HEWLETT PACKARD

CMOS Hermetic Extended Temperature Range 5x7 Alphanumeric Displays

Technical Data

HCMS-201X/201XTXV/ 201XTXVB Series HCMS-231X/231XTXV/ 231XTXVB

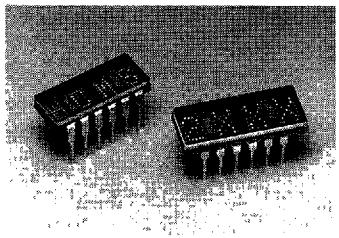
Sunlight Viewable Series HCMS-235X/ 235XTXV/235XTXVB Series

Features

- **On-Board Low Power CMOS IC**
  Integrated Shift Register with Constant Current LED Drivers
- **Wide Operating Temperature Range**
  -55°C to +100°C
- **HI-REL Screening per MIL-D-87157**
  Quality Level A
  TXV or TVXB
- **Hermetic Package**
- **Compact Glass Ceramic 4 Character Package**
  HCMS-201X Series End Stackable
  HCMS-231X/-235X Series X-Y Stackable
- **HCMS-235X Series are Sunlight Viewable**
- **Five Colors**
  Standard Red
  High Efficiency Red
  Orange
  Yellow
  High Performance Green
- **5x7 LED Matrix Displays Full ASCII Set**
- **Two Character Heights**
  3.8mm (0.15 inch)
  5.0mm (0.20 inch)
- **Wide Viewing Angle**
  X Axis = ±50°
  Y Axis = ±65°
- **Long Viewing Distance**
  HCMS-201X Series to 2.6 Meters (8.6 Feet)
  HCMS-231X/-235X Series to 3.5 Meters(11.5 Feet)
- **Categorized for Luminous Intensity**
- **HCMS-2011/2013 HCMS-2311/-2313/-2314 HCMS-2351/-2353/-2354**
  Useable in Night Vision Lighting Applications
- **HCMS-2011/-2013, HCMS-2311/-2313 and HCMS-2351/-2353:**
  Categorized for Color

Typical Applications

- **Military Avionics**
- **Communications Systems**
- **Radar Systems**
- **Fire Control Systems**



Description

The HCMS-201X, HCMS-231X and the sunlight viewable HCMS-235X series are 5x7 LED four character displays contained in 12 pin dual-in-line packages designed for displaying alphanumeric information. The character height for the HCMS-201X series displays is 3.8mm (0.15 inch), and for the HCMS-231X and HCMS-235X series displays the character height is 5.0mm (0.20 inch). The HCMS-201X series displays are available in four LED colors: standard red, high efficiency red, yellow and high performance green. The HCMS-231X series are available in all five

ESD WARNING: STANDARD CMOS HANDLING PRECAUTIONS SHOULD BE OBSERVED.

LED colors. The HCMS-235X series displays are available in four LED colors: high efficiency red, orange, yellow and high performance green. The HCMS-201X series displays are end stackable. The HCMS-231X and HCMS-235X series displays are end/row stackable.

These displays are designed with on-board CMOS integrated circuits for use in applications where conservation of power is important. The 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.

Compatibility with HDSP-201X/-231X/-235X TTL IC Series Displays

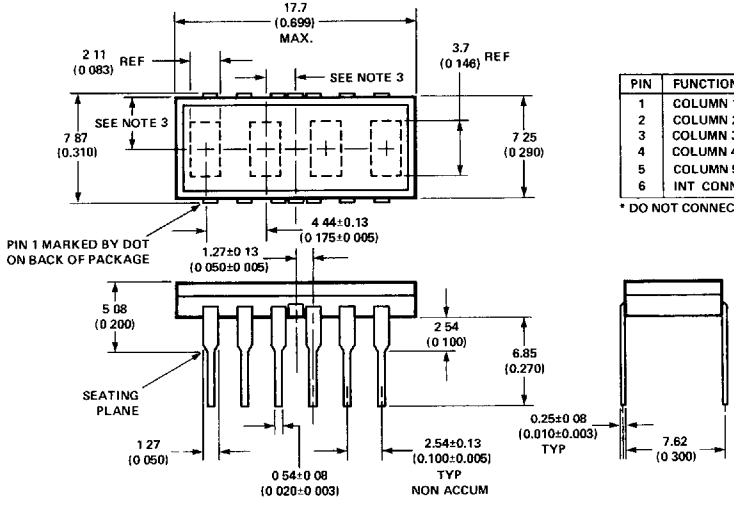
The HCMS-201X, HCMS-231X and HCMS-235X CMOS IC displays are "drop-in" replacements for the equivalent HDSP-201X, HDSP-231X and HDSP-235X TTL IC displays. The 12 pin glass/ceramic package configuration, four digit character matrix and pin functions are identical.

Display Selection Table

Part Number	Character Size	LED Color
HCMS-2010/2010TXV/2010TXVB	3.8 mm (0.15 inch)	Standard Red
HCMS-2011/2011TXV/2011TXVB	3.8 mm (0.15 inch)	Yellow
HCMS-2012/2012TXV/2012TXVB	3.8 mm (0.15 inch)	High-Efficiency Red
HCMS-2013/2013TXV/2013TXVB	3.8 mm (0.15 inch)	High-Performance Green
HCMS-2310/2310TXV/2310TXVB	5.0 mm (0.20 inch)	Standard Red
HCMS-2311/2311TXV/2311TXVB	5.0 mm (0.20 inch)	Yellow
HCMS-2312/2312TXV/2312TXVB	5.0 mm (0.20 inch)	High-Efficiency Red
HCMS-2313/2313TXV/2313TXVB	5.0 mm (0.20 inch)	High-Performance Green
HCMS-2314/2314TXV/2314TXVB	5.0 mm (0.20 inch)	Orange
Sunlight Viewable Displays		
HCMS-2351/2351TXV/2351TXVB	5.0 mm (0.20 inch)	Yellow
HCMS-2352/2352TXV/2352TXVB	5.0 mm (0.20 inch)	High-Efficiency Red
HCMS-2353/2353TXV/2353TXVB	5.0 mm (0.20 inch)	High-Performance Green
HCMS-2354/2354TXV/2354TXVB	5.0 mm (0.20 inch)	Orange

Note:
Basic part numbers (ie. HCMS-2351) are without hi-rel screening. Part numbers with TXV or TXVB suffix (ie. HCMS-2351TXV) are with hi-rel screening per MIL-D-87157, Quality Level A.

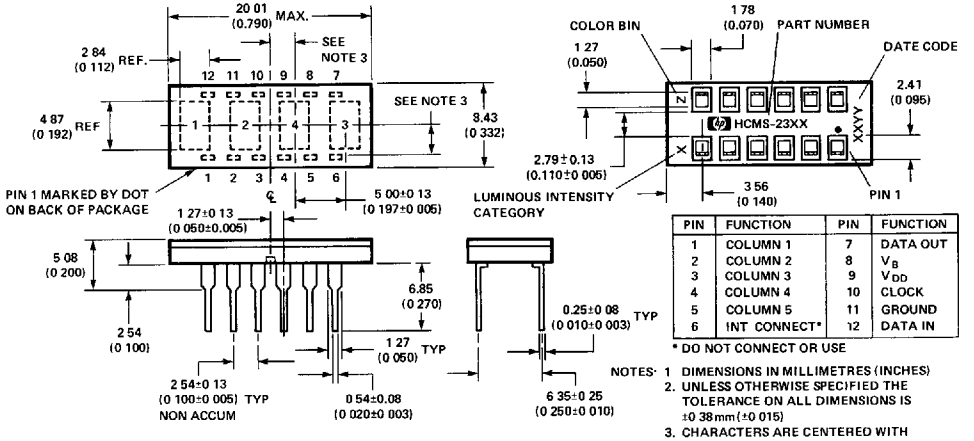
Package Dimensions



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

* DO NOT CONNECT OR USE

HCMS-201X Series



PIN	FUNCTION	PIN	FUNCTION
1	COLUMN 1	7	DATA OUT
2	COLUMN 2	8	V_B
3	COLUMN 3	9	V_{DD}
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 MILLIMETRES (INCHES)
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ±0.38mm (±0.015)
3. CHARACTERS ARE CENTERED WITH RESPECT TO LEADS WITHIN ±0.13mm (±0.005")
4. LEAD MATERIAL IS COPPER ALLOY, SOLDER DIPPED

HCMS-231X/-235X Series

Absolute Maximum Ratings

Supply Voltage V_{DD} to Ground .....–0.3 V to 7.0 V
Data Input, Data Output, V_B .....–0.3 V to V_{DD}
Column Input Voltage, V_{COL} .....–0.3 V to V_{DD}
Free Air Operating Temperature Range, T_A .....–55°C to +100°C
Storage Temperature Range, T_S .....–65°C to +125°C
HCMS-2310/-2311/-2312/-2314
HCMS-2351/-2352/-2354
Storage Temperature Range, T_S .....–55°C to +100°C
HCMS-2010/-2011/-2012/-2013
HCMS-2313
HCMS-2353
Maximum Allowable Package Power Dissipation, P_D [1,2]
HCMS-2010/-2011/-2012/-2013 at T_A = 83°C .....0.79 Watts
HCMS-2310/-2311/-2312/-2313/-2314 at T_A = 88°C .....0.92 Watts
HCMS-2351/-2352/-2353/-2354 at T_A = 71°C .....1.31 Watts
Maximum Solder Temperature
1.59 mm (0.063") Below Seating Plane, t ≤ 5 sec .....260°C
ESD Protection @ 1.5kΩ, 100pf .....V_Z = 4 kV (each pin)

Notes:
1. Maximum allowable power dissipation is derived from V_{DD} = 5.25 V, V_B = 2.4 V, V_{COL} = 3.5 V, 20 LEDs ON per character, 20% DF.
2. The power dissipation for these displays should be derated as follows:
HCMS-201X series derate above 83°C at 17 mW/°C, $R\theta_{J-A}$ = 60°C/W
HCMS-231X series derate above 88°C at 22 mW/°C, $R\theta_{J-A}$ = 45°C/W
HCMS-325X series derate above 71°C at 23 mW/°C, $R\theta_{J-A}$ = 45°C/W.

Deratings based on $R\theta_{PC-A}$ = 35°C/W per display for printed circuit board assembly.
See Figure 1 for power derating based on lower $R\theta_{J-A}$ values.

Recommended Operating Conditions Over Operating Temperature Range (-55°C to +100°C)

Parameter	Symbol	Min.	Typ.	Max.	Units
Supply Voltage	V_{DD}	4.75	5.00	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 (-55°C to +100°C)

Parameter	Symbol	Test Conditions	Min.	Typ.*	Max.	Units
Supply Current, Dynamic[1]	I_{DDD}	f_{CLOCK} = 5 MHz		6.2	7.8	mA
Supply Current, Static[2]	I_{DDSoff} I_{DDSon}	V_B = 0.4 V V_B = 2.4 V		1.8 2.2	2.6 3.3	mA
Column Input Current	I_{COL}	V_B = 0.4 V			10	µA
HCMS-2010/-2011/-2012/-2013		V_B = 2.4 V		310	384	mA
HCMS-2310/-2311/-2312/-2313/-2314		V_B = 2.4 V		360	451	mA
HCMS-2351/-2352/-2353/-2354		V_B = 2.4 V		500	650	mA
Input Logic High Data, V_B, Clock	V_{IH}	V_{DD} = 4.75 V	2.0			V
Input Logic Low Data, V_B, Clock	V_{IL}	V_{DD} = 5.25 V			0.8	V
Input Current Data, Clock V_B	I_I	V_{DD} = 5.25 V $0 \le V_I \le 5.25$ V $0 \le V_B \le 5.25$ V	-10 -40		+10 0	µA
Data Out Voltage	V_{OH}	V_{DD} = 4.75 V I_{OH} = -0.5 mA I_{COL} = 0 mA	2.4	4.2		V
	V_{OL}	V_{DD} = 5.25 V I_{OL} = 1.6 mA I_{COL} = 0 mA		0.2	0.4	V
Power Dissipation Per Package[3]	P_D	V_{DD} = 5.0 V V_{COL} = 3.5 V 17.5% DF V_B = 2.4 V 15 LEDs ON per Character				
HCMS-2010/-2011/-2012/-2013				414		mW
HCMS-2310/-2311/-2312/-2313/-2314				481		mW
HCMS-2351/-2352/-2353/-2354				668		mW
Thermal Resistance IC Junction-to-Pin[4]						
HCMS-2010/-2011/-2012/-2013	$R\theta_{J\text{-}PIN}$			25		°C/W
HCMS-2310/-2311/-2312/-2313/-2314				10		°C/W
HCMS-2351/-2352/-2353/-2354				10		°C/W
Leak Rate					$5x10^{-8}$	cc/sec

*All typical values specified at V_{DD} = 5.0V and T_A = 25°C.

Notes:
1. I_{DD} Dynamic is the IC current while clocking column data through the on-board shift register at a clock frequency of 5MHz, the display is not illuminated.
2. I_{DD} Static is the IC current after column data is loaded and not being clocked through the on-board shift register.
3. Four characters are illuminated with a typical ASCII character composed of 15 dots per character.
4. IC junction temperature $T_J(IC) = (P_D)(R\theta_{J\text{-}PIN} + R\theta_{PC\text{-}A}) + T_A$

Optical Characteristics at $T_A = 25°C$

Standard Red HCMS-2010/-2310

Description	Symbol	Test Condition	Min.	Typ.	Max.	Units
Peak Luminous Intensity per LED[5,9] (Character Average) HCMS-2010	I_{vPEAK}	$V_{DD} = 5.0$ V, $V_{COL} = 3.5$ V, $V_B = 2.4$ V, $T_j = 25°C$[7]	105	200		µcd
HCMS-2310			220	370		
Dominant Wavelength[8]	λ_d			639		nm
Peak Wavelength	λ_{PEAK}			655		nm

Yellow HCMS-2011/-2311/-2351

Description	Symbol	Test Condition	Min.	Typ.	Max.	Units
Peak Luminous Intensity per LED[5,9] (Character Average) HCMS-2011	I_{vPEAK}	$V_{DD} = 5.0$ V, $V_{COL} = 3.5$ V, $V_B = 2.4$ V, $T_j = 25°C$[7]	400	750		µcd
HCMS-2311			650	1140		
HCMS-2351			2400	3400		
Dominant Wavelength[6,8]	λ_d			585		nm
Peak Wavelength	λ_{PEAK}			583		nm

High Efficiency Red HCMS-2012/-2312/-2352

Description	Symbol	Test Condition	Min.	Typ.	Max.	Units
Peak Luminous Intensity per LED[5,9] (Character Average) HCMS-2012	I_{vPEAK}	$V_{DD} = 5.0$ V, $V_{COL} = 3.5$ V, $V_B = 2.4$ V, $T_j = 25°C$[7]	400	1430		µcd
HCMS-2312			650	1430		
HCMS-2352			1920	2850		
Dominant Wavelength[8]	λ_d			625		nm
Peak Wavelength	λ_{PEAK}			635		nm

High Performance Green HCMS-2013/-2313/-2353

Description	Symbol	Test Condition	Min.	Typ.	Max.	Units
Peak Luminous Intensity per LED[5,9] (Character Average) HCMS-2013	I_{vPEAK}	$V_{DD} = 5.0$ V, $V_{COL} = 3.5$ V, $V_B = 2.4$ V, $T_j = 25°C$[7]	850	1550		µcd
HCMS-2313			1280	2410		
HCMS-2353			2400	3000		
Dominant Wavelength[6,8]	λ_d			574		nm
Peak Wavelength	λ_{PEAK}			568		nm

Orange HCMS-2314/-2354

Description	Symbol	Test Condition	Min.	Typ.	Max.	Units
Peak Luminous Intensity per LED[5,9] (Character Average) HCMS-2314 HCMS-2354	I_{vPEAK}	V_{DD} = 5.0 V, V_{COL} = 3.5 V, V_B = 2.4 V, T_j = 25°C[7]	650 1920	1430 2850		µcd
Dominant Wavelength[8]	λ_d			602		nm
Peak Wavelength	λ_{PEAK}			600		nm

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

Notes:

5. These LED displays are categorized for luminous intensity, with the intensity category designated by a letter code on the back of the package.
6. The HCMS-2011/-2311/-2351 and HCMS-2013/-2313/-2353 are categorized for color with the color category designated by a number on the back of the package.
7. Ti refers to the initial case temperature of the display immediately prior to the light measurement.
8. Dominant wavelength, λ_d, is derived from the CIE Chromaticity Diagram, and represents the single wavelength which defines the color of the device.
9. The luminous sterance of the individual LED pixels may be calculated using the following equations:

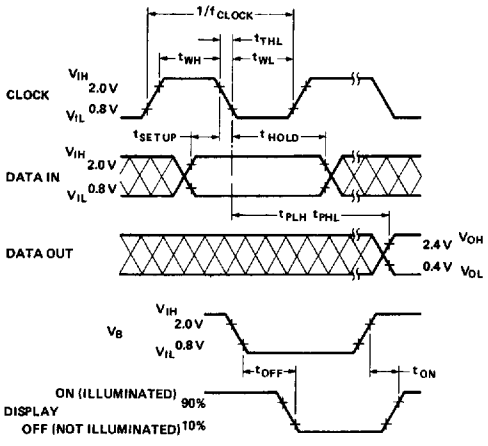
L_v(cd/m^2) = I_v(Candela)*DF/A(Metre)^2

L_v(Footlamberts) = πI_v(Candela)*DF/A(Foot)^2

Where: A = LED pixel area = 5.3 x 10^{-8}M^2 or 5.8 x 10^{-7}ft^2

DF = LED on-time duty factor

Switching Characteristics, T_A = –55°C to +100°C



Parameter	Condition	Typ.	Max.	Units
f_{clock} CLOCK Rate			5	MHz
t_{PLH}, t_{PHL} Propagation Delay CLOCK to DATA OUT	C_L = 15 pF, R_L = 2.4 kΩ		105	ns
t_{OFF} V_B (0.4 V) to Display OFF		4	5	µs
t_{ON} V_B (2.4 V) to Display ON		1	2	µs

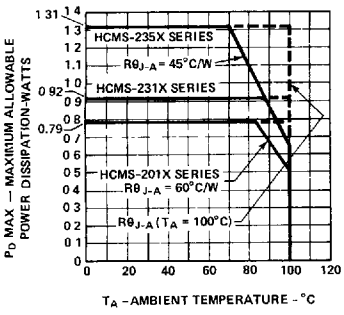


Figure 1. Maximum Allowable Power Dissipation vs Ambient Temperature as a Function of Thermal Resistance Junction-to-Ambient, $R\theta_{J-A}$. Derated Operation Assumes $R\theta_{PC-A}$ = 35°C/W per Display for Printed Circuit Board. T_J (IC) MAX = 130°C. $R\theta_{J-A}$ (T_A = 100°C)
- **= 22°C/W for HCMS-235X Series**
- **= 32°C/W for HCMS-231X Series**
- **= 38°C/W for HCMS-201X Series**

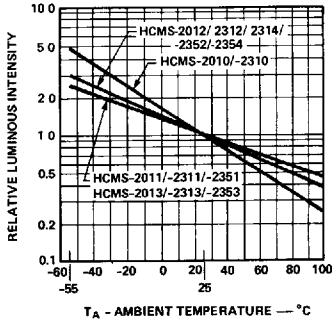


Figure 2. Relative Luminous Intensity vs Display Pin Temperature

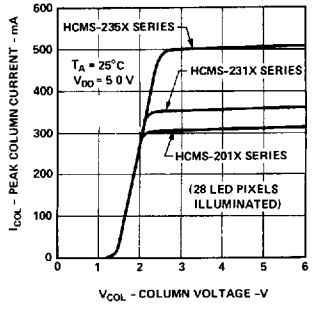


Figure 3. Peak Column Current vs Column Voltage

Electrical Description

Each display device contains four 5x7 LED dot matrix characters and two CMOS integrated circuits, as shown in Figure 4. 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. The nominal current sink per LED driver is 11mA for the HCMS-201X displays, 13mA for the HCMS-231X displays and 18mA for the HCMS-235X displays. 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_{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_{COL} inputs should be at logic low to insure 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_{COL} inputs is energized.

Refer to Application Note 1016 for drive circuit information.

ESD Susceptibility

The HCMS-201X/-231X/-235X series displays have an ESD susceptibility ratings of CLASS 3 per DOD-STD-1686 and CLASS B per MIL-STD-883C. It is recommended that normal CMOS handling precautions be observed 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.

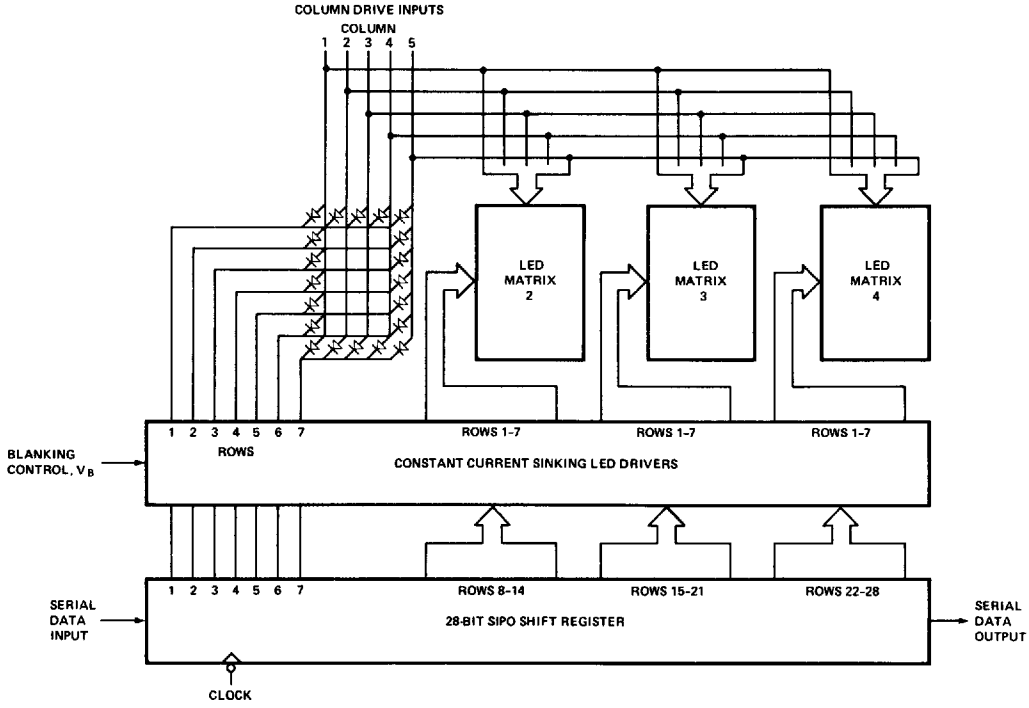


Figure 4. Block Diagram of an HCMS-2XXX Series LED Alphanumeric Display.

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 1/2 to 2 seconds. The recommended solvent for post solder cleaning is Genesolv DES, manufactured by Allied Chemical. For aqueous cleaning, a water temperature of 60°C (140°F) with an immersion time not exceeding 15 minutes is recommended. For more detailed information, refer to Application *Note 1027 Soldering LED Components.*

Contrast Enhancement

When used with the proper contrast enhancement filters, the HCMS-235X series displays are readable in sunlight and the HCMS-201X/231X series displays are readable in daylight ambients. Refer to Application Note 1029 *Luminous Contrast and Sunlight Readability of the HDSP-238X Series Alphanumeric Displays* for Military Applications for information on contrast enhancement for sunlight and daylight ambients. Refer to Application Note 1015 *Contrast Enhancement Techniques for LED Displays* for information on contrast enhancement in moderate ambients.

Night Vision Lighting

When used with the proper NVG/DV filters, the HCMS-2311/-2351 and HCMS-2133/-2353 displays may be used in night vision lighting applications. The HCMS-2311/-2351 (yellow) displays are used as master caution and warning indicators. The HCMS-2313/-2353 (high performance green) displays are used for general instrumentation. 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.

Table I. Quality Level A of MIL-D-87157 – 100% Screening

Test Screen	MIL-STD-750 Method	Conditions
1. Precap Visual	2072	Interpreted by HP Procedure 5956-7512-52
2. High Temperature Storage	1032	T_A = 125°C, Time = 24 hours[3]
3. Temperature Cycling	1051	Condition B, 10 cycles, 15 minute dwell
4. Constant Acceleration	2006	10,000 G's at Y_1 orientation
5. Fine Leak	1071	Condition H
6. Gross Leak	1071	Condition C or K[4]
7. Interim Electrical/ Optical Tests[1]	—	I_{DD} (at V_B = 0.4 V and 2.4 V), I_{COL} (at V_B = 0.4 V and 2.4 V) I_{IH} (V_B, Clock and Data In), I_{IL} (V_B, Clock and Data In), I_{OH}, I_{OL} and I_{VPEAK}. V_{IH} and V_{IL} inputs are guaranteed by the electronic shift register test. T_A = 25°C
8. Burn-In[1]	1015	Condition B at V_{DD} = V_B = 5.25 V, V_{COL} = 3.5 V, T_A = +100°C LED ON-Time Duty Factor = 5%, 35 Dots On; t = 160 hours
9. Final Electrical Test[2]	—	Same as step 7
10. Delta Determinations	—	ΔI_{DD} = ±6 mA, ΔI_{IH} (clock) = ±10 µA, ΔI_{IH} (Data In) = ±10 µA ΔI_{OH} = ±10% of initial value, and ΔI_V = -20%, T_A = 25°C
11. External Visual[1]	2009	

Notes:
1. MIL-STD-883 Test Method applies.
2. Limits and conditions are per the electrical/optical characteristics. The I_{OH} and I_{OL} tests are the inverse of V_{OH} and V_{OL} specified in the electrical characteristics.
3. T_A = +100°C for HCMS-2013/-2313/-2353.
4. Fluid temperature = +100°C for HCMS-2013/-2313/-2353.

Table II. Group A Electrical Tests – MIL-D-87157

Subgroup Test	Parameters	LTPD
Subgroup 1 DC Electrical Tests at 25°C[1]	I_{DD} (at V_B = 0.4 V and 2.4 V), I_{COL} (at V_B = 0.4 V and 2.4 V) I_{IH} (V_B, Clock and Data In), I_{IL} (V_B, Clock and Data In), I_{OH}, I_{OL} Visual Function and I_{VPEAK}. V_{IH} and V_{IL} inputs are guaranteed by the electronic shift register test.	5
Subgroup 2 DC Electrical Tests at High Temperature[1]	Same as Subgroup 1 except delete I_V and visual function, T_A = +100°C	7
Subgroup 3 DC Electrical Tests at Low Temperature[1]	Same as Subgroup 1 except delete I_V and visual function, T_A = -55°C	7
Subgroup 4, 5, and 6 not tested		
Subgroup 7 Optical and Functional Tests at 25°C	Satisfied by Subgroup 1	5
Subgroup 8 External Visual	MIL-STD-883, Method 2009	7

Notes:
1. Limits and conditions are per the electrical/optical characteristics. The I_{OH} and I_{OL} tests are the inverse of V_{OH} and V_{OL} specified in the electrical characteristics.

Table IIIa. Group B, Class A and B of MIL-D-87157

Subgroup Test	MIL-STD-750 Method	Conditions	Sample Size
Subgroup 1 Resistance to Solvents	1022		4 Devices/ 0 Failures
Internal Visual and Design Verification[1]	2075[7]		1 Device/ 0 Failures
Subgroup 2[2,3] Solderability	2026	T_A = 245°C for 5 seconds	LTPD = 15
Subgroup 3 Thermal Shock (Temp. Cycle)	1051	Condition B1, 15 minute dwell	LTPD = 15
Moisture Resistance[4]	1021		
Fine Leak	1071	Condition H	
Gross Leak	1071	Condition C or K[8]	
Electrical/Optical Endpoints[5]	—	I_{DD} (at V_B = 0.4 V and 2.4 V), I_{COL} (at V_B = 0.4 V and 2.4 V), I_{IH} (V_B, Clock and Data In), I_{IL} (V_B, Clock and Data In), I_{OH}, I_{OL} Visual Function and I_{VPEAK}. V_{IH} and V_{IL} inputs are guaranteed by the electronic shift register test. T_A = 25°C	
Subgroup 4 Operating Life Test (340 hrs.)	1027	T_A = +100°C at V_{DD} = V_B = 5.25 V, V_{COL} = 3.5 V, LED ON-Time Duty Factor = 5%, 35 Dots On	LTPD = 10
Electrical/Optical Endpoints[5]	—	Same as Subgroup 3	
Subgroup 5 Non-Operating Storage Life Test (340 hrs.)	1032	T_A = +125°C[6]	LTPD = 10
Electrical/Optical Endpoints[5]	—	Same as Subgroup 3	

Notes:
1. Visual inspection is performed through the display window.
2. Whenever electrical/optical tests are not required as endpoints, electrical rejects may be used.
3. 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.
4. Initial conditioning is a 15° inward bend for one cycle.
5. Limits and conditions are per the electrical/optical characteristics. The I_{OH} and I_{OL} tests are the inverse of V_{OH} and V_{OL} specified in the electrical characteristics.
6. T_A = 100°C for HCMS-2013/-2313/-2353.
7. Equivalent to MIL-STD-883, Method 2014.
8. Fluid temperature = +100°C for HCMS-2013/-2313/-2353.

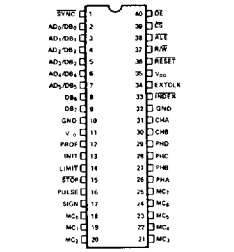
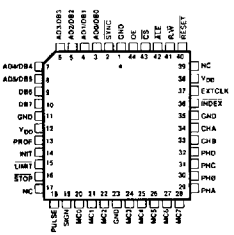
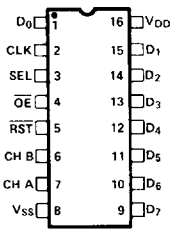
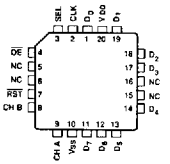
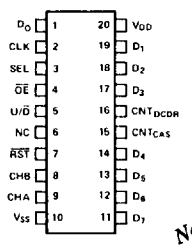
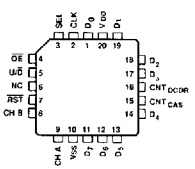
Table IVa. Group C, Class A and B of MIL-D-87157

Subgroup Test	MIL-STD-750 Method	Conditions	Sample Size
Subgroup 1 Physical Dimensions	2066		2 Devices/ 0 Failures
Subgroup 2[2] Lead Integrity[7,9]	2004	Condition B2	LTPD = 15
Fine Leak	1071	Condition H	
Gross Leak	1071	Condition C or K[10]	
Subgroup 3 Shock	2016	1500G. Time = 0.5 ms, 5 blows in each orientation X_1, Y_1, Z_1	LTPD = 15
Vibration Variable Frequency	2056		
Constant Acceleration	2006	10,000G at Y_1 orientation	
External Visual[4]	1010 or 1011		
Electrical/Optical Endpoints[8]	—	I_{DD} (at V_B = 0.4 V and 2.4 V), I_{COL} (at V_B = 0.4 V and 2.4 V), I_{IH} (V_B, Clock and Data In), I_{IL} (V_B, Clock and Data In), I_{OH}, I_{OL}, Visual Function and I_{VPEAK}. V_{IH} and V_{IL} inputs are guaranteed by the electronic shift register test. T_A = 25°C	
Subgroup 4[1,3] Salt Atmosphere	1041		LTPD = 15
External Visual[4]	1010 or 1011		
Subgroup 5 Bond Strength[5]	2037	Condition A	LTPD = 20 (C = 0)
Subgroup 6 Operating Life Test[6]	1026	T_A = +100°C at V_{DD} = V_B = 5.25 V, V_{COL} = 3.5 V LED ON-Time Duty Factor = 5%, 35 Dots On	λ = 10
Electrical/Optical Endpoints[8]	—	Same as Subgroup 3	

Notes:

1. Whenever electrical/optical tests are not required as endpoints, electrical rejects may be used.
2. 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.
3. Solderability samples shall not be used.
4. Visual requirements shall be as specified in MIL-STD-883, Methods 1010 or 1011.
5. Displays may be selected prior to seal.
6. 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.
7. MIL-STD-883 test method applies.
8. Limits and conditions are per the electrical/optical characteristics. The I_{OH} and I_{OL} tests are the inverse of V_{OH} and V_{OL} specified in the electrical specifications.
9. Initial conditioning is a 15° inward bend for three cycles.
10. Fluid temperature = +100°C for HCMS-2013/-2313/-2353.

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	1-102

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 1-22 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 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 OPT 0 □□	Alignment Tool for HEDS-5540/5545 and HEDS-5640/5645. Order in appropriate shaft size.	1-61