HEWLETT PACKARD

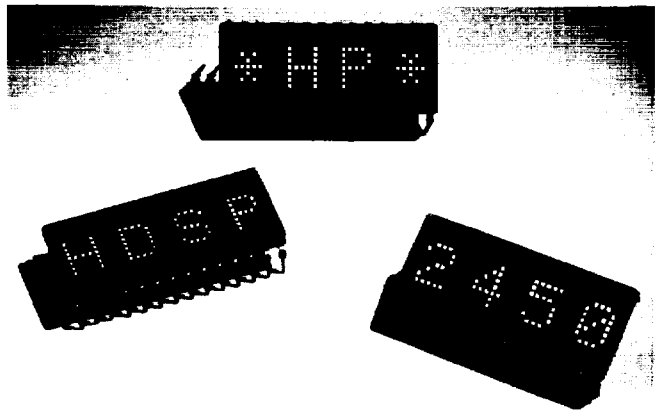
HERMETIC, EXTENDED TEMPERATURE RANGE 6.9mm (.27") 5x7 ALPHANUMERIC DISPLAYS

STANDARD RED HDSP-2450
YELLOW HDSP-2451
HIGH EFFICIENCY RED HDSP-2452
ALSO TXV AND TXVB SCREENED VERSIONS

TECHNICAL DATA SEPTEMBER 1982

Features

- WIDE OPERATING TEMPERATURE RANGE -55°C TO +85°C
- TRUE HERMETIC PACKAGE
- CAPABLE OF LEVEL A MIL-D-87157
- THREE COLORS
  Standard Red
  High Efficiency Red
  Yellow
- CATEGORIZED FOR LUMINOUS INTENSITY
- YELLOW DISPLAYS CATEGORIZED FOR COLOR
- INTEGRATED SHIFT REGISTERS WITH CONSTANT CURRENT DRIVERS
- 5x7 LED MATRIX DISPLAYS FULL ASCII CHARACTER SET
- WIDE VIEWING ANGLE
- END STACKABLE
- TTL COMPATIBLE



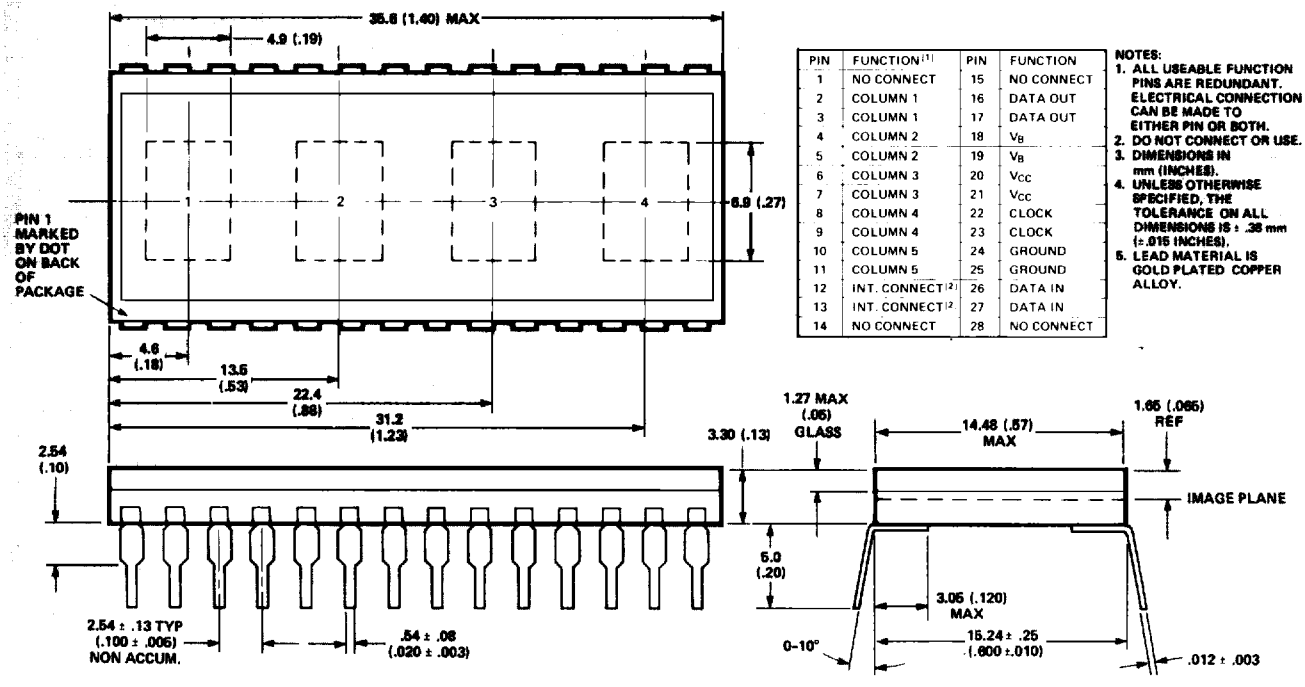
Typical Applications

- MILITARY EQUIPMENT
- AVIONICS
- HIGH RELIABILITY INDUSTRIAL EQUIPMENT

Description

The HDSP-2450 series displays are 6.9mm (0.27 in.) 5x7 LED arrays for display of alphanumeric information. These devices are available in standard red, yellow, and high efficiency red. Each four character cluster is contained in a hermetic 28 pin dual-in-line, solder glass sealed ceramic 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.

Package Dimensions



PIN	FUNCTION[1]	PIN	FUNCTION
1	NO CONNECT	15	NO CONNECT
2	COLUMN 1	16	DATA OUT
3	COLUMN 1	17	DATA OUT
4	COLUMN 2	18	V_B
5	COLUMN 2	19	V_B
6	COLUMN 3	20	V_{CC}
7	COLUMN 3	21	V_{CC}
8	COLUMN 4	22	CLOCK
9	COLUMN 4	23	CLOCK
10	COLUMN 5	24	GROUND
11	COLUMN 5	25	GROUND
12	INT. CONNECT[2]	26	DATA IN
13	INT. CONNECT[2]	27	DATA IN
14	NO CONNECT	28	NO CONNECT

NOTES:
1. ALL USEABLE FUNCTION PINS ARE REDUNDANT. ELECTRICAL CONNECTION CAN BE MADE TO EITHER PIN OR BOTH.
2. DO NOT CONNECT OR USE.
3. DIMENSIONS IN mm (INCHES).
4. UNLESS OTHERWISE SPECIFIED, THE TOLERANCE ON ALL DIMENSIONS IS ± .38 mm (± .015 INCHES).
5. LEAD MATERIAL IS GOLD PLATED COPPER ALLOY.

Absolute Maximum Ratings (HDSP-2450/-2451/-2452)

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 [1,2] ..... —55°C to +85°C
Storage Temperature Range, T_S ..... —65°C to +125°C
Maximum Allowable Package Dissipation
at T_A = 25°C [1,2,3] ..... 1.46 Watts
Maximum Solder Temperature 1.59 mm (0.63")
Below Seating Plane t < 5 secs ..... 260°C

Recommended Operating Conditions (HDSP-2450/-2451/-2452)

Parameter	Symbol	Min.	Nom.	Max.	Units	Fig.
Supply Voltage	V_{CC}	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, Column On HDSP-2450	V_{COL}	2.4		3.5	V	4
Column Input Voltage, Column On HDSP-2451/2452	V_{COL}	2.75		3.5	V	4
Setup Time	t_{setup}	70	45		ns	1
Hold Time	t_{hold}	30	0		ns	1
Width of Clock	$t_{w(Clock)}$	75			ns	1
Clock Frequency	f_{clock}	0		3	MHz	1
Clock Transition Time	t_{THL}			200	ns	1
Free Air Operating Temperature Range [1,2]	T_A	-55		85	°C	

Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified)

Description		Symbol	Test Conditions		Min.	Typ.*	Max.	Units	Fig.
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} = 5.25 V V_{COL} = 3.5V	V_B = 0.4V			500	µA	4
Column Current at any Column Input		I_{COL}	All SR Stages = Logical 1	V_B = 2.4V		380	520	mA	
V_B, Clock or Data Input Threshold High		V_{IH}	V_{CC} = 4.75V		2.0			V	
V_B, Clock or Data Input Threshold Low		V_{IL}					0.8	V	
Clock Input 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} = -0.5 mA, I_{COL} = 0 mA		2.4	3.4		V	
		V_{OL}	V_{CC} = 4.75V, I_{OH} = 1.6 mA, I_{COL} = 0 mA			0.2	0.4	V	
Power Dissipation Per Package**		P_D	V_{CC} = 5.0V, V_{COL} = 3.5V, 17.5% DF 15 LEDs on per character, V_B = 2.4V			0.78		W	2
Thermal Resistance IC Junction-to-Case		$R\theta_{J-C}$				20		°C/W/ Device	2
Leak Rate							$5x10^{-8}$	cc/sec	

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

**Power dissipation per package with four characters illuminated.

Notes:

1. Operation above 85°C ambient is possible provided the IC junction temperature, T_J, does not exceed 125°C.
2. The device should be derated linearly above 60°C at 22.2 mW/°C. This derating is based on a device mounted in a socket having a thermal resistance from case to ambient at 25°C/W per device. See Figure 2 for power deratings based on a lower thermal resistance.
3. Maximum allowable dissipation is derived from V_{CC} = 5.25V, V_B 2.4V, V_{COL} = 3.5V 20 LEDs on per character, 20% DF.

Optical Characteristics

STANDARD RED HDSP-2450

Description	Symbol	Test Conditions	Min.	Typ.*	Max.	Units	Fig.
Peak Luminous Intensity per LED[4,8] (Character Average)	I_{vPeak}	V_{CC} = 5.0V, V_{COL} = 3.5V T_j = 25° C[6], V_B = 2.4V	220	370		µcd	3
Peak Wavelength	λ_{PEAK}			655		nm	
Dominant Wavelength[7]	λ_d			539		nm	

YELLOW HDSP-2451

Description	Symbol	Test Conditions	Min.	Typ.*	Max.	Units	Fig.
Peak Luminous Intensity per LED[4,8] (Character Average)	I_{vPeak}	V_{CC} = 5.0V, V_{COL} = 3.5V T_j = 25° C[6], V_B = 2.4V	850	1400		µcd	3
Peak Wavelength	λ_{PEAK}			583		nm	
Dominant Wavelength[5,7]	λ_d			585		nm	

HIGH EFFICIENCY RED HDSP-2452

Description	Symbol	Test Conditions	Min.	Typ.*	Max.	Units	Fig.
Peak Luminous Intensity per LED[4,8] (Character Average)	I_{vPeak}	V_{CC} = 5.0V, V_{COL} = 3.5V T_j = 25° C[6], V_B = 2.4V	850	1530		µcd	3
Peak Wavelength	λ_{PEAK}			635		nm	
Dominant Wavelength[7]	λ_d			626		nm	

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

**Power dissipation per package with four characters illuminated.

Notes:

4. The characters are categorized for luminous intensity with the intensity category designated by a letter code on the bottom of the package.
5. The HDSP-2451 is categorized for color with the color category designated by a number code on the bottom of the package.
6. T_j refers to the initial case temperature of the device immediately prior to the light measurement.
7. Dominant wavelength λ_d, is derived from the CIE chromaticity diagram, and represents the single wavelength which defines the color of the device.
8. The luminous sterance of the LED may be calculated using the following relationships:
   L_v (cd/m²) = I_v (Candela /A Metre²)
   L_v Footlamberts = πI_v Candela /A Foot²)
   A = 5.3 x 10^{-8} M² = 5.8 x 10^{-7} Foot²)

Electrical Description

The HDSP-2450 series of four character alphanumeric displays have 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. 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 disgram for the displays. 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 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 input data for digit 4, column 1 is loaded into the 7 on-board shift register locations 1 through 7. Column 1 data for digits 3, 2, and 1 is similarly 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:

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

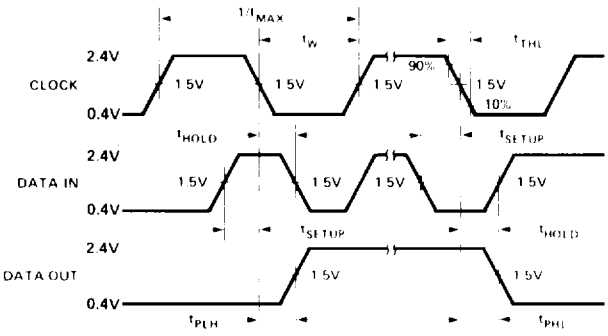
The time frame, t + T, alloted to each column of the display is generally chosen to provide the maximum duty factor consistent with the minimum refresh rate necessary to achieve a flicker free display. For most strobed display systems, each column of the display should be refreshed (turned on) at a minimum rate of 100 times per second.

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

$$1/|5 \times (100)| = 2 \text{ msec}$$

If the device is operated at 3.0 MHz clock rate maximum, it is possible to maintain t<<T. For short display strings, the duty factor will then approach 20%.

For further applications information, refer to HP Application Bulletin 56 and Application Note 1016.



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 HDSP-2450/-2451/-2452 (T_A = -55°C to +85°C)

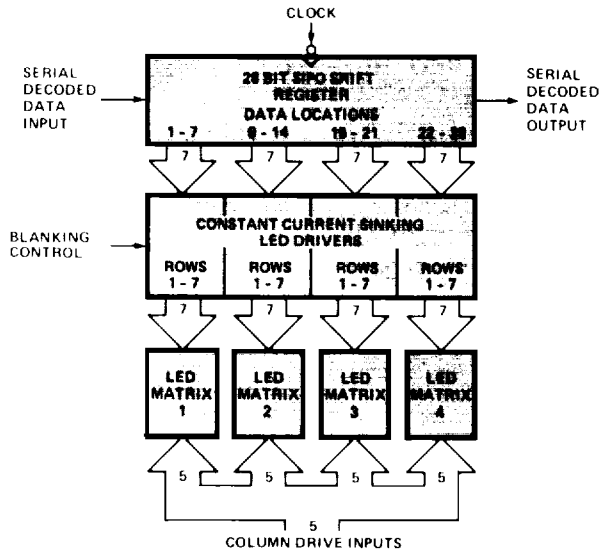


Figure 5. Block Diagram of HDSP-2450/-2451/-2452

Mechanical and Thermal Considerations

The HDSP-2450 series displays are available in standard ceramic dual-in-line packages. They are designed for plugging into sockets or soldering into PC boards. The packages may be horizontally or vertically stacked for character arrays of any desired size. HDSP-2450 series displays utilize a high output current IC to provide excellent readability in bright ambient lighting. Full power operation (V_{CC} = 5.25V, V_B = 2.4V, V_{COL} = 3.5V) with worst case thermal resistance from IC junction to ambient of 45° C/watt/device is possible up to ambient temperature of 60° C. For operation above 60° C, the maximum device dissipation should be derated linearly at 22.2 mW/°C (see Figure 2). With an improved thermal design, operation at higher ambient temperatures without derating is possible.

Power derating for this family of displays can be achieved in several ways. The power supply voltage can be lowered to a minimum of 4.75V. Column Input Voltage, V_{COL}, can be decreased to the recommended minimum values of 2.4V for the HDSP-2450 and 2.75V for the HDSP-2451/-2452. Also, the average drive current can be decreased through pulse width modulation of V_B.

The HDSP-2450 series displays have glass windows. A front panel contrast enhancement filter is desirable in most actual display applications. Some suggested filter materials are provided in Figure 6. Additional information on filtering and contrast enhancement can be found in HP Application Note 1015.

Post solder cleaning may be accomplished using water or Freon/alcohol mixtures formulated for vapor cleaning processing or Freon/alcohol mixtures formulated for room temperature cleaning. Freon/alcohol vapor cleaning processing for up to 2 minutes in vapors at boiling is permissible. Suggested solvents include Freon TF, Freon TE, Genesolv DI-15, Genesolv DE-15, and water.

Display Color	Ambient Lighting		
	Dim	Moderate	Bright
HDSP-2450 Std. Red	Panelgraphic Dark Red 63 Ruby Red 60 Chequers Red 118 Plexiglass 2423	Polaroid HNCP37 3M Light Control Film Panelgraphic Gray 10	
HDSP-2451 (Yellow)	Panelgraphic Yellow 27 Chequers Amber 107	Chequers Grey 105	Polaroid HNCP10
HDSP-2452 (HER)	Panelgraphic Ruby Red 60 Chequers Red 112		

Figure 6. Contrast Enhancement Filters

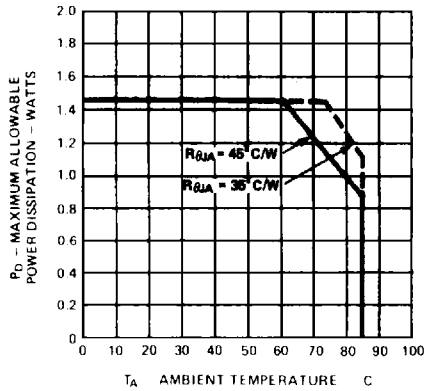


Figure 2. Maximum Allowable Power Dissipation vs. Temperature

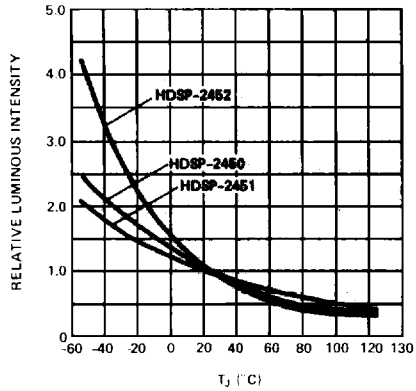


Figure 3. Relative Luminous Intensity vs. Temperature

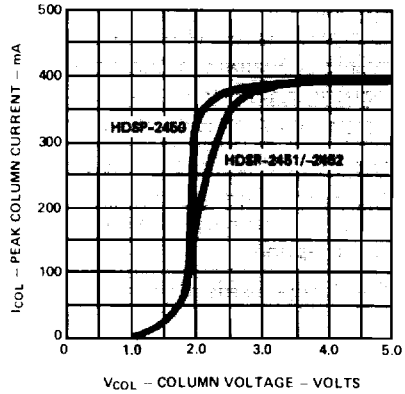


Figure 4. Peak Column Current vs. Column Voltage

High Reliability Testing

Two standard reliability testing programs are available. The TXVB program is in conformance with Quality Level A of MIL-D-87157 for hermetically sealed LED displays with 100% screening tests. A TXVB product is tested to Tables I, II, IIIa, and IVa. The TXV program is an HP modification to the full conformance program and offers the 100% screening of Quality Level A, Table I, and Group A, Table II.

Part Marking System

Standard Product	With Table I and II	With Tables I, II, IIIa, IVa
HDSP-2450	HDSP-2450 TXV	HDSP-2450 TXVB
HDSP-2451	HDSP-2451 TXV	HDSP-2451 TXVB
HDSP-2452	HDSP-2452 TXV	HDSP-2452 TXVB

100% Screening

Table I. Quality Level A of MIL-D-87157

Test Screen	MIL-STD-750 Method	Conditions
1. Precap Visual	—	HP Procedure 5956-7512-52
2. High Temperature Storage	1032	T_A = 125°C, Time = 24 hours
3. Temperature Cycling	1051	Condition B, 10 cycles
4. Constant Acceleration	2006	10,000 G's at Y_1 orientation
5. Fine Leak	1071	Condition H
6. Gross Leak	1071	Condition C
7. Interim Electrical/Optical Tests[2]	—	I_{CC} (at V_B = 0.4V and 2.4V), I_{COL} (at V_B = 0.4V and 2.4V) I_{IH} (V_B, Clock and Data In), I_{IL} (V_B, Clock and Data In), I_{OH}, I_{OL}, Visual Function and I_V Peak. 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_{CC} = V_B = 5.25V, V_{COL} = 3.5V, T_A = +85°C, LED ON-Time Duty Factor = 5%, t = 168 hours
9. Final Electrical Test[2]	—	Same as Step 7
10. Delta Determinations	—	ΔI_{CC} = ±6 mA, ΔI_{IH} (clock) = ±8 μA, ΔI_{IH} (Data In) = ±5 μA ΔI_{OH} = ±50 μA, and ΔI_V = -20%, T_A = 25°C
11. External Visual	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.

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

Subgroup/Test	Parameters	LTPD
Subgroup 1 DC Electrical Tests at 25°C[1]	I_{CC} (at V_B = 0.4V and 2.4V), I_{COL} (at V_B = 0.4V and 2.4V) I_{IH} (V_B, Clock and Data In), I_{IL} (V_B, Clock and Data In), I_{OH}, I_{OL} Visual Function and Iv peak. 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 Iv and visual function, T_A = +85°C	7
Subgroup 3 DC Electrical Tests at Low Temperature[1]	Same as Subgroup 1, except delete Iv 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		7

Note:
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 Mechanical[3]	2014		1 Device/ 0 Failures
Subgroup 2[1,2] Solderability	2026	T_A = 260°C for 5 seconds	LTPD = 15
Subgroup 3 Thermal Shock (Temp. Cycle)	1051	Condition B, 10 cycles	LTPD = 15
Moisture Resistance	1021		
Fine Leak	1071	Condition H	
Gross Leak	1071	Condition C	
Electrical/Optical Endpoints[4]	—	I_{CC} (at V_B = 0.4V and 2.4V), I_{COL} (at V_B = 0.4V and 2.4V), I_{IH} (V_B, Clock and Data In), I_{IL} (V_B, Clock and Data In), I_{OH}, I_{OL} Visual Function and Iv peak. 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 = +85°C at V_{CC} = V_B = 5.25V, V_{COL} = 3.5V, LED ON-Time Duty Factor = 5%	LTPD = 10
Electrical/Optical Endpoints[4]	—	Same as Subgroup 3	
Subgroup 5 Non-operating (Storage) Life Test (340 hrs.)	1032	T_A = +125°C	LTPD = 10
Electrical/Optical Endpoints[4]	—	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. MIL-STD-883 test methods apply.
4. 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 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[2,7]			
Lead Integrity	2004	Condition B2	LTPD = 15
Fine Leak	1071	Condition H	
Gross Leak	1071	Condition C	
Subgroup 3			
Shock	2016	1500G, Time = 0.5 ms, 5 blows in each orientation X_1, Y_1, Y_2	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_{CC} (at V_B = 0.4V and 2.4V) I_{COL} (at V_B = 0.4V and 2.4V) I_{IH} (V_B, Clock and Data In) I_{IL} (V_B, Clock and Data In) I_{OH}, I_{OL}, Visual Function and I_V peak. V_{IH} and V_{IL} inputs are guaranteed by the electronic shift register test. T_A = 25°C.	
Subgroup 4[1,3]			
Salt Atmosphere	1014		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 = +85°C at V_{CC} = V_B = 5.25V, V_{COL} = 3.5V	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 three 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 characteristics.

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

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