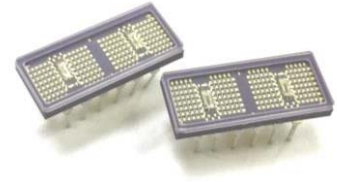


## HCMS-2333

### CMOS Extended Temperature Range 5 × 7 Smart Alphanumeric Display



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#### Description

This Broadcom<sup>®</sup> sunlight-viewable 5 × 7 LED four-character display is contained in 12-pin dual-inline packages designed for displaying alphanumeric information. The display is designed with onboard CMOS integrated circuits. Two CMOS ICs form an onboard 28-bit serial-in/parallel-out shift register with constant current output LED row drivers. Decoded column data is clocked into the onboard shift register for each refresh cycle. Full character display is achieved with external column strobing.

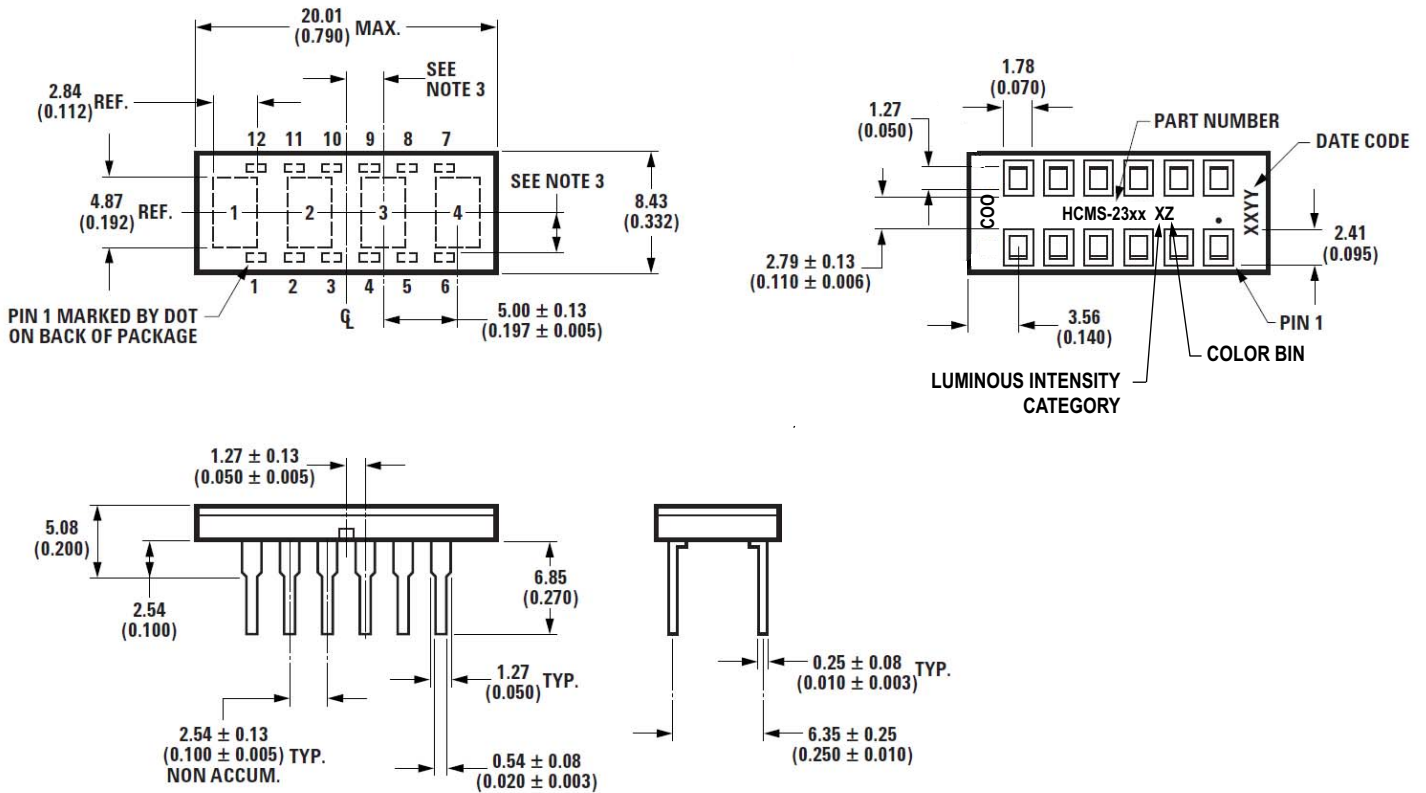
#### Features

- Onboard low-power CMOS IC
- Integrated shift register with constant current LED drivers
- Wide operating temperature range:  $-55^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$
- Compact glass ceramic four-character package series X-Y stackable
- Sunlight viewable
- 5 × 7 LED matrix displays full ASCII set
- Character height of 5.0 mm (0.20 in.)
- Wide viewing angle
  - X axis =  $\pm 50^{\circ}$
  - Y axis =  $\pm 65^{\circ}$
- Usable in night vision lighting applications

#### Typical Applications

- Avionics
- Communication systems
- Fire control systems
- Radar systems

Figure 1: Package Drawing



**NOTE:**

1. Dimensions are in mm (in.).
2. Unless otherwise specified, tolerance on dimensions is ±0.38 mm (±0.015 in.).
3. Characters are centered with respect to leads within ±0.13 mm (±0.005 in.).
4. Lead material is copper alloy, solder dipped.

**Pin Function Assignment Table**

Pin Number	Function	Pin Number	Function
1	Column 1	7	Data Out
2	Column 2	8	VB
3	Column 3	9	VDD
4	Column 4	10	Clock
5	Column 5	11	Ground
6	Internal connection <sup>a</sup>	12	Data In

a. Do not connect or use.

## Absolute Maximum Ratings

Parameter	HCMS-2333	Units
Supply Voltage, $V_{DD}$ to Ground <sup>a</sup>	-0.3V to 7.0V <sup>a</sup>	V
Data Input, Data Output, $V_B$	-0.3V to $V_{DD}$	V
Column Input Voltage, $V_{COL}$	-0.3V to $V_{DD}$	V
Free Air Operating Temperature Range, $T_A$	-55 to 100	°C
Storage Temperature Range, $T_S$	-55 to 100	°C
Maximum Allowable Package Power Dissipation, $P_D$ <sup>b,c</sup> at $T_A = 71^\circ\text{C}$	1.31	Watts
Wave Solder Condition (1.6 mm below Standoff)	250°C peak for 3 seconds, maximum	
Soldering Dipping Condition (1.6 mm below Standoff)	260°C peak for 5 seconds, maximum	
ESD Protection at 1.5Ω, 100 pF	4 kV (each pin)	

a. Maximum duration 2 seconds.

b. Maximum allowable power dissipation is derived from  $V_{DD} = 5.25\text{V}$ ,  $V_B = 2.4\text{V}$ ,  $V_{COL} = 3.5\text{V}$ , 20 LEDs ON per character, 20% DF.

c. HCMS-2333 derate above 71°C at 23 mW/°C,  $R\theta_{JA} = 45^\circ\text{C/W}$ .

## Recommended Operating Conditions over Operating Range (-55°C to 100°C)

Parameter	Symbol	Minimum	Nominal	Maximum	Units
Supply Voltage	$V_{DD}$	4.75	5.0	5.25	V
Data out Current, Low State	$I_{OL}$	—	—	1.6	mA
Data out Current, High State	$I_{OH}$	—	—	-0.5	mA
Column Input Voltage	$V_{COL}$	2.75	3.0	3.5	V
Setup Time	$t_{SETUP}$	10	—	—	ns
Hold Time	$t_{HOLD}$	25	—	—	ns
Clock Pulse Width High	$t_{WH(CLOCK)}$	50	—	—	ns
Clock Pulse Width Low	$t_{WL(CLOCK)}$	50	—	—	ns
Clock High to Low Transition	$t_{THL}$	—	—	200	ns
Clock Frequency	$f_{CLOCK}$	—	—	5	MHz

## Electrical Characteristics over Operating Temperature Range

Parameter	Symbol	Min.	Typ. <sup>a</sup>	Max.	Units	Test Conditions
Supply Current, Dynamic <sup>b</sup>	I <sub>DDD</sub>	—	6.2	7.8	mA	f <sub>CLOCK</sub> = 5 MHz
Supply Current, Static <sup>c</sup>	I <sub>DDDSoff</sub>	—	1.8	2.6	mA	V <sub>B</sub> = 0.4V, Data and Clock = 0.4V
	I <sub>DDDSon</sub>	—	2.2	6.0	mA	V <sub>B</sub> = 0.4V, Data and Clock = 0.4V
Column Input Current	I <sub>COL</sub>	—	—	10	μA	V <sub>B</sub> = 0.4V
		—	500	650	mA	V <sub>B</sub> = 2.4V
Input Logic High Data, V <sub>B</sub> , Clock	V <sub>IH</sub>	2.0	—	—	V	V <sub>DD</sub> = 4.75V
Input Logic Low Data, V <sub>B</sub> , Clock	V <sub>IL</sub>	—	—	0.8	V	V <sub>DD</sub> = 5.25V
Input Current Data, Clock V <sub>B</sub>	I <sub>I</sub>	-46 -92	-60 -120	-103 -206	μA	V <sub>DD</sub> = 5.25V V <sub>I</sub> <sup>d</sup> = 2.4V (Logic High) or V <sub>I</sub> <sup>d</sup> = 0.4V (Logic Low)
Data Out Voltage	V <sub>OH</sub>	2.4	4.2	—	V	V <sub>DD</sub> = 4.75V I <sub>OH</sub> = -0.5 mA I <sub>COL</sub> = 0 mA
	V <sub>OL</sub>	—	0.2	0.4	V	V <sub>DD</sub> = 5.25V I <sub>OL</sub> = 1.6 mA I <sub>COL</sub> = 0 mA
Power Dissipation per Package <sup>e</sup>	P <sub>D</sub>	—	668	—	mW	V <sub>DD</sub> = 5.0V V <sub>COL</sub> = 3.5V 17.5% DF V <sub>B</sub> = 2.4V 15 LEDs ON per character
Thermal Resistance IC Junction-to-Pin <sup>f</sup>	R <sub>θJ-PIN</sub>	—	10	—	°C/W	
Leak Rate		—	—	5 × 10 <sup>-8</sup>	cc/sec	

a. All typical values specified at V<sub>DD</sub> = 5.0V and T<sub>A</sub> = 25°C.

b. I<sub>DD</sub> Dynamic is the IC current while clocking column data through the onboard shift register at a clock frequency of 5 MHz, the display is not illuminated.

c. I<sub>DD</sub> Static is the IC current after column data is loaded and not being clocked through the onboard shift register.

d. V<sub>I</sub> represents the input voltage to an input pin.

e. Four characters are illuminated with a typical ASCII character composed of 15 dots per character.

f. IC junction temperature T<sub>J</sub> (IC) = (P<sub>D</sub>)(R<sub>θPC-A</sub>) + T<sub>A</sub>.

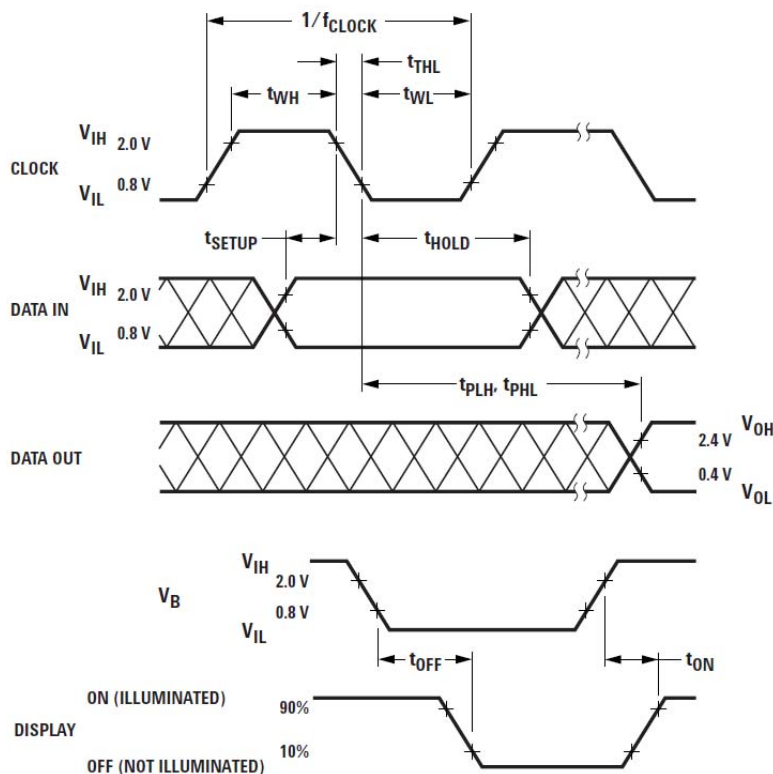
# Optical Characteristics at $T_A = 25^\circ\text{C}$

$V_{DD} = 5.0\text{V}$  at full brightness, LED color = yellow green.

Parameter	Min.	Typ. <sup>a</sup>	Test Conditions
Luminous Intensity per Character Average (All Dots ON), $I_V$ (mcd) <sup>b</sup>	76	202	$V_{DD} = 5.0\text{V}$ $V_{COL} = 3.5\text{V}$ $V_B = 2.4\text{V}$ $T_i = 25^\circ\text{C}^c$
Peak Wavelength, $\lambda_{PEAK}$ (nm)	—	574	
Dominant Wavelength, $\lambda_d$ (nm) <sup>d, e</sup>	—	572	

- a. All typical values specified at  $V_{DD} = 5.0\text{V}$  and  $T_A = 25^\circ\text{C}$ .
- b. These LED displays are categorized for luminous intensity, with the intensity designated by a letter code on the back of the package.
- c.  $T_i$  refers to the initial case temperature of the display immediately prior to the light measurement.
- d. Dominant wavelength,  $\lambda_d$ , derived from the CIE chromaticity diagram, and represents the single wavelength that defines the color of the device.
- e. Categorized for color with the color category designated by a number on the back of the package.

**Figure 2: Switching Characteristics**



## Timing Characteristics

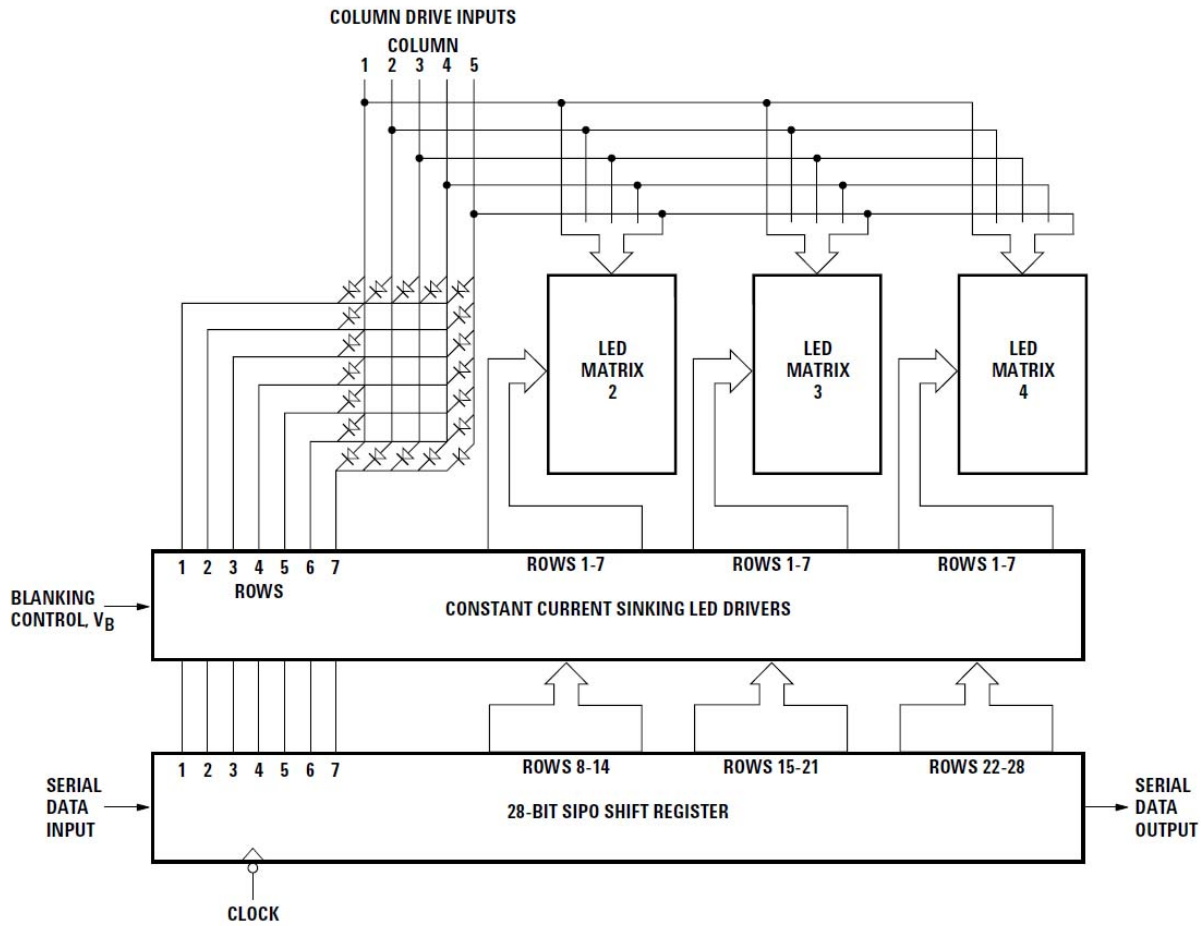
Parameter	Condition	Typ.	Max.	Units
$f_{\text{CLOCK}}$ CLOCK Rate		—	5	MHz
$t_{\text{PLH}}$ , $t_{\text{PHL}}$ Propagation Delay CLOCK to DATA OUT	$C_L = 15 \text{ pF}$ $R_L = 2.4 \text{ k}\Omega$	—	105	ns
$t_{\text{OFF}}$ $V_B$ (0.4V) to Display OFF		4	5	$\mu\text{s}$
$t_{\text{ON}}$ $V_B$ (2.4V) to Display ON		1	2	$\mu\text{s}$

## Electrical Description

The display contains four 5 × 7 LED dot-matrix characters and two CMOS integrated circuits, as shown in [Figure 2](#). The two CMOS integrated circuits form an onboard 28-bit serial-in/parallel-out shift register that will accept standard TTL logic levels. The Data Input, pin 12, is connected to bit position 1 and the Data Output, pin 7, is connected to bit position 28. The shift register outputs control constant current sinking LED row drivers. A logic 1 stored in the shift register enables the corresponding LED row driver and a logic 0 stored in the shift register disables the corresponding LED row driver.

The electrical configuration of these CMOS IC alphanumeric displays allows for an effective interface to a display controller circuit that supplies decoded character information. The row data for a given column (one 7-bit byte per character) is loaded (bit serial) into the onboard 28-bit shift register with high to low transitions of the Clock input. To load decoded character information into the display, column data for character 4 is loaded first and the column data for character 1 is loaded last in the following manner. The 7 data bits for column 1, character 4, are loaded into the onboard shift register. Next, the 7 data bits for column 1, character 3, are loaded into the shift register, shifting the character 4 data over one character position. This process is repeated for the other two characters until all 28 bits of column data (four 7-bit bytes of character column data) are loaded into the onboard shift register. Then the column 1 input,  $V_{\text{COL}}$  pin 1, is energized to illuminate column 1 in all four characters. This process is repeated for columns 2, 3, 4, and 5. All  $V_{\text{COL}}$  inputs should be at logic low to ensure the display is off when loading data. The display will be blanked when the blanking input  $V_B$ , pin 8, is at logic low regardless of the outputs of the shift register or whether one of the  $V_{\text{COL}}$  inputs is energized.

Figure 3: HCMS-2333 Display Block Diagram



## ESD Susceptibility

The display has an ESD susceptibility rating of Class 3 of MIL-STD-883E, HBM. Observe normal CMOS handling precautions with these devices.

## Soldering and Post Solder Cleaning

These displays may be soldered with a standard wave solder process using either an RMA flux and solvent cleaning or an OA flux and aqueous cleaning. For optimum soldering, the solder wave temperature should be 245°C and the dwell time for any display lead passing through the wave should be 1.5 to 2 seconds. For more detailed information, refer to Application Note 1027, *Soldering LED Components*.

## Contrast Enhancement

When used with the proper contrast enhancement filters, the display is readable in sunlight.

Refer to Application Note 1029, *Luminous Contrast and Sunlight Readability of the HDSP-235X Series Alphanumeric Displays for Sunlight Viewable Applications*, for information on contrast enhancement for sunlight and daylight ambient. Refer to Application Note 1015, *Contrast Enhancement Techniques for LED Displays*, for information on contrast enhancement in moderate ambient.

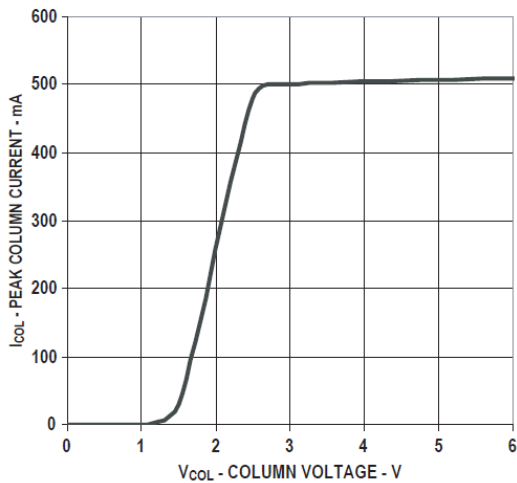
## Night Vision Lighting

When used with the proper NVG/DV filters, HCMS-235x display may be used in night vision lighting applications. For a list of NVG/DV filters and a discussion on night vision lighting technology, refer to Application Note 1030, *LED Displays and Indicators and Night Vision Imaging System Lighting*.

## Controller Circuits, Power Calculations, and Display Dimming

Refer to Application Note 1016, *Using the HDSP-2000 Alphanumeric Display Family*, for information on controller circuits to drive these displays, how to do power calculations, and a technique for display dimming.

**Figure 4: Peak Column Current vs. Column Voltage at  $T_A = 25^\circ\text{C}$**



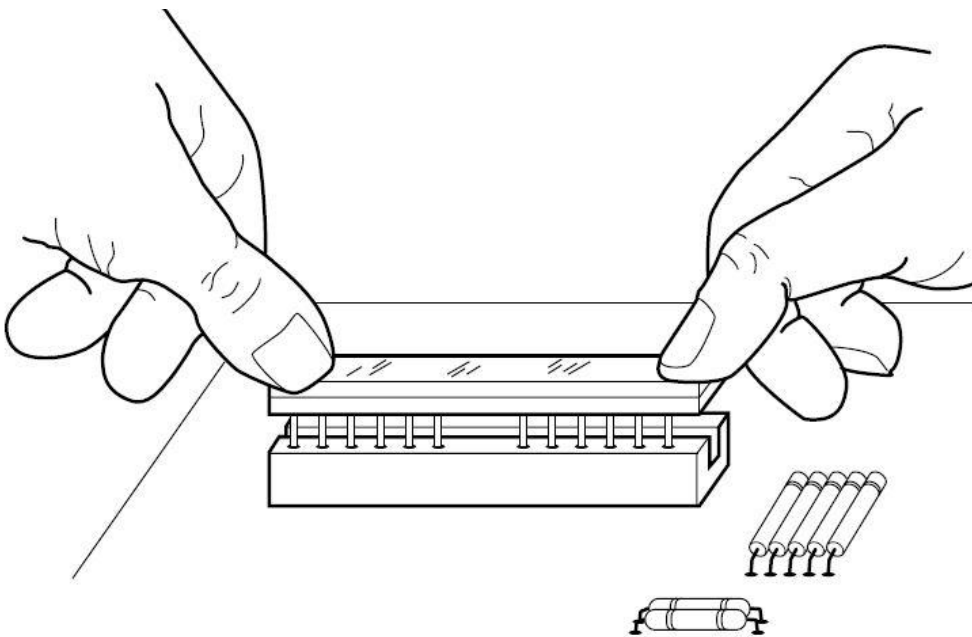


## Precautionary Notes

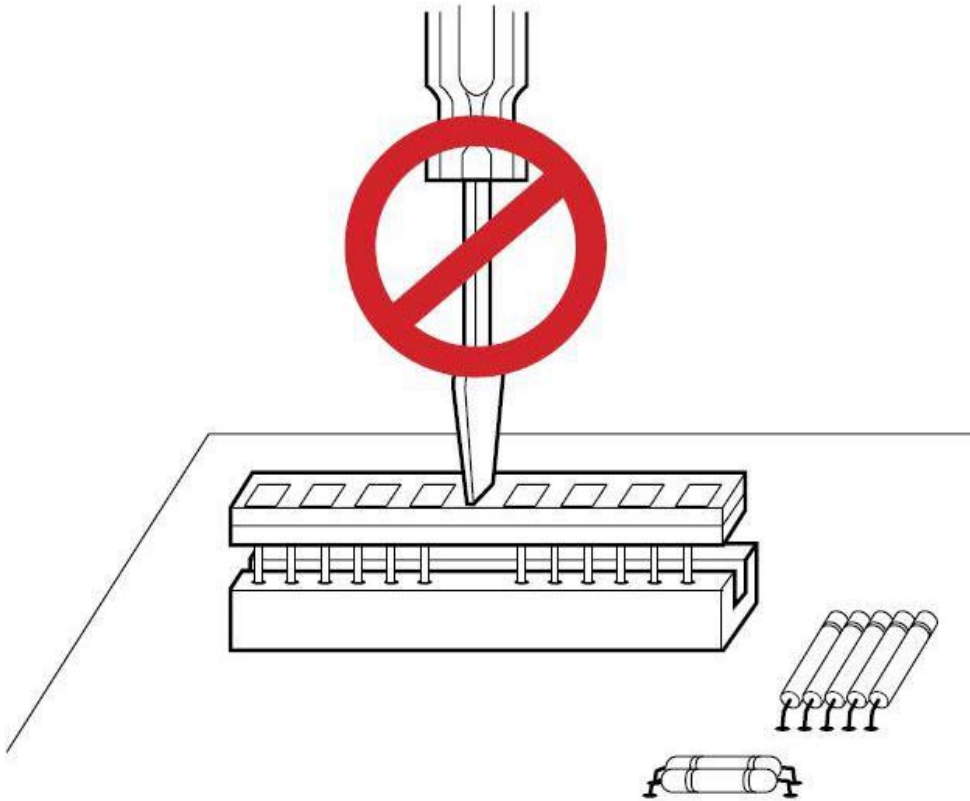
### Mechanical Considerations

The HCMS-2333 is assembled by die attaching and wire bonding 140 LED chips and two CMOS ICs to a thermally conductive printed circuit board. A glass lens placed over the substrate creates an air gap over the LED wire bonds. [Figure 5](#) shows the proper method to insert the display by hand. To prevent damage to the display, apply pressure uniformly with fingers located at both ends of the part. Using a tool, shown in [Figure 6](#), such as a screwdriver or pliers to push the display into the printed circuit board or socket may damage the display. The force exerted by a screwdriver is sufficient to damage the glass lens. Any damaged glass lens exposing the LEDs wire bonds cause shorts or opens that result in catastrophic failure of the LEDs.

**Figure 5: Proper Method to Manually Insert a Display**



**Figure 6: Improper Method to Manually Insert a Display**



## Intensity Bin Limits

Bin	I <sub>V</sub> , Average per Character (All dots on) (mcd)	
	Min.	Max.
B	76	121
C	99	157
D	128	204
E	167	266
F	218	345

**NOTE:** Test conditions as specified in the Optical Characteristics table.

## Color Bin Limits

Color Bin	Color Range (nm)	
	Min.	Max.
1	576.0	580.0
2	573.0	577.0
3	570.0	574.0
4	567.0	571.0

**NOTE:** Test conditions as specified in the Optical Characteristics table.

## Part Numbering System

H C M S - 2 3 3 3 - 

x <sub>1</sub>	x <sub>2</sub>	x <sub>3</sub>
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 x x

Code	Description	Option	
x <sub>1</sub> , x <sub>2</sub>	I <sub>V</sub> Bin Range Identifier	x <sub>1</sub>	Minimum I <sub>V</sub> bin
		x <sub>2</sub>	Maximum I <sub>V</sub> bin
x <sub>3</sub>	Color Bin Range Identifier	A	Color Bins 2 and 3
		B	Color Bins 4 and 5
		C	Color Bins 5 and 6
		D	Color Bins 3 and 4

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