

4N51, 4N52
67023 4N53, 4N54 HERMETIC , NUMERIC AND HEXADECIMAL
DISPLAYS

Mii
OPTOELECTRONIC PRODUCTS
DIVISION

Features:

- Conforms to MIL-PRF-87157
- Three character options
Numeric, Hexidecimal or Over range
- 4 X 7 dot matrix character
- Memory latch/decoder/driver is TTL compatible
- Available in Red or Green
- Categorized for luminous intensity

Applications:

- High reliability systems
- Instrumentation panels
- Communication equipment
- Medical equipment
- Harsh environments
- IR blocking filter available

DESCRIPTION

The **4N51-4N54** series are solid state numeric and hexidecimal displays for use in high reliability applications. The displays feature an on-board decoder/driver and memory (except 4N53). These displays are hermetically sealed and conform to MIL-PRF-87157, the general specification for light emitting diode displays. The character height is 7.4mm (.29"). The green LED version conforms to MIL-D-87157 with exception of color.

The 4N51 is a numeric display which decodes positive BCD logic into the numbers "0-9", a "-" sign, a right-hand decimal point, and a test pattern (all LED's on).

The 4N52 is the same as the 4N51, but the decimal point is located on the left side of the device.

The 4N53 is an over range device which displays "±1" and a right-hand decimal point. This display is typically driven using external switching transistors.

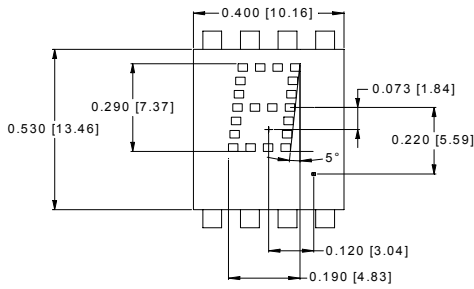
The 4N54 is a hexidecimal display which decodes positive BCD logic into 16 characters "0-9, A-F". An input is provided to blank the display (all LED's off) without losing the contents of the memory.

ABSOLUTE MAXIMUM RATINGS

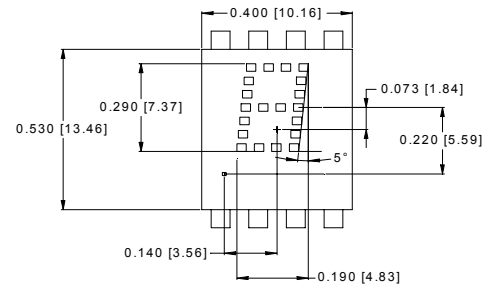
| | |
|--|-----------------|
| Storage Temperature..... | -65°C to +125°C |
| Operating Free-Air Temperature Range..... | -55°C to +100°C |
| Lead Solder Temperature (1/16" [1.6mm] below seating plane for 10s)..... | 260°C |
| Supply Voltage, V _{CC} (4N51, 4N52, 4N54)..... | -0.5V to 7V |
| Voltage Applied to Input Logic, DP and Enable Pins..... | -0.5V to 7V |
| Voltage Applied to Blanking Input (4N54 only)..... | -0.5V to 7V |
| Forward Current, Each LED (4N53 only)..... | 10mA |
| Reverse Voltage, Each LED (4N53 only)..... | 4V |

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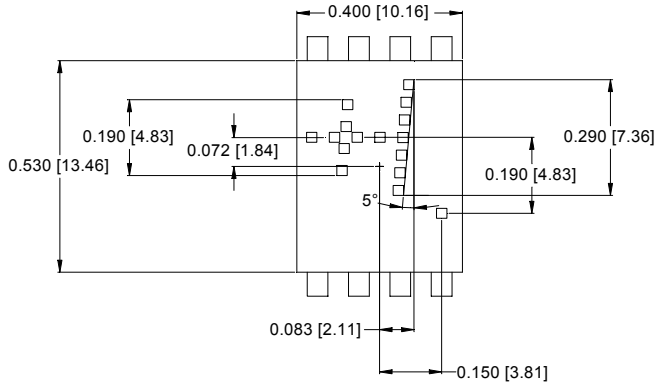
*** HERMETIC, NUMERIC AND HEXIDECIMAL DISPLAYS**



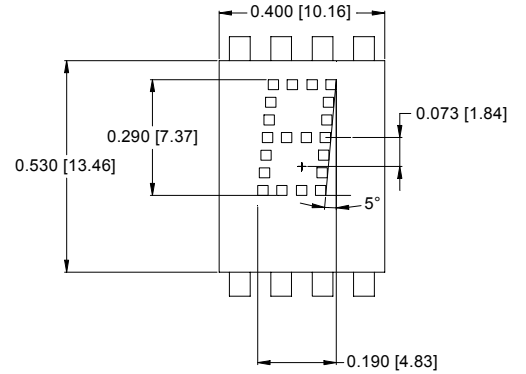
4N51



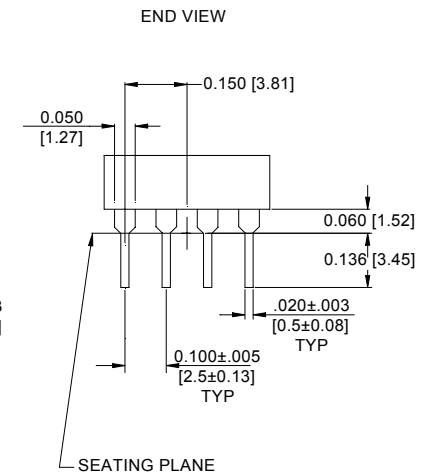
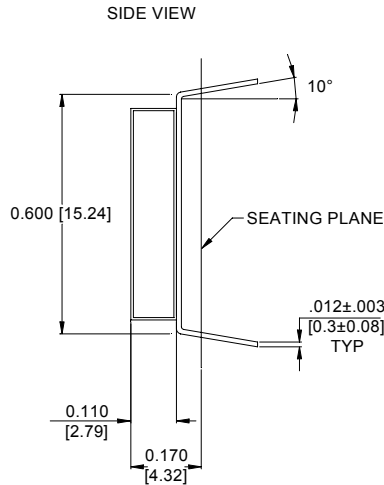
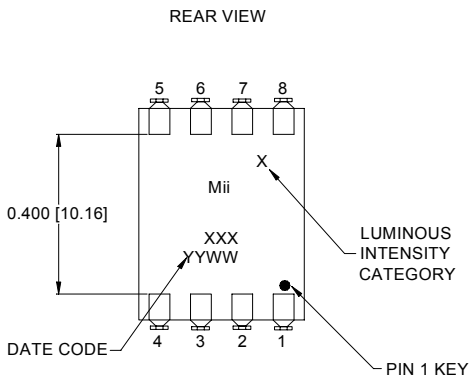
4N52



4N53



4N54



*JEDEC Registered Data

**4N51, 4N52,
67023 4N53, 4N54**

HERMETIC, NUMERIC AND HEXIDECIMAL DISPLAYS

***ELECTRICAL OPTICAL CHARACTERISTICS**

T_A = -55°C to +100°C unless otherwise specified.

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNITS | TEST CONDITIONS | NOTE |
|---|------------------------------|-----------------|--------------------------|--------------------------|--------|---|------|
| Supply Current | 4N51 4N52 4N54 | I _{CC} | 112 112 112 | 170 170 170 | mA | V _{CC} = 5.5V Numeral 5 and DP lighted | 1 |
| Power Dissipation | 4N51 4N52 4N53 4N54 | P _T | 560 560 280 560 | 935 935 320 935 | mW | V _{CC} = 5.5V Numeral 5 and DP lighted | 1,4 |
| Luminous Intensity per LED | 4N51 4N52 4N53 4N54 | I _V | 40 40 45 40 | 85 85 85 85 | μcd | V _{CC} = 5V, T _A = 25°C V _{CC} = 5V, T _A = 25°C I _F = 10mA, A = 25°C V _{CC} = 5V, A = 25°C | 2 |
| Forward Voltage per LED | 4N53 | V _F | 1.6 | 2.0 | V | I _F = 10mA | |
| Logic Low-Level Input Voltage | 4N51 4N52 4N54 | V _{IL} | | 0.8 0.8 0.8 | V | V _{CC} = 4.5V | |
| Logic Low-Level Input Voltage | 4N51 4N52 4N54 | V _{IH} | 2 2 2 | | V | V _{CC} = 4.5V | |
| Enable Low-Voltage; Data Being Entered | 4N51 4N52 4N54 | V _{EL} | | 0.8 0.8 0.8 | V | V _{CC} = 4.5V | |
| Enable High-Voltage; data not being entered | 4N51 4N52 4N54 | V _{EH} | 2 2 2 | | V | V _{CC} = 4.5V | |
| Blanking Low-Voltage display not blanked | 4N54 | V _{BL} | | 0.8 | V | V _{CC} = 4.5V | |
| Blanking High-Voltage display blanked | 4N54 | V _{BH} | 3.5 | | V | V _{CC} = 4.5V | |
| Leak Rate | ALL | | | 5x10 ⁻⁸ | cc/sec | | |
| Blanking Low-Level Input Current | 4N54 | I _{BL} | | 50 | mA | V _{CC} = 5.5V, V _{BL} = 0.8V | |
| Blanking High-Level Input Current | 4N54 | I _{BH} | | 1.0 | mA | V _{CC} = 5.5V, V _{BH} = 4.5V | |
| Logic Low-Level Input Current | 4N51 4N52 4N54 | I _{IL} | | -1.6 | mA | V _{CC} = 5.5V, V _{IL} = 0.4V | |
| Logic High-Level Input Current | 4N51 4N52 4N54 | I _{IH} | | +100 | μA | V _{CC} = 5.5V, V _{IH} = 2.4V | |
| Enable Low-Level Input Current | 4N51 4N52 4N54 | I _{EL} | | -1.6 | mA | V _{CC} = 5.5V, V _{EL} = 0.4V | |
| Enable High-Level Input Current | 4N51 4N52 4N54 | I _{EH} | | +130 | μA | V _{CC} = 5.5V, V _{EH} = 2.4V | |
| Wavelength at Peak Emission | ALL | λ _P | 655 | | nm | t _A = 25°C | |
| Dominant Wavelength | ALL | d | 640 | | | t _A = 25°C | 3 |
| Forward Voltage per LED | 4N53 | V _F | 1.6 | 2.0 | V | I _F = 10mA | |
| Weight | ALL | | 1 | | gm | | |

NOTES:

1. All typical values at V_{CC} = 5.0 volts, t_A = 25°C.
2. Luminous intensity for a specific temperature may be calculated with the following relationship: I_V(t_A) = I_V(25°C) (.985)^[t_A - 25°C].
3. The dominant wavelength, λ_d is a single wavelength that defines the saturated color of monochromatic light, as derived from the CIE chromaticity diagram.
4. For 4N53 test conditions, I_F = 10mA, all diodes lit.

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***RECOMMENDED OPERATING CONDITIONS:**

| PARAMETER | | SYMBOL | MIN | MAX | UNITS |
|--|------|--------------------|-----|-----|-------|
| Supply Voltage | 4N51 | V _{CC} | 4.5 | 5.5 | V |
| | 4N52 | | 4.5 | 5.5 | V |
| | 4N53 | | NA | NA | NA |
| | 4N54 | | 4.5 | 5.5 | V |
| Operating Temperature | ALL | t _A | -55 | 100 | °C |
| Enable Pulse Width | 4N51 | t _W | 100 | | ns |
| | 4N52 | | | | |
| | 4N54 | | | | |
| Time data must be held before positive transition of enable line | 4N51 | t _{SETUP} | 50 | | ns |
| | 4N52 | | | | |
| | 4N54 | | | | |
| Time data must be held after positive transition of enable line | 4N51 | t _{HOLD} | 50 | | ns |
| | 4N52 | | | | |
| | 4N54 | | | | |
| Enable pulse rise time | 4N51 | t _{TLH} | | 200 | ns |
| | 4N52 | | | | |
| | 4N54 | | | | |
| Forward Current | 4N53 | I _F | 5 | 10 | m |

SELECTION GUIDE

| | |
|------------|--|
| 67023-001 | 4N51 Commercial (0° to 70°C) |
| 67023-101 | 4N51 Screened to TXV level (-55° to +100°C) with 100% screening. |
| 67023-101C | 4N51 marked with DSCC P/N JM87157/00101AXX (-55° to +100°C) with 100% screening. |
| 67023-002 | 4N52 Commercial (0° to 70°C) |
| 67023-102 | 4N52 Screened to TXV level (-55° to +100°C) with 100% screening. |
| 67023-102C | 4N52 marked with DSCC P/N JM87157/00102AXX (-55° to +100°C) with 100% screening. |
| 67023-003 | 4N53 Commercial (0° to 70°C) |
| 67023-103 | 4N53 Screened to TXV level (-55° to +100°C) with 100% screening. |
| 67023-103C | 4N53 marked with DSCC P/N JM87157/00103AAX (-55° to +100°C) with 100% screening. |
| 67023-004 | 4N54 Commercial (0° to 70°C) |
| 67023-104 | 4N54 Screened to TXV level (-55° to +100°C) with 100% screening. |
| 67023-104C | 4N54 marked with DSCC P/N JM87157/00104AAX (-55° to +100°C) with 100% screening. |
| 67023-034 | 4N54, green commercial (0° to 70°C) |
| 67023-315 | 4N54, green Mil-Temp (-55° to +100°C) with 100% screening. |

NOTES:

1. When ordering DSCC part numbers, you may order by the MII part number or the DSCC part number.
2. The first X at the end of M87157/0010XA[X]X designates lead finish. In place of the X use A for hot solder dip or C for gold finish.
3. Second X at the end of the M87157/0010XAX[X] designates luminous intensity code. In place of the X use C thru K to indicate desired intensity level.

*JEDEC Registered Data

4N51, 4N52, 4N54 Logic

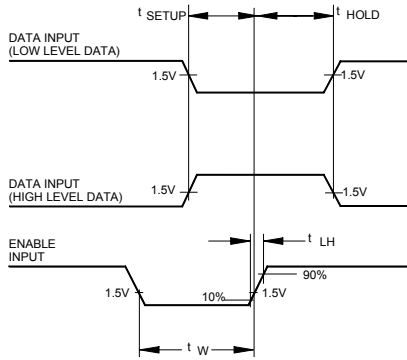


FIGURE 1 Timing Diagram of 4N51, 4N52 and 4N54 Series Logic

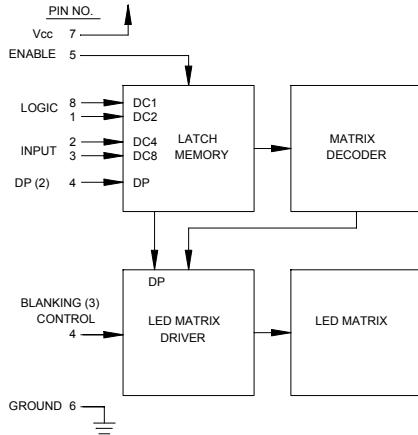


FIGURE 2 Block Diagram of 4N51, 4N52 and 4N54 Series Logic

| TRUTH TABLE | | | | | |
|----------------------------|----------------|----------------|----------------|-------------|--------------------|
| BCD DATA ⁽¹⁾ | | | | 4N51/4N52 | 4N54 |
| X ₈ | X ₄ | X ₂ | X ₁ | | |
| L | L | L | L | 0 | 0 |
| L | L | L | H | 1 | 1 |
| L | L | H | L | 2 | 2 |
| L | L | H | H | 3 | 3 |
| L | H | L | L | 4 | 4 |
| L | H | L | H | 5 | 5 |
| L | H | H | L | 6 | 6 |
| L | H | H | H | 7 | 7 |
| H | L | L | L | 8 | 8 |
| H | L | L | H | 9 | 9 |
| H | L | H | L | █ | A |
| H | L | H | H | (BLANK) | B |
| H | H | L | L | (BLANK) | C |
| H | H | L | H | | D |
| H | H | H | L | (BLANK) | E |
| H | H | H | H | (BLANK) | F |
| DECIMAL PT. ⁽²⁾ | | | | ON | V _{DP} =L |
| | | | | OFF | V _{DP} =H |
| ENABLE ⁽¹⁾ | | | | LOAD DATA | V _E =L |
| | | | | LATCH DATA | V _E =H |
| BLANKING ⁽³⁾ | | | | DISPLAY ON | V _B =L |
| | | | | DISPLAY OFF | V _B =H |

NOTES:

1. H = Logic High; L = Logic Low. With the enable input at logic high changes in BCD input levels or D.P. input have no effect upon display memory, displayed character, or D.P.
2. The decimal point, DP, pertains only to the 4n51 and 4n52 displays.
3. The blanking control, B, pertains only to the 4n54 hexadecimal display. Blanking input has no effect upon memory.

4N53 Over Range Character

| PIN | FUNCTION |
|-----|-------------|
| 1 | Plus |
| 2 | Numeral One |
| 3 | Numeral One |
| 4 | DP |
| 5 | Open |
| 6 | Open |
| 7 | Vcc |
| 8 | Minus/Plus |

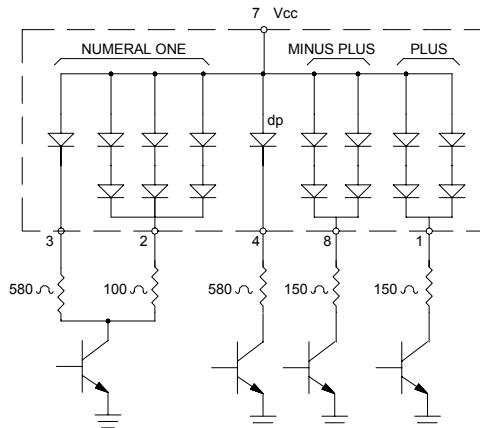


FIGURE 3
TYPICAL DRIVING CIRCUIT

TRUTH TABLE FOR TYPICAL DRIVING CIRCUIT

| CHARACTER | PIN | | | |
|---------------|-----|-----|---|---|
| | 1 | 2,3 | 4 | 8 |
| + | H | X | X | H |
| - | L | X | X | H |
| 1 | X | H | X | X |
| DECIMAL POINT | X | X | H | X |
| BLANK | L | L | L | L |

NOTES:

- L: Line switching transistor in figure 3 cutoff.
- H: Line transistor in figure 3 saturated
- X: Don't Care.

PART MARKING SYSTEM

| PREFERRED PART NUMBER SYSTEM | | MII PART NUMBERS | | |
|------------------------------|-------------------------------|------------------|------------------------|--|
| Standard Product | With Tables I, II, III and IV | Quality Level A | TXV Tables I, II | Commercial Table II, Subgroups I, VII |
| 4N51 | M87157/00101XXX | 67023-201 | | |
| 4N52 | M87157/00102XXX | 67023-202 | 67023-101 67023-102 | 67023-001 67023-002 |
| 4N53 | M87157/00103XXX | 67023-203 | 67023-103 | 67023-003 |
| 4N54 | M87157/00104XXX | 67023-204 | 67023-104 | 67023-004 |

TABLE I
100% SCREENING – CLASS A OF MIL-PRF-87157

| Test Screen | MIL-PRF-750 Method | Conditions |
|--|-----------------------|---|
| 1. Precap Visual | 2072 | |
| 2. High Temperature Storage | 1032 | T _A = 125°C, Time = 24 hours |
| 3. Temperature Cycling | 1051 | Condition B, 10 Cycles, 15 Min. 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 |
| 7. Interim Electrical / Optical Tests ⁽²⁾ | ----- | I _V , I _{CC} , I _{BL} , I _{BH} , I _{EL} , I _{EH} , I _{IL} , and I _{IH} T _A = 25°C |
| 8. Burn-In ^(1,3) | 1015 | Condition B at V _{CC} = 5V and cycle through logic at 1 character per second. T _A = 100°C, t = 160 hours |
| 9. Final Electrical Test ⁽²⁾ | ----- | Same as Step 7 |
| 10. Delta Determinations | ----- | ΔI _V = 20%, ΔI _{CC} = ±10 mA, ΔI _{IH} = ±10 μA and ΔI _{EH} = ±13μA |
| 11. External Visual ⁽¹⁾ | 2009 | |

TABLE II
GROUP A ELECTRICAL TEST – CLASS A OF MIL-PRF-87157

| Test | Parameters | LTPD |
|--|---|------|
| Subgroup 1 DC Electrical Test at 25°C ⁽²⁾ | I _V , I _{CC} , I _{BL} , I _{BH} , I _{EL} , I _{EH} , I _{IL} , and I _{IH} and visual function, T _A = 25°C | 5 |
| Subgroup 2 DC Electrical Tests at High Temperature ⁽²⁾ | Same as Subgroup 1, except delete I _V and visual function. T _A = +100°C | 7 |
| Subgroup 3 DC Electrical Tests at Low Temperature ⁽²⁾ | 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 | | 7 |

HERMETIC, NUMERIC AND HEXIDECIMAL DISPLAYS

TABLE III
GROUP B, CLASS A AND B OF MIL-PRF-87157

| Test | MIL-PRF-750 Method | Conditions | Sample Size |
|---|---------------------------------------|--|---|
| Subgroup 1 Resistance to Solvents Internal Visual and Mechanical ⁽¹⁰⁾ | 1022 2075 | | 4 Devices / 0 Failures 1 Device / 0 Failures |
| Subgroup 2 ^(1,2) Solderability | 2026 | T _A = 245°C for 5 seconds | LTPD = 15 |
| Subgroup 3 Thermal Shock (Temp. Cycle) Moisture Resistance ⁽³⁾ Fine Leak Gross Leak Electrical / Optical Endpoints ⁽⁴⁾ | 1051 1021 1071 1071 ----- | Condition B1, 15 Min. Dwell Condition H Condition C I _V , I _{CC} , I _{BL} , I _{BH} , I _{EL} , I _{EH} , I _{IL} , I _{IH} and visual function. T _A = 25°C | LTPD = 15 |
| Subgroup 4 Operating Life Test (340 hrs.) ⁽⁵⁾ Electrical / Optical Endpoints ⁽⁴⁾ | 1027 ----- | T _A = 100°C, at V _{CC} = 5.0V and cycling through logic at 1 character per second. Same as Subgroup 3 | LTPD = 10 |
| Subgroup 5 Non-operating (Storage) Life Test (340 hrs.) Electrical / Optical Endpoints ⁽⁴⁾ | 1032 ----- | T _A = 125°C Same as Subgroup 3 | LTPD = 10 |

TABLE IV
GROUP C, CLASS A AND B OF MIL-PRF-87157

| Test | MIL-PRF-750 Method | Conditions | Sample Size |
|--|---|--|------------------------|
| Subgroup 1 Physical Dimensions | 2066 | | 2 Devices / 0 Failures |
| Subgroup 2 ^(2, 10) Lead Integrity Fine Leak Gross Leak | 2004 1071 1071 | Condition B2 Condition H Condition C | LTPD = 15 |
| Subgroup 3 Shock Vibration, Variable Frequency Constant Acceleration External Visual ⁽⁷⁾ Electrical / Optical Endpoints ⁽⁴⁾ | 2016 2056 2006 1010 or 1011 ----- | 1500G, Time = 0.5 ms, 5 blows in each orientation X ₁ , Y ₁ , Z ₁ 10,000G at Y ₁ orientation I _V , I _{CC} , I _{BL} , I _{BH} , I _{EL} , I _{EH} , I _{IL} , I _{IH} and visual function. T _A = 25°C | LTPD = 15 |
| Subgroup 4 ^(1,6) Salt Atmosphere External Visual ⁽⁷⁾ | 1041 1010 or 1011 | | LTPD = 15 |
| Subgroup 5 Bond Strength ⁽⁸⁾ | 2037 | Condition A | LTPD = 20 (c = 0) |
| Subgroup 6 Operating Life Test ⁽⁹⁾ Electrical / Optical Endpoints ⁽⁴⁾ | 1026 ----- | T _A = +100°C 1000 HRS Same as Subgroup 3 | LTPD = 10 |

- NOTES:**
- Whenever electrical/optical tests are not required as endpoints, electrical rejects may be used.
 - 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.
 - Initial conditioning should be a 15" bend inward one cycle.
 - Limits and conditions are per the electrical/optical characteristics.
 - Burn-in for the over range shall use Condition B at a nominal I_F = 8 mA with "+1" illuminated for t=340 hours.
 - Solderability samples shall not be used.
 - Visual requirements shall be as specified in MIL-PRF-883, Methods 1010 or 1011.
 - Displays may be selected prior to seal.
 - If a given inspection lot, undergoing Group B inspection, has been selected to satisfy the 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.
 - MIL-PRF-883 test method applies.