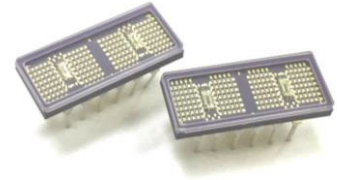


## HCMS-2333

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



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#### Description

This 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 on-board CMOS integrated circuits. Two CMOS ICs form an on-board 28-bit serial-in/parallel-out shift register with constant current output LED row drivers. Decoded column data is clocked into the on-board shift register for each refresh cycle. Full character display is achieved with external column strobing.

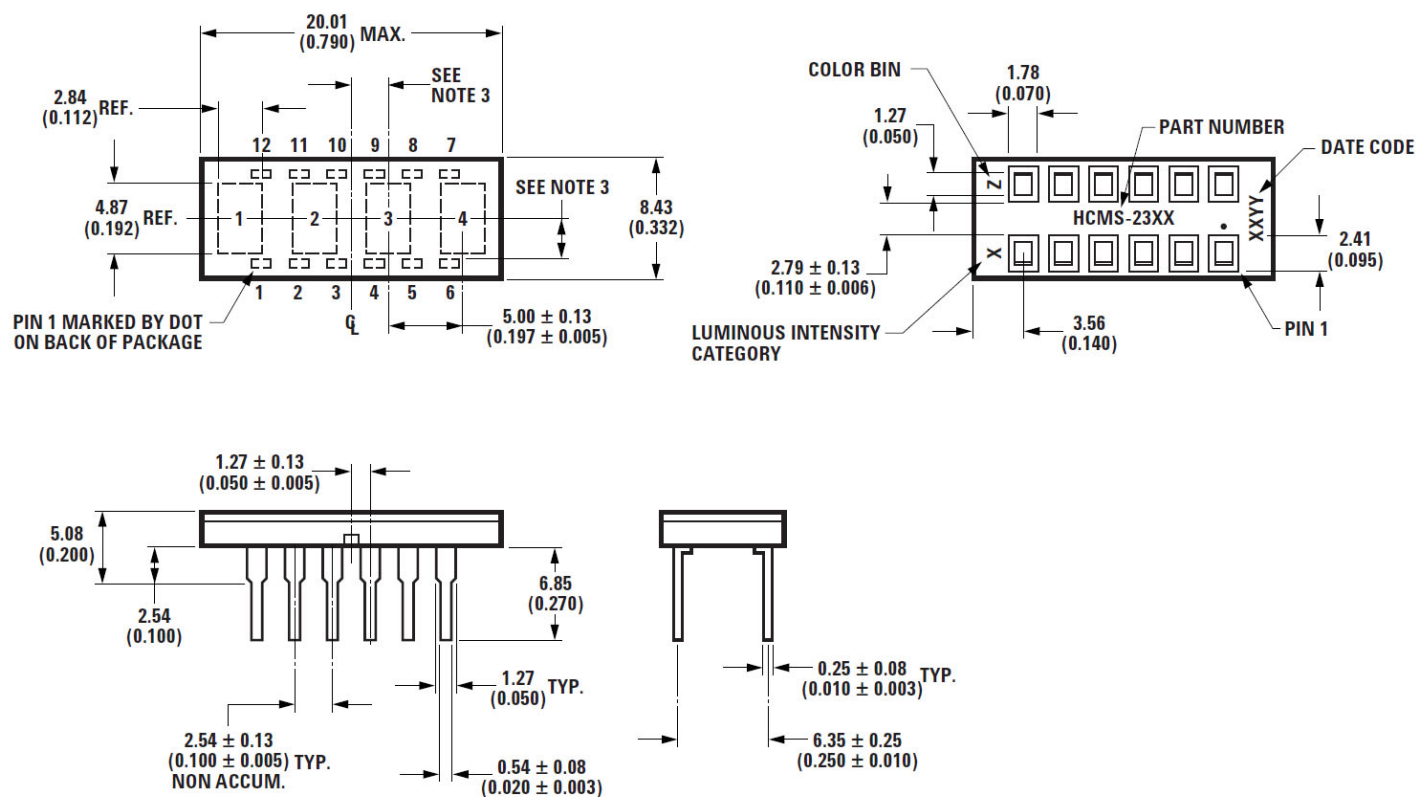
#### Features

- On-board 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 Application

- 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  $\pm 0.38$  mm ( $\pm 0.005$  in.).
3. Characters are centered with respect to leads within  $\pm 0.13$  mm ( $\pm 0.005$  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

Parameters	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, $T_A$	−40 to 85	°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	260°C peak for 3s maximum	
Soldering Dipping Condition 1.6 mm Below Standoff	250°C peak for 5s 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).

Parameters	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

Parameters	Symbol	Min.	Typ. <sup>a</sup>	Max.	Units	Test Condition
Supply Current, Dynamic <sup>b</sup>	I <sub>DDD</sub>	—	6.2	7.8	mA	fCLOCK = 5 MHz
Supply Current, Static <sup>c</sup>	I <sub>DDDSoff</sub> I <sub>DDDSon</sub>	—	—	—		V <sub>B</sub> = 0.4V, Data and Clock = 0.4V V <sub>B</sub> = 0.4V, Data and Clock = 0.4V
Column Input Current	I <sub>COL</sub>	—	—	—		V <sub>B</sub> = 0.4V 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	I <sub>I</sub>	—	—	—	μA	V <sub>DD</sub> = 5.25V
Data		−46	−60	−103		V <sub>I</sub> <sup>d</sup> = 2.4V (Logic High) or
Clock, V <sub>B</sub>		−92	−120	−206		V <sub>I</sub> <sup>d</sup> = 0.4V (Logic Low)
Data Out Voltage	VOH	2.4	4.2	—	V	V <sub>DD</sub> = 4.75V I <sub>OH</sub> = −0.5 mA I <sub>COL</sub> = 0 mA
	VOL	—	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 on-board 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 on-board 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>.

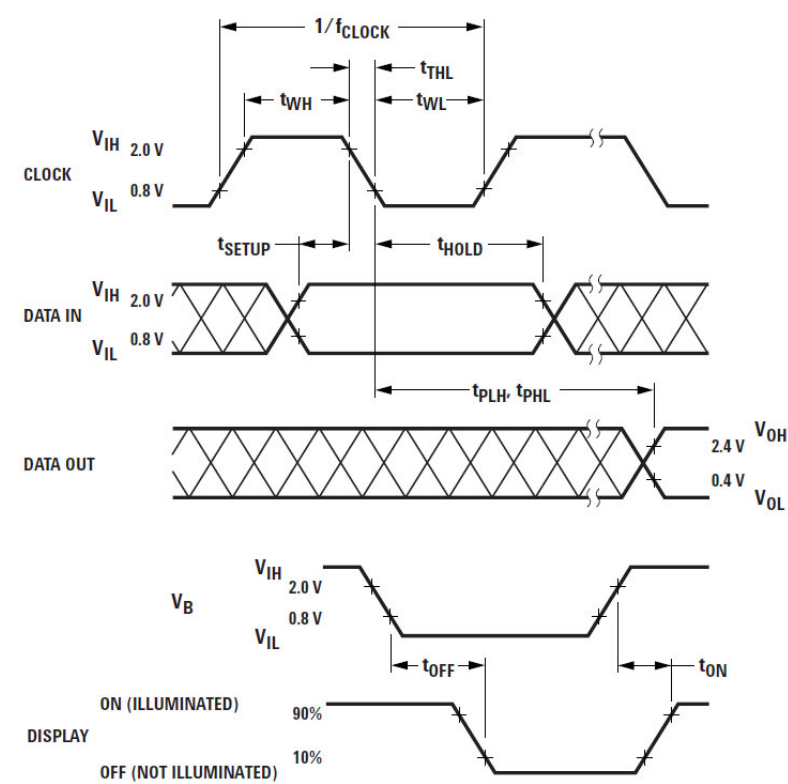
Optical Characteristics at T<sub>A</sub> = 25°C

V<sub>DD</sub> = 5.0V at full brightness, LED color = yellow green.

Parameters	Min.	Typ. <sup>a</sup>	Test Condition
Luminous Intensity per Character Average (All Dots ON), I <sub>V</sub> (mcd) <sup>b</sup>	76	159	V <sub>DD</sub> = 5.0V V <sub>COL</sub> = 3.5V V <sub>B</sub> = 2.4V T <sub>i</sub> = 25°C <sup>c</sup>
Peak Wavelength, λ <sub>PEAK</sub> (nm)	—	574	
Dominant Wavelength, λ <sub>d</sub> (nm) <sup>d, e</sup>	—	572	

- a. All typical values specified at V<sub>DD</sub> = 5.0V and T<sub>A</sub> = 25°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<sub>i</sub> refers to the initial case temperature of the display immediately prior to the light measurement.
- d. Dominant wavelength, λ<sub>d</sub>, 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

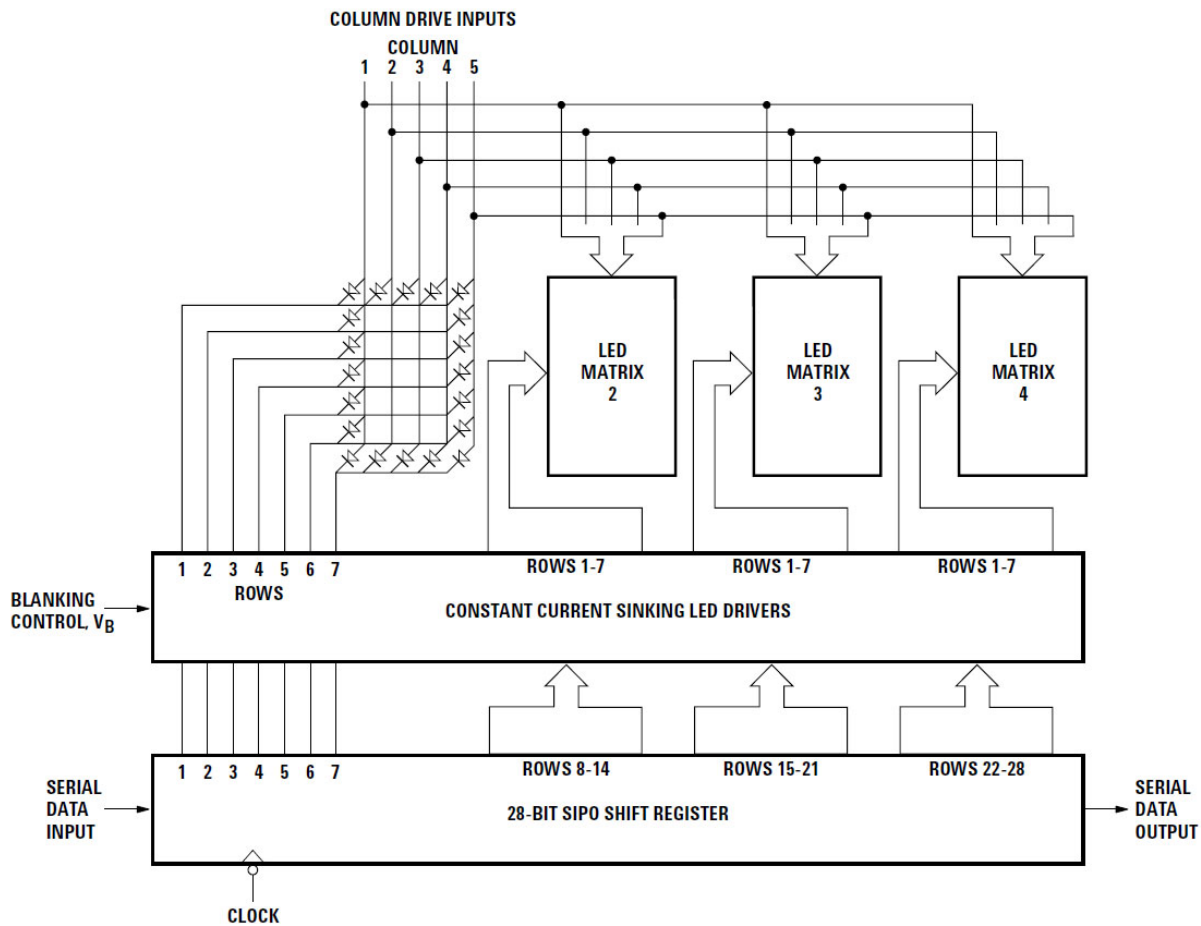
Parameter	Condition	Typ.	Max.	Units
$f_{\text{CLOCK}}$ CLOCK Rate		—	5	MHz
$t_{\text{PLH}}, t_{\text{PHL}}$ Propagation Delay CLOCK to DATA OUT	$C_L = 15 \text{ pF}$ $R_L = 2.4 \text{ k}\Omega$	—	105	ns
$t_{\text{OFF}}$ $V_B$ (0.4V) to Display OFF		4	5	$\mu\text{s}$
$t_{\text{ON}}$ $V_B$ (2.4V) to Display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

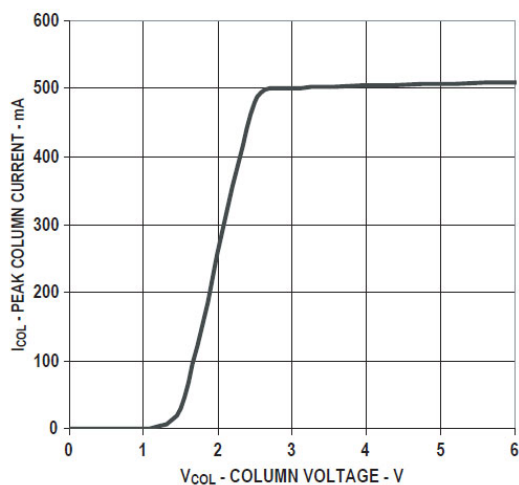
## Night Vision Lighting

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**

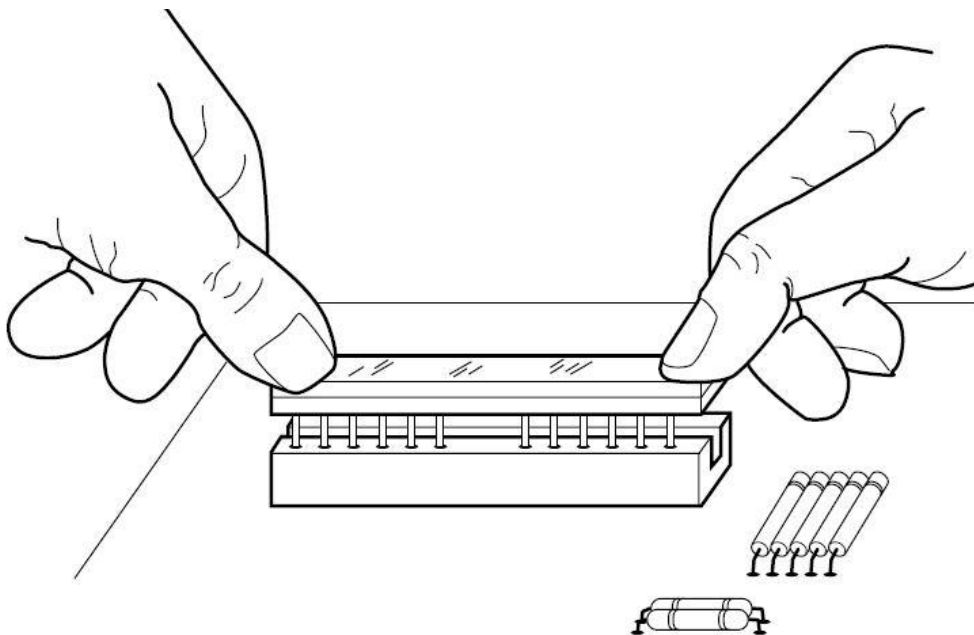
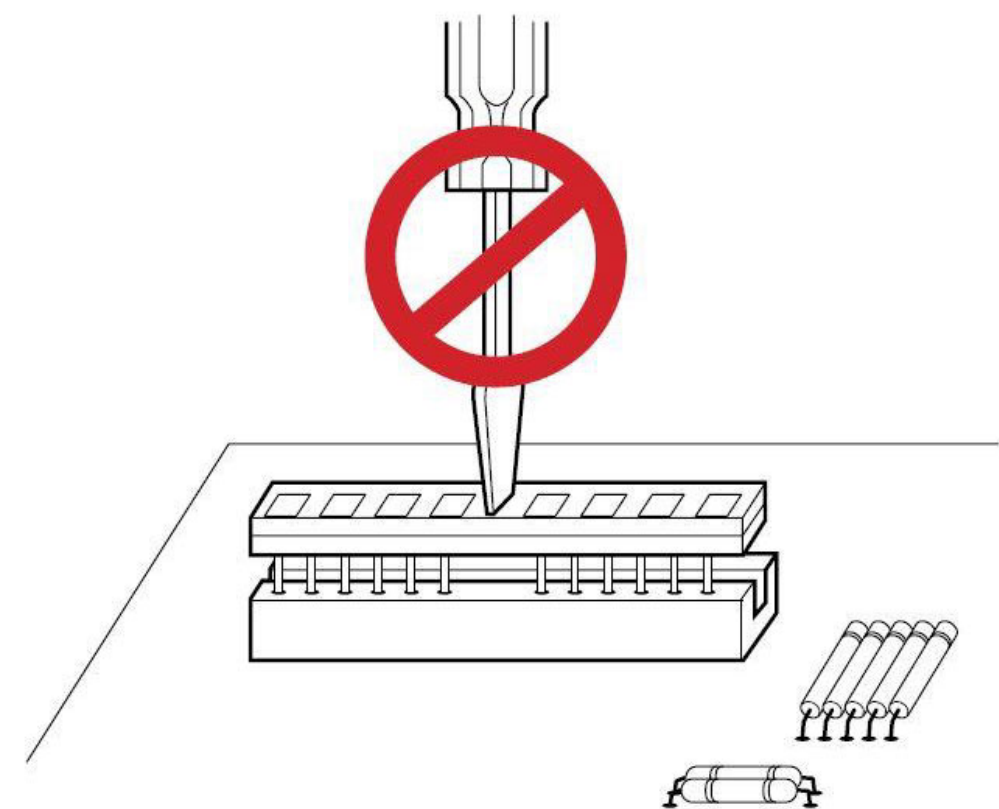


Figure 6: Improper Method to Manually Insert a Display



Intensity Bin Limits

Bin	Iv, average per character (All dots on) (mcd)	
	Min.	Max.
B	76	121
C	99	157
D	128	204
E	167	266

**NOTE:** Test conditions as specified in Optical Characteristic 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 Optical Characteristic table.

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