



THINGWELL ELECTRONICS

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SPECIFICATION FOR LCM MODULE

MODULE NO.: LCM1602B-14

REVISION NO.: A

Customer Approval:

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| | SIGNATURE |
|-------------|-----------|
| PREPARED BY | |
| VERIFIED BY | |
| APPROVED BY | |



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RECORDS OF REVISION

| Date | Rev. | Description | Page | Design by |
|-----------|------|-------------|------|-----------|
| 2018/5/10 | 0 | New Sample. | - | - |
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1. SPECIFICATIONS

1.1 Features

| Item | Standard Value |
|-------------------|---------------------------------|
| Display Type | 16characters × 2 lines |
| LCD Type | VA, NEGATIVE, TRANSMISSIVE |
| Driver Condition | LCD Module : 1/16Duty , 1/5Bias |
| Viewing Direction | 6 O'clock |
| Backlight Type | SIDE WHITE |
| Interface | 8-bit MPU interface |
| Driver IC | AIP31066 |

1.2 Mechanical Specifications

| Item | Standard Value | Unit |
|-------------------|--------------------------|------|
| Outline Dimension | 122(L) X 44(W) X 12.3(T) | mm |
| Viewing Area | 99(L) X 24(W) | mm |
| Dot size | 0.88(W) X 1.05(H) | mm |
| Dot pitch | 0.98(W) X 1.15(H) | mm |
| Character size | 4.8(W) X 7.95(H) | mm |

1.3 Absolute Maximum Ratings

| Item | Symbol | Condition | Min. | Max. | Unit |
|-----------------------------|-----------------|------------|--------|-----------|------|
| System Power Supply Voltage | VDD | - | -0.3 | 5.5 | V |
| LCD Driver Supply Voltage | VLCD | - | VDD-12 | VDD-0.3 | V |
| Input Voltage | V _{IN} | - | -0.3 | VDD + 0.3 | V |
| Operating Temperature | T _{OP} | - | -20 | 70 | °C |
| Storage Temperature | T _{ST} | - | -30 | 80 | °C |
| Storage Humidity | H _D | Ta < 40 °C | 20 | 90 | %RH |



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1.4 DC Electrical Characteristics

VDD = 5.0V ± 0.2V, GND = 0V, Ta = 25°C

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|----------------------|-----------------|-----------|--------|------|--------|------|
| Logic Supply Voltage | VDD | - | 3.0 | 5.0 | 5.5 | V |
| Input High Voltage | V _{IH} | - | 0.8VDD | - | VDD | V |
| Input Low Voltage | V _{IL} | - | GND | - | 0.3VDD | V |
| Output High Voltage | V _{OH} | - | 0.7VDD | - | VDD | V |
| Output Low Voltage | V _{OL} | - | GND | - | 0.2VDD | V |

1.5 Backlight Characteristics

LCD Module without LED Backlight

Electrical / Optical Characteristics

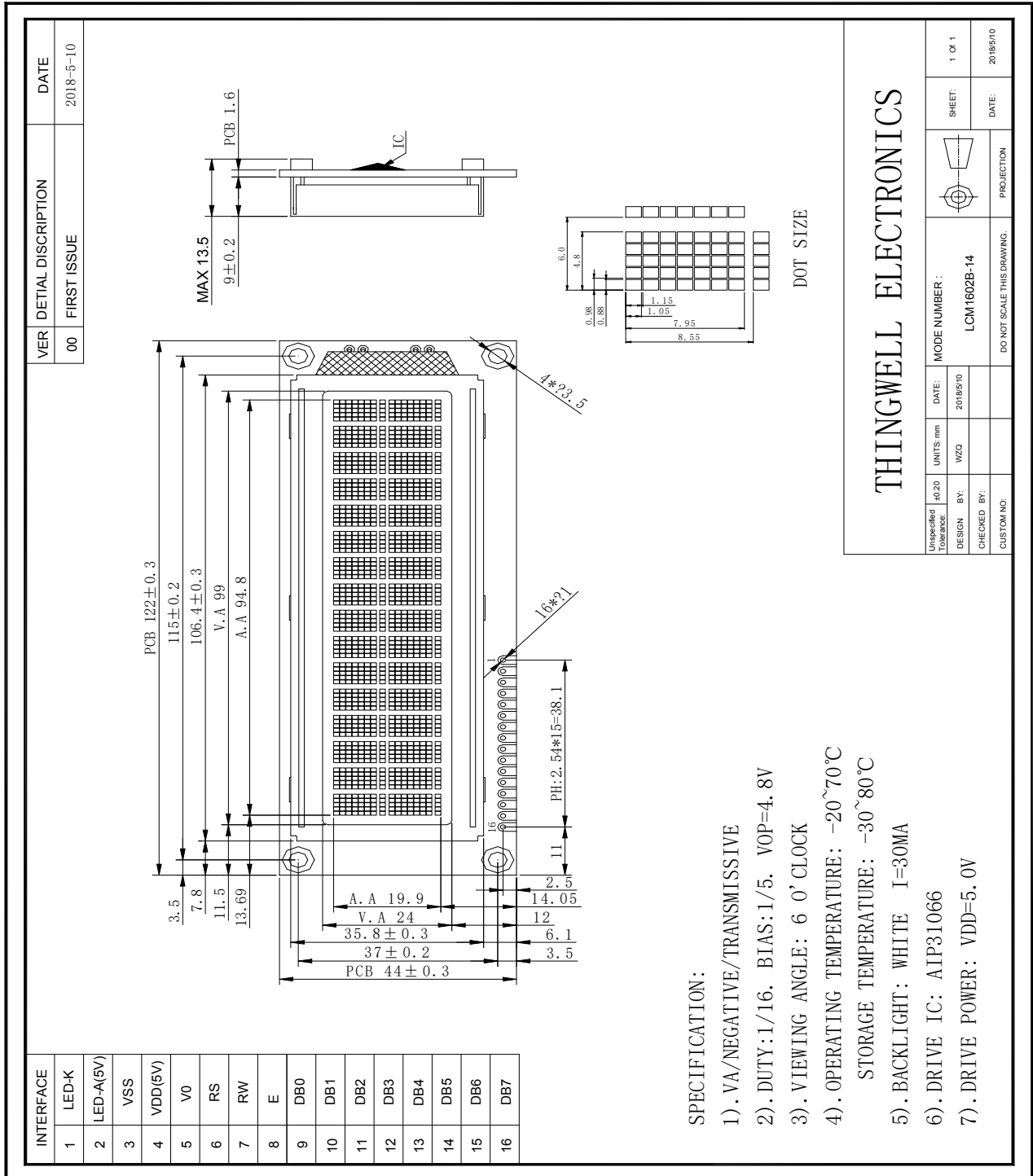
Ta = 25°C

| Item | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|-------------------------------------|--------------------|---|------|------|------|-------------------|
| Forward Voltage | V _f | I _f =30mA | 4.8 | 5.0 | 5.2 | V |
| Reverse Current | I _r | I _f =5v | | | -- | uA |
| Average Brightness | I _V | I _f =30mA | | | | cd/m ² |
| Wavelength (Without LCD) | λ _d | I _f =30mA | -- | -- | -- | nm |
| Luminous Intensity (without LCD) | L _v Sub | I _f =30mA | | | | cd/m ² |
| Uniformity | Δ% | I _v Min / I _v Max *100% | -- | - | - | % |
| Color | WHITE | | | | | |

2. MODULE STRUCTURE

2.1 Counter Drawing

2.1.1 LCM Mechanical Diagram

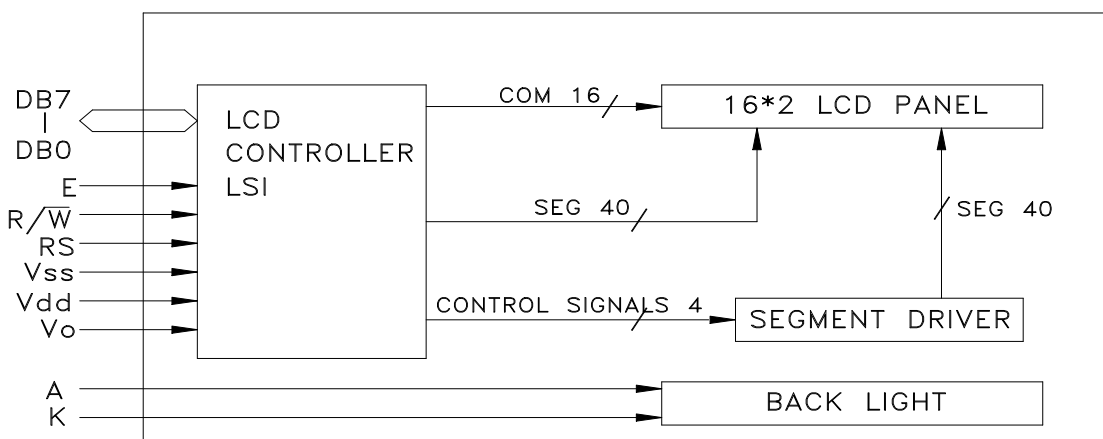


SPECIFICATION:

- 1). VA/NEGATIVE/TRANSMISSIVE
- 2). DUTY: 1/16. BIAS: 1/5. VOP=4. 8V
- 3). VIEWING ANGLE: 6 0' CLOCK
- 4). OPERATING TEMPERATURE: -20~70°C
STORAGE TEMPERATURE: -30~80°C
- 5). BACKLIGHT: WHITE I=30MA
- 6). DRIVE IC: AIP31066
- 7). DRIVE POWER: VDD=5. 0V

2.2 Interface Pin Description

| No. | Symbol | Function |
|-----|--------|-----------------------------------|
| 1 | LED_K | LED Power Supply - (0V) |
| 2 | LED_A | LED Power Supply + (5.0V) |
| 3 | VSS | Ground (0V) |
| 4 | VDD | Supply Voltage for Logic (+5.0V) |
| 5 | VO | Contrast Adjustment |
| 6 | RS | Data/Instruction Select |
| 7 | R/W | Read/Write Select |
| 8 | E | Enable Signal |
| 9 | DB0 | Data Bus |
| 10 | DB1 | Data Bus |
| 11 | DB2 | Data Bus |
| 12 | DB3 | Data Bus |
| 13 | DB4 | Data Bus |
| 14 | DB5 | Data Bus |
| 15 | DB6 | Data Bus |
| 16 | DB7 | Data Bus |





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2.3 Timing Characteristics

DC Characteristics

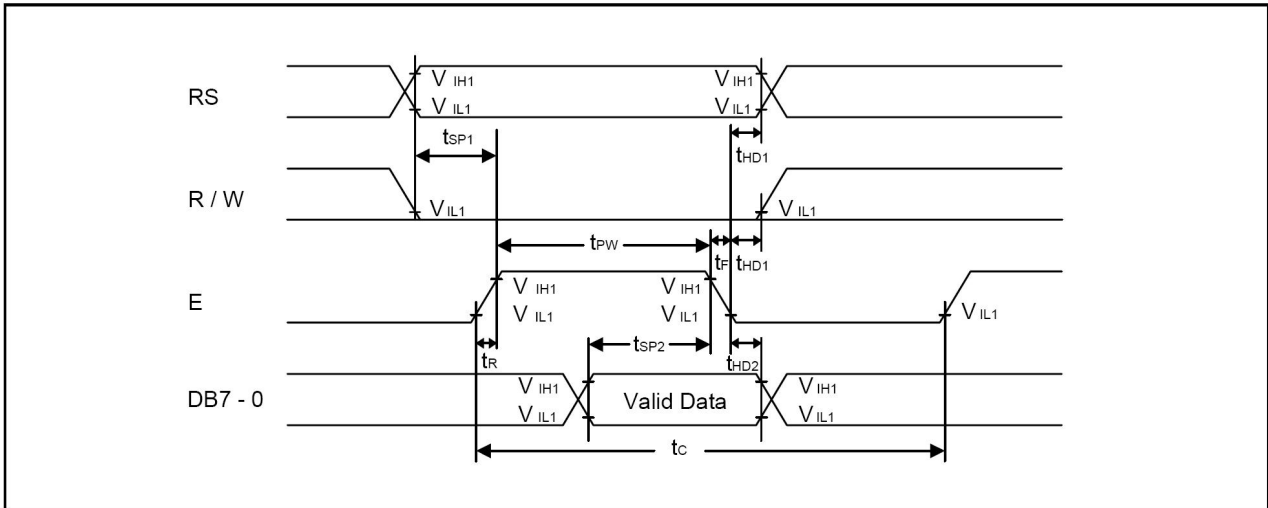
| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|----------------------------|------------------|--------|-------|--------|------|--|
| | | Min. | Typ. | Max. | | |
| Operating Current | IDD | - | 0.55 | 0.8 | mA | External clock (Note) |
| Input High Voltage | V _{IH1} | 2.2 | - | VDD | V | Pins:(E, RS, R/W, DB7 - 0) |
| Input Low Voltage | V _{IL1} | -0.3 | - | 0.6 | V | |
| Input High Voltage | V _{IH2} | VDD-1 | - | VDD | V | Pin OSC1 |
| Input Low Voltage | V _{IL2} | -0.2 | - | 1.0 | V | Pin OSC1 |
| Input High Current | I _{IH} | -2.0 | - | 2.0 | μA | Pins: (RS, R/W, DB7 - 0) |
| Input Low Current | I _{IL} | -20.0 | -50.0 | -100.0 | μA | VDD = 5.0V |
| Output High Voltage (TTL) | V _{OH1} | 2.4 | - | VDD | V | I _{OH} = - 0.1mA Pins: DB7 - 0 |
| Output Low Voltage (TTL) | V _{OL1} | - | - | 0.4 | V | I _{OL} = 0.1mA Pins: DB7 - 0 |
| Output High Voltage (CMOS) | V _{OH2} | 0.9VDD | - | VDD | V | I _{OH} = - 40.0μA, Pins: CL1, CL2, M, D |
| Output Low Voltage (CMOS) | V _{OL2} | - | - | 0.1VDD | V | I _{OL} = 40.0μA, Pins: CL1, CL2, M, D |
| Driver ON Resistance (COM) | R _{COM} | - | - | 20.0 | KΩ | I _O = ±50.0μA, V _{LCD} = 4.0V Pins: COM16 - 1 |
| Driver ON Resistance (SEG) | R _{SEG} | - | - | 30.0 | KΩ | I _O = ±50.0μA, V _{LCD} = 4.0V Pins: SEG40 - 1 |
| LCD Voltage | V _{LCD} | 3.0 | - | 11.0 | V | VDD - V5, 1/4 bias or 1/5 bias |

Note: F_{OSC} = 250.0KHz, VDD = 5.0V, pin E = "L", RS, R/W, DB7 - 0 are open, all outputs are no loads.

AC Characteristics

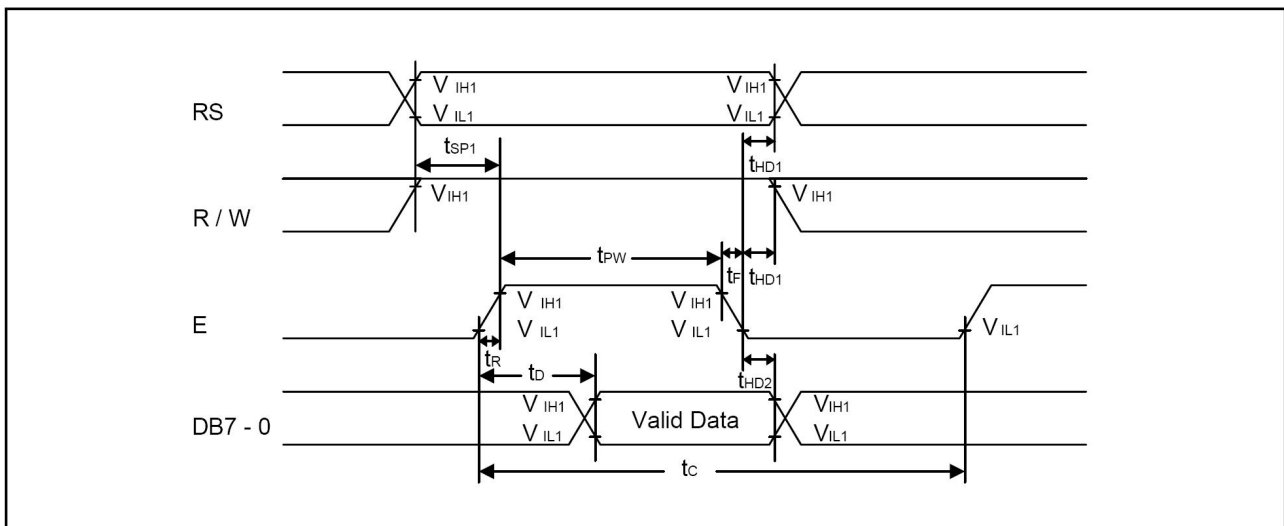
| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|-----------------|-------------------|-------|-------|-------|------|------------------------------|
| | | Min. | Typ. | Max. | | |
| OSC Frequency | F _{OSC1} | 190.0 | 270.0 | 350.0 | KHz | VDD = 5.0V Rf = 91.0KΩ±2% |

Timing Diagram Writing mode



| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|--------------------|------------|-------|------|------|------|------------------|
| | | Min. | Typ. | Max. | | |
| E Cycle Time | t_c | 400.0 | - | - | ns | Pin E |
| E Pulse Width | t_{PW} | 150.0 | - | - | ns | Pin E |
| E Rise/Fall Time | t_R, t_F | - | - | 25.0 | ns | Pin E |
| Address Setup Time | t_{SP1} | 30.0 | - | - | ns | Pins: RS, R/W, E |
| Address Hold Time | t_{HD1} | 10.0 | - | - | ns | Pins: RS, R/W, E |
| Data Setup Time | t_{SP2} | 40.0 | - | - | ns | Pins: DB7 - 0 |
| Data Hold Time | t_{HD2} | 10.0 | - | - | ns | Pins: DB7 - 0 |

Read mode





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| Characteristics | Symbol | Limit | | | Unit | Test Condition |
|------------------------|------------|-------|------|-------|------|-----------------|
| | | Min. | Typ. | Max. | | |
| E Cycle Time | t_c | 400.0 | - | - | ns | Pin E |
| E Pulse Width | t_w | 150.0 | - | - | ns | Pin E |
| E Rise/Fall Time | t_R, t_F | - | - | 25.0 | ns | Pin E |
| Address Setup Time | t_{SP1} | 30.0 | - | - | ns | Pins: RS, R/W,E |
| Address Hold Time | t_{HD1} | 10.0 | - | - | ns | Pins: RS, R/W,E |
| Data Output Delay Time | t_D | - | - | 100.0 | ns | Pins: DB7 - 0 |
| Data hold time | t_{HD2} | 20.0 | - | - | ns | Pin DB7 - 0 |

2.4 Instruction Table

◆ Display Control Instruction

| Instruction | Instruction Code | | | | | | | | | | Description | Execution time ($F_{osc} = 270KHz$) |
|------------------------------------|------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| | RS | RW | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | | |
| Clear Display | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Write "20H" to DDRAM and set DDRAM address to "00H" from AC | 1.52ms |
| Return Home | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed. | 1.52ms |
| Entry Mode Set | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S | Assign cursor moving direction and enable the shift of entire display | 38 μ s |
| Display ON/OFF Control | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | Set display(D), cursor(C), and blinking of cursor(B) on/off control bit. | 38 μ s |
| Cursor or Display Shift | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | - | - | Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data. | 38 μ s |
| Function Set | 0 | 0 | 0 | 0 | 1 | DL | N | F | - | - | Set interface data length (DL: 8-bit/4-bit), numbers of display line (N: 2-line/1-line) and, display font type (F: 5x10 dots/5x8 dots) | 38 μ s |
| Set CGRAM Address | 0 | 0 | 0 | 1 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set CGRAM address in address counter. | 38 μ s |
| Set DDRAM Address | 0 | 0 | 1 | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set DDRAM address in counter | 38 μ s |
| Read Busy Flag and Address Counter | 0 | 1 | BF | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read. | |
| Write Data to RAM | 1 | 0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Write data into internal RAM (DDRAM/CGRAM). | 38 μ s |
| Read Data from RAM | 1 | 1 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Read data from internal RAM (DDRAM/CGRAM). | 38 μ s |

* "-": don't care



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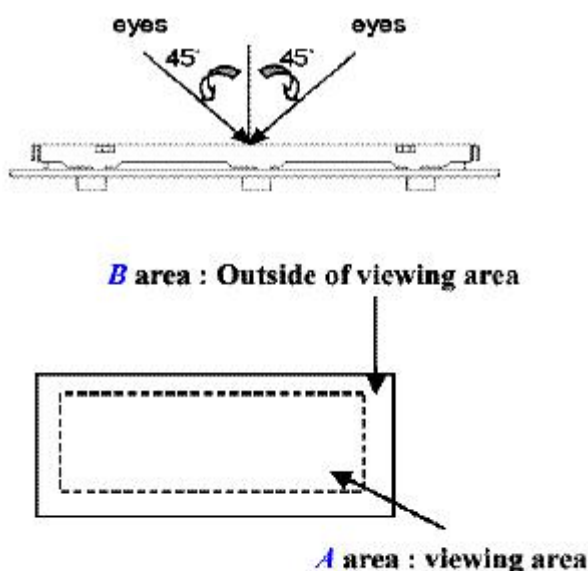
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2.5 Character Generator ROM

| Upper 4 bit Lower 4 bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLLH | HHLH | HHLH | HHLH |
|----------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B |
| LLLH | | | ! | 1 | A | Q | S | W | | | . | ア | キ | シ | フ |
| LLHL | | | " | 2 | B | R | D | F | | | 「 | イ | ウ | エ | オ |
| LLHH | | | # | 3 | C | S | C | E | | | 」 | ウ | テ | モ | メ |
| LHLL | | | * | 4 | D | T | d | t | | | ノ | エ | ト | ナ | ル |
| LHLH | | | & | 5 | E | U | e | u | | | ・ | オ | 大 | ユ | ヨ |
| LHHL | | | & | 6 | F | U | f | u | | | ヲ | カ | ニ | ヨ | ヨ |
| LHHH | | | ' | 7 | G | W | g | w | | | ヲ | キ | タ | ラ | リ |
| HLLL | | | C | 8 | H | X | h | x | | | イ | ウ | キ | リ | ル |
| HLLH | | | > | 9 | I | Y | i | y | | | ウ | カ | ル | ル | ル |
| HLHL | | | * | 0 | J | Z | j | z | | | ホ | コ | シ | レ | リ |
| HLHH | | | + | 1 | K | C | k | c | | | ホ | ウ | ロ | ロ | ロ |
| HLLL | | | < | 2 | L | 羊 | l | 羊 | | | ホ | シ | フ | フ | フ |
| HHLH | | | — | 3 | M | J | m | j | | | ホ | ウ | シ | シ | シ |
| HHHL | | | . | 4 | N | > | n | > | | | ヨ | セ | ホ | シ | シ |
| HHHH | | | / | 5 | O | L | o | L | | | ウ | シ | ウ | ウ | ウ |


2.6 Inspection Specification

- ◆ Inspection Standard : MIL-STD-105E Table Normal Inspection Single Sampling Level II .
- ◆ Equipment : Gauge、MIL-STD、Powertip Tester、Sample
- ◆ Defect Level : Major Defect AQL 0.4; Minor Defect AQL 1.5 .
- ◆ OUT Going Defect Level : Sampling .
- ◆ Manner of appearance test :
 - (1). The test be under 40W×2 fluorescent light ' and distance of view must be at 30 cm.
 - (2). The test direction is base on about around 45° of vertical line. (Fig. 1)
 - (3). Definition of area . (Fig. 2)

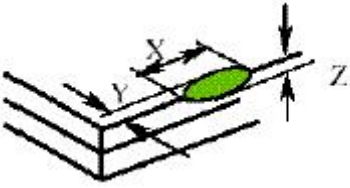
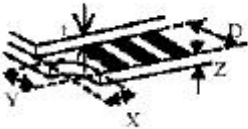
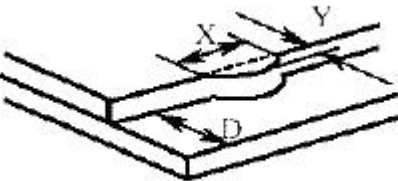


◆ Specification:

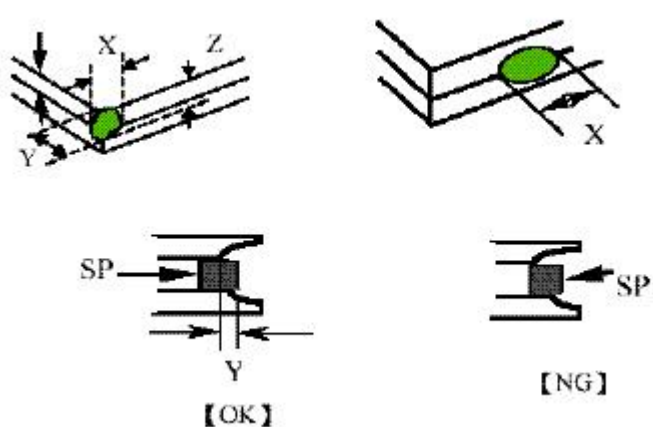
| NO | Item | Criterion | level |
|----|--|--|-------|
| 01 | Product condition | 1.1 The part number is inconsistent with work order of Production. | Major |
| | | 1.2 Mixed production types. | Major |
| | | 1.3 Assembled in inverse direction. | Major |
| 02 | Quantity | 2.1 The quantity is inconsistent with work order of production. | Major |
| 03 | Outline dimension | 3.1 Product dimension and structure must conform to Structure diagram. | Major |
| 04 | Electrical Testing | 4.1 Missing line character、dot and icon. | Major |
| | | 4.2 No function or no display. | Major |
| | | 4.3 Output data is error. | Major |
| | | 4.4 LCD viewing angle defect. | Major |
| | | 4.5 Current consumption exceeds product specifications. | Major |
| 05 | Black or white dot、scratch、contamination Round type | 5.1 Round type: 5.1.1 display only : <ul style="list-style-type: none"> • White and black spots on display $\leq 0.25\text{mm}$, no more than Four white or black spots present. • Densely spaced : NO more than two spots or lines within | Minor |

| | | | |
|----|-----------------------|---|-------|
| 06 | Polarizer Bubble | <p>Dimension (diameter : Φ)</p> <p>A area</p> <p>Acceptance(Q'ty)</p> <p>B area $\Phi \leq 0.20\text{mm}$ Accept no dense Don't count</p> <p>$0.20\text{mm} < \Phi \leq 0.50\text{mm}$ 3 Don't count</p> <p>$0.50\text{mm} < \Phi \leq 1.00\text{mm}$ 2 Don't count</p> <p>$\Phi > 1.00\text{mm}$ 0 Don't count</p> <p>Total quantity 4 Don't count</p> | Minor |
| 07 | The crack of glass | <p>● Glass Crack: 7.1 Crack on the circuit of electrode terminal :</p>  <p>X Y Z</p> <p>Front $X \leq 1/5 a$ $Y \leq 1/2 D$ $Z \leq t$</p> <p>Back</p> <p>Neglect</p> | Minor |

◆ Specification :

| NO | Item | Criterion | Level |
|----|---|---|-------|
| 07 | <p>The crack of glass</p> <p>X: The length of Crack</p> <p>Y: The width of crack</p> <p>Z: The thickness of crack</p> <p>D: terminal length</p> <p>T: The thickness of glass</p> <p>A : The length of glass</p> | <p>● Glass Crack:</p> <p>7.2 General glass crack and corner edge:</p> <p>7.2.1</p>  <p>X Y Z Neglect Out A area Neglect</p> <p>7.2.2</p>  <p>X Y Z Neglect Out A area Neglect</p> | Minor |
| | | <p>7.3 Glass remain:</p>  <p>X Y Neglect $\leq 1/3 d$</p> | Minor |

◆ Specification :

| NO | Item | Criterion | Level |
|----|---|---|-------|
| 07 | <p>The crack of glass</p> <p>X: The length of Crack</p> <p>Y: The width of crack</p> <p>Z: The thickness of crack</p> <p>D: terminal length</p> <p>T: The thickness of glass</p> <p>A : The length of glass</p> | <p>7.4 Corner crack and medial crack:</p>  <p>X Y Z $\cong 1/5a$ Crack can't enter viewing area $\cong 1/2t$ $\cong 1/5a$ Crack can't exceed the half of width of SP width of SP $1/2t < Z \cong 2t$</p> | Minor |
| 08 | Backlight elements | 8.1 Backlight can't work normally. | Major |
| | | 8.2 Backlight doesn't light or color is wrong. | Major |
| | | 8.3 Illumination source flickers when lit. | Major |
| 09 | General appearance | 9.1 pin type must match type in specification sheet | Major |
| | | 9.2 No short circuits in components on PCB or FPC | Major |
| | | 9.3 Product packaging must be the same as specified on packaging specification sheet. | Major |
| | | 9.4 The folding and peeled off in polarizer are not acceptable | Major |
| | | 9.5 The PCB or FPC between B/L assembled distance (PCB or FPC) is $\cong 1.5\text{mm}$ | Major |