

LCD MODULE SPECIFICATION

MODEL NO.

BC1601A series

FOR MESSRS:

ON DATE OF:

APPROVED BY:

C O N T E N T S

1. Numbering System
2. Precautions in use of LCD Modules
3. General Specification
4. Absolute Maximum Rating
5. Electrical Characteristics
6. Optical Characteristics
7. Interface Pin Function
8. Power supply for LCD Module and LCD operating voltage adjustment
9. Backlight information
10. Quality Assurance
11. Reliability
12. Appendix (Drawing , EL inverter data , KS0066 controller data)
 - 12-1 Drawing
 - 12-2 EL inverter data (P/N:IVEL-01)
 - 12-3 KS0066 controller data
 - 12-3.1 Function description
 - 12-3.2 C.G ROM table. table 2
 - 12-3.3 Instruction table
 - 12-3.4 Timing characteristics
 - 12-3.5 Initializing soft ware of LCM

1. Numbering System

| <u>B</u> | <u>C</u> | <u>2004</u> | <u>A</u> | <u>G</u> | <u>P</u> | <u>L</u> | <u>E</u> | <u>B</u> | <u>xxx</u> |
|----------|----------|-------------|----------|----------|----------|----------|----------|----------|------------|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

| | | | | |
|---|--------------------------------------|--|--|---|
| 0 | Brand | | Bolymin | |
| 1 | Module Type | | C= character type G= graphic type P= TAB/TCP type | O= COG type F= COF type |
| 2 | Format | | 2002=20 characters, 4 lines 12232= 122 x 32 dots | |
| 3 | Version No. | | A type | |
| 4 | LCD Color | | G=STN/gray Y=STN/yellow-green C=color STN | B=STN/blue F=FSTN T=TN |
| 5 | LCD Type | | R=positive/reflective P=positive/transflective | M=positive/transmissive N=negative/transmissive |
| 6 | Backlight type/color | | L=LED array/ yellow-green H=LED edge/white R=LED array/red G=LED edge/yellow-green | D=LED edge/blue E=EL/white B=EL/blue C=CCFL/white |
| 7 | CGRAM Font | | J=English/Japanese Font E=English/European Font | C=English/Cyrillic Font H=English/Hebrew Font |
| 8 | View Angle/ Operating Temperature | | B=Bottom/Normal Temperature H=Bottom/Wide Temperature U=Bottom/Ultra wide Temperature | T=Top/Normal Temperature W=Top/Wide Temperature C=9H/Normal Temperature |
| 9 | Special Code | | 3=3 volt logic power supply n=negative voltage for LCD c=cable/connector xxx=to be assigned on data sheet | t=temperature compensation for LCD p=touch panel |

2. Precaution in use of LCD Module

- (1) Avoid applying excessive shocks to the module or making any alterations or modifications to it.
- (2) Don't make extra holes on the printed circuit board, modify its shape or change the components of LCD module.
- (3) Don't disassemble the LCM.
- (4) Don't operate it above the absolute maximum rating.
- (5) Don't drop, bend or twist LCM.
- (6) Soldering: only to the I/O terminals.
- (7) Storage: please storage in anti-static electricity container and clean environment.
- (8) Don't touch the elastmer connector, especially insert a backlight panel (EL or CCFL)

3. General Specification

(1) Mechanical Dimension

| Item | Dimension | Unit |
|-----------------------------------|---|------|
| Number of Characters | 16characters x 1 Lines | - |
| Module dimension (L x W x H) | 80.0 x 36.0 x 13.2(Max)- LED array B/L, LED edge B/L (white, blue) 80.0 x 36.0 x 9.4 (Max) – LED edge / blue B/L, EL or No B/L | mm |
| View area | 66.0 x 16.0 | mm |
| Active area | 59.62 x 6.56 | mm |
| Dot size | 0.55 x 0.75 | mm |
| Dot pitch | 0.63 x 0.83 | mm |
| Character size (L x W) | 3.07 x 6.56 | mm |
| Character pitch (L x W) | 3.77 x 6.56 | mm |

(2) Controller IC: **KS0066 (or Equivalent) controller**

(3) Temperature Range

| | Normal | Wide |
|-----------|----------|----------|
| Operating | 0 ~+50 | -20 ~+70 |
| Storage | -10 ~+60 | -30 ~+80 |

4. Absolute Maximum Ratings

4.1 Electrical Absolute Maximum Ratings

(V_{ss}=0V, Ta=25)

| Item | Symbol | Min | Max | Unit |
|-----------------------------|----------------------------------|-----------------|-----------------|------|
| Supply Voltage (Logic) | V _{dd} -V _{ss} | -0.3 | 7 | V |
| Supply Voltage (LCD Driver) | V _{dd} -V _o | -0.3 | 13 | V |
| Input Voltage | V _I | V _{ss} | V _{dd} | V |
| Normal Type | TOP | 0 | +50 | |
| | TSTG | -10 | +60 | |
| Wide Temperature Type | Top | -20 | +70 | |
| | Tstg | -30 | +80 | |

4.2 Environmental Absolute Maximum Ratings

| Item | Operating | | Storage | | Comment |
|-----------|-----------|----------------------|----------|----------------------|----------------------|
| | (Min.) | (Max.) | (Min.) | (Max.) | |
| Humidity | Note (2) | | Note (2) | | Without condensation |
| Vibration | -- | 4.9M/S ² | -- | 19.6M/S ² | XYZ Direction |
| Shock | -- | 29.4M/S ² | -- | 490M/S ² | XYZ Direction |

Note (1) Ta = 0 : 50Hr Max.

Note (2) Ta 40 : 90% RH MAX

Ta > 40 : Absolute humidity must be lower than the humidity of 90% at 40 .

5. Electrical Characteristics

| Item | Symbol | Condition | Min | Typ | Max | Unit |
|---|-----------------|-----------|-----|------------|-----|------|
| Supply Voltage For Logic | Vdd-Vss | - | 3.0 | - | 5.5 | V |
| Supply Voltage For LCD * Wide Temp、 Type | Vdd-Vo | * Ta=-20 | - | 5.5 | - | V |
| | | Ta=0 | - | - | - | V |
| | | Ta=25 | - | 4.5 | - | V |
| | | Ta=50 | - | - | - | V |
| | | * Ta=+70 | - | 3.8 | - | V |
| Input High Volt. | V _{IH} | - | 2.2 | - | Vdd | V |
| Input Low Volt. | V _{IL} | - | - | - | 0.6 | V |
| Output High Volt. | V _{OH} | - | 2.4 | - | - | V |
| Output Low Volt. | V _{OL} | - | - | - | 0.4 | V |
| Supply Current | I _{dd} | Vdd=5V | - | 1.2 | - | mA |

6. Optical Characteristics

a. STN

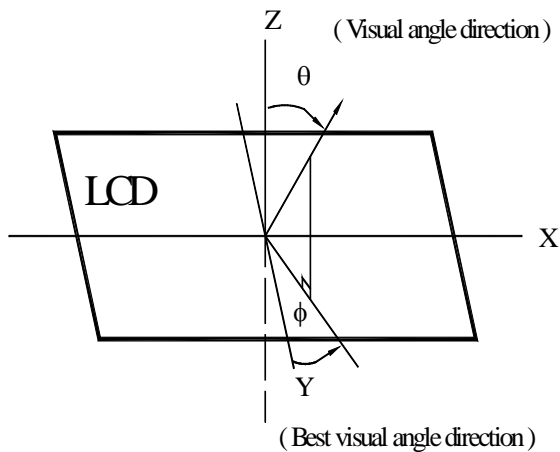
| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------|--------|-----------|------|------|------|------|
| View Angle | (V) | CR 2 | 10 | | 45 | deg |
| | (H) | CR 2 | -30 | | 30 | deg |
| Contrast Ratio | CR | - | | 3 | | - |
| Response Time 25 | T rise | - | | 100 | 150 | ms |
| | T fall | - | | 150 | 200 | ms |

b. FSTN

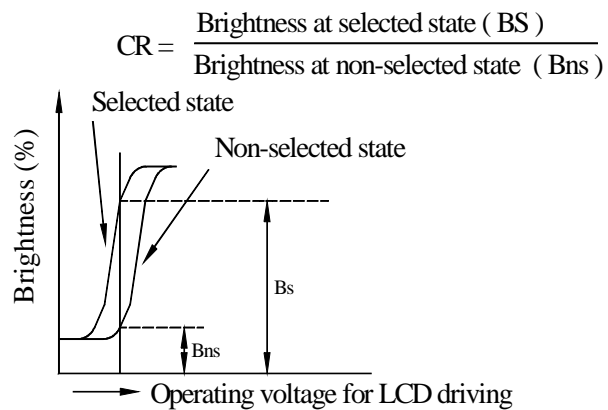
| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------|--------|-----------|------|------|------|------|
| View Angle | (V) | CR 3 | 10 | | 60 | deg |
| | (H) | CR 3 | -45 | | 45 | deg |
| Contrast Ratio | CR | - | | 5 | | - |
| Response Time 25 | T rise | - | | 100 | 150 | ms |
| | T fall | - | | 150 | 200 | ms |

6.1 Definitions

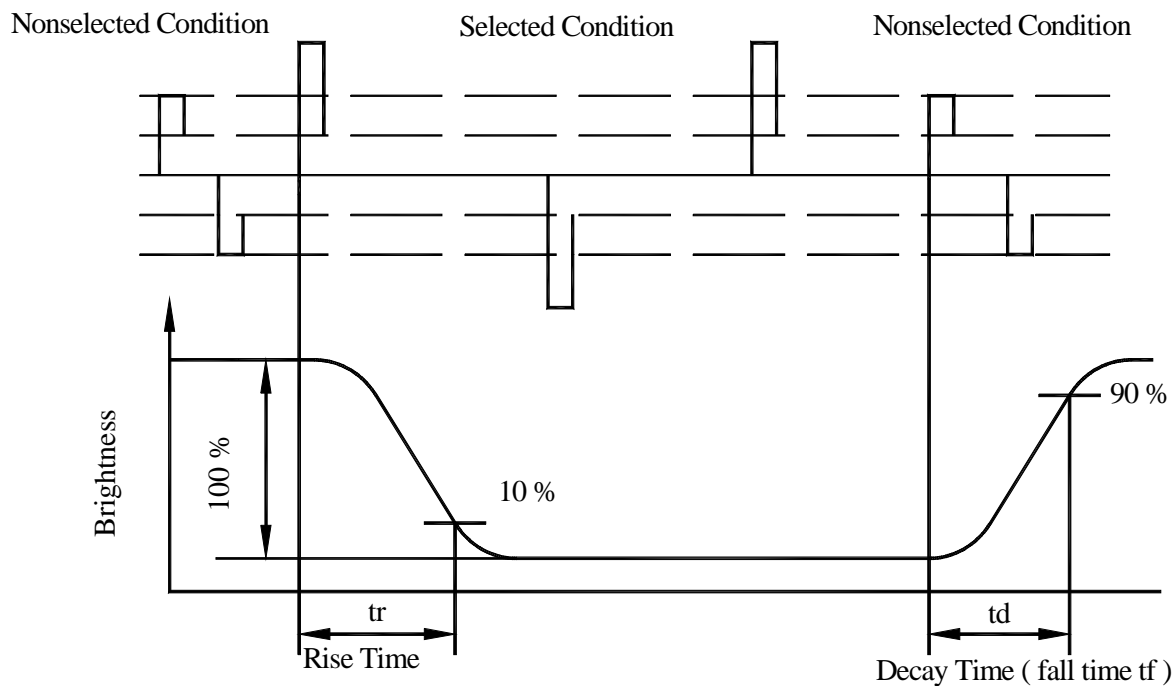
View Angles



Contrast Ratio



Response Time

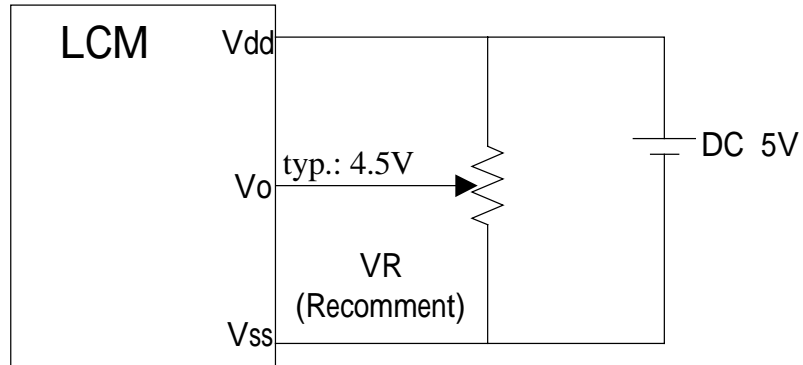


7. Interface Pin Function

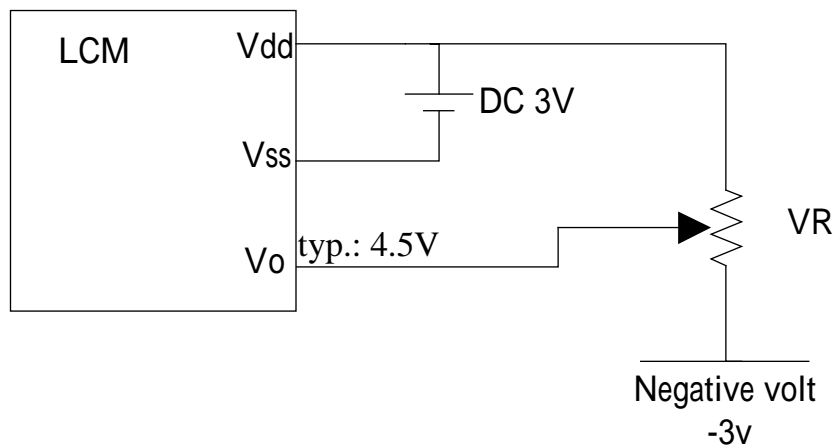
| Pin No. | Symbol | Level | Description |
|---------|---------|------------|---|
| 1 | Vss | 0V | Ground |
| 2 | Vdd | 5.0V | Supply Voltage for logic (option +3V) |
| 3 | Vo | (Variable) | Operating voltage for LCD |
| 4 | RS | H/L | H:DATA, L:Instruction code |
| 5 | R/W | H/L | H:Read(MPU Module)L:Write(MPU Module) |
| 6 | E | H,H L | Chip enable signal |
| 7 | DB0 | H/L | Data bit 0 |
| 8 | DB1 | H/L | Data bit 1 |
| 9 | DB2 | H/L | Data bit 2 |
| 10 | DB3 | H/L | Data bit 3 |
| 11 | DB4 | H/L | Data bit 4 |
| 12 | DB5 | H/L | Data bit 5 |
| 13 | DB6 | H/L | Data bit 6 |
| 14 | DB7 | H/L | Data bit 7 |
| 15 | A / Vee | - | Power supply for LED backlight (+) / Negative voltage output |
| 16 | K | - | Power supply for LED backlight (-) |

8. Power Supply for LCD Module and LCD Operating Voltage a Adjustment

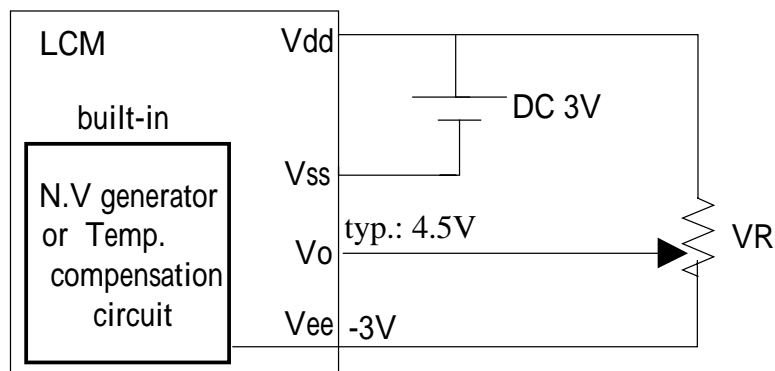
* Standart Type



* (Option) LCM operating on " DC 3V " input , with external negative



* (Option) LCM operating on " DC 3V " input , with built-in negative Voltage



9.Backlight Information

9.1 Specification

(1) LED array / yellow-green

| Parameter | Symbol | Min | Typ | Max | Unit | Test Condition |
|--------------------|------------------|-----|--------|-----|-------------------|-------------------------|
| Supply Current | I _{LED} | | 100 | | mA | V=4.2V |
| Supply Voltage | V | - | 4.2 | 4.3 | V | |
| Reverse Voltage | V _R | - | - | 8 | V | |
| Luminous Intensity | I _V | 60 | - | - | cd/m ² | I _{LED} =100mA |
| Wave Length | p | | 574 | | nm | I _{LED} =100mA |
| Life Time | | - | 100000 | - | Hr. | V 4.2V |
| Color | Yellow Green | | | | | |

(2) LED edge / (white / blue)

| Parameter | Symbol | Min | Typ | Max | Unit | Test Condition |
|--------------------|------------------|-----|-------------|-----|-------------------|------------------------|
| Supply Current | I _{LED} | | 20 | 25 | mA | V=3.4V |
| Supply Voltage | V | - | 3.4 | 3.5 | V | |
| Reverse Voltage | V _R | - | - | 8 | V | |
| Luminous Intensity | I _V | 50 | - | - | cd/m ² | I _{LED} =20mA |
| Life Time | | - | 10000-white | - | Hr. | V 3.4 V |
| | | | 50000-blue | | | |
| Color | White / Blue | | | | | |

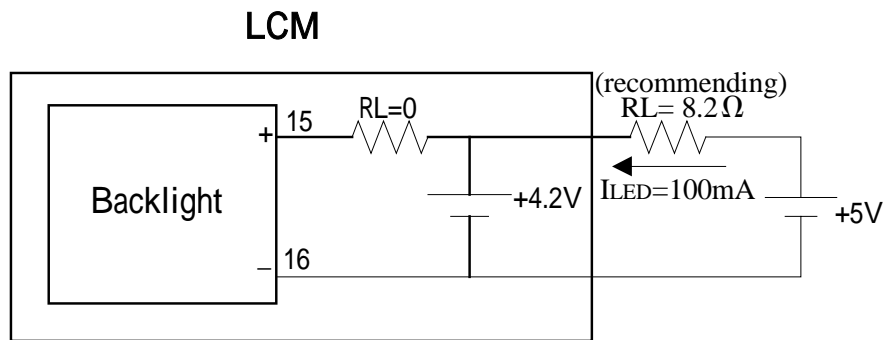
(3) EL / Blue

| Parameter | Symbol | Min | Typ | Max | Unit | Test Condition |
|--------------------------|--------------------|-----|----------|-----|------|------------------|
| Voltage | Vrms | -- | 110 (AC) | | -- | |
| Frequency | HZ | -- | 400 | | -- | |
| Brightness* | cd/m ² | 48 | 60 | | -- | 110Vrms 400Hz |
| CIE Chromaticity Diagram | X | -- | 0.1852 | | -- | |
| | Y | -- | 0.3937 | | -- | |
| Current Dissipation | mA/cm ² | -- | 1.33 | | -- | |
| Power Dissipation | mW/cm ² | -- | 26.29 | | -- | |
| Color | Blue | | | | | |

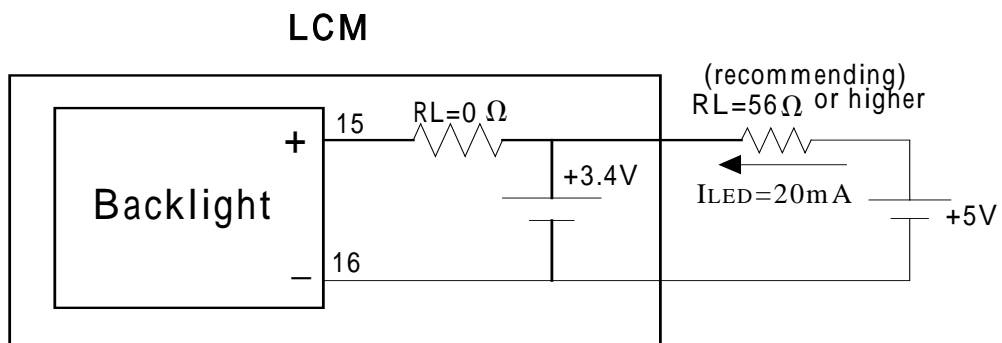
9.2 Backlight driving methods

a. LED B/L drive from pin15 (LED+) pin16 (LED-)

a.1 array / yellow-green

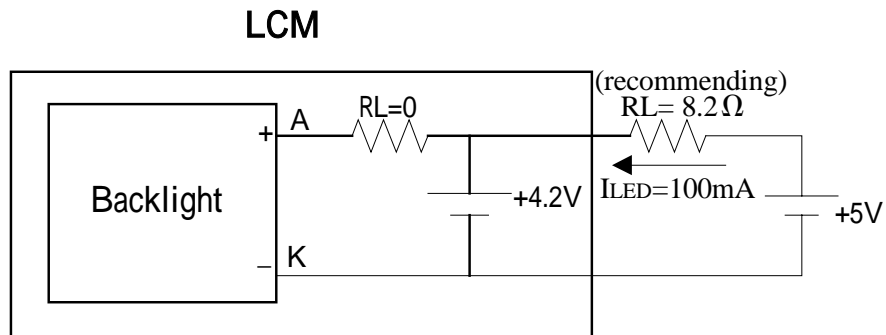


a.2 edge / (white / blue)

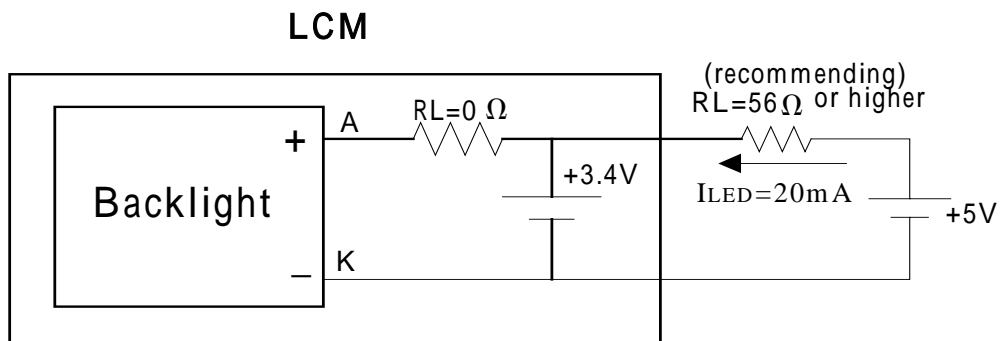


b. LED B/L drive from A. K directly

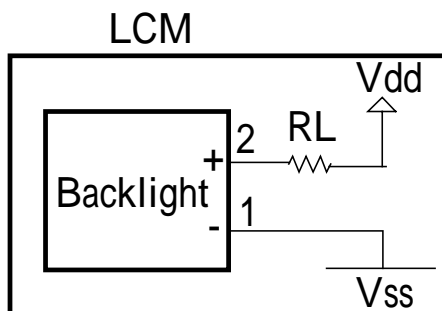
b.1 array / yellow-green



b.2 edge / (white/blue)

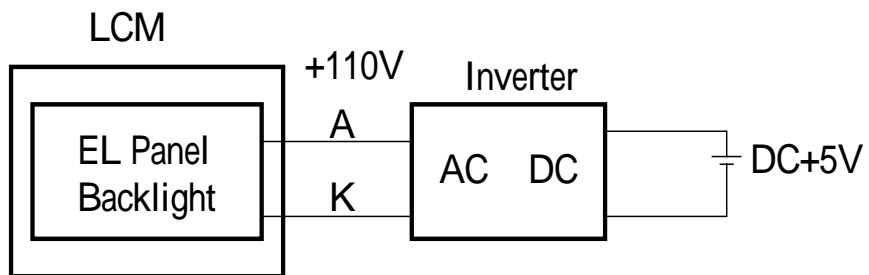


c. * (Option) LED B/L drive from pin1 (Vss) pin2 (Vdd)



- (1) Jump 1,2 Short
- (2) Current Resistor required on RL
- (3) Jump 15,16 open
- (4) To be sure of enough current supply for both Vdd + LED B/L

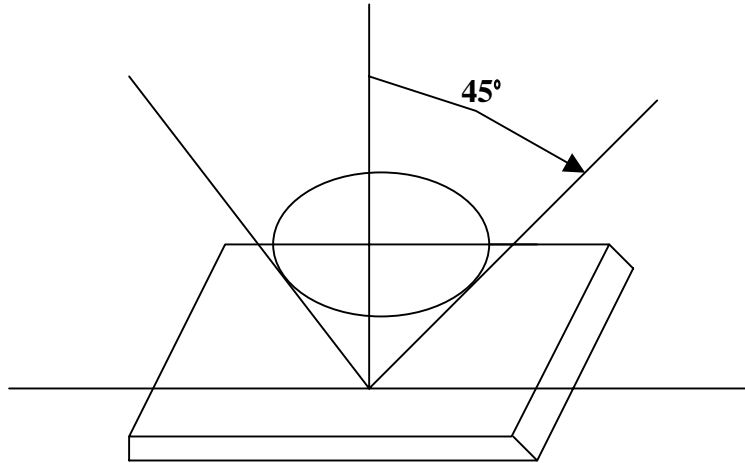
d. EL B/L drive from A.K directly



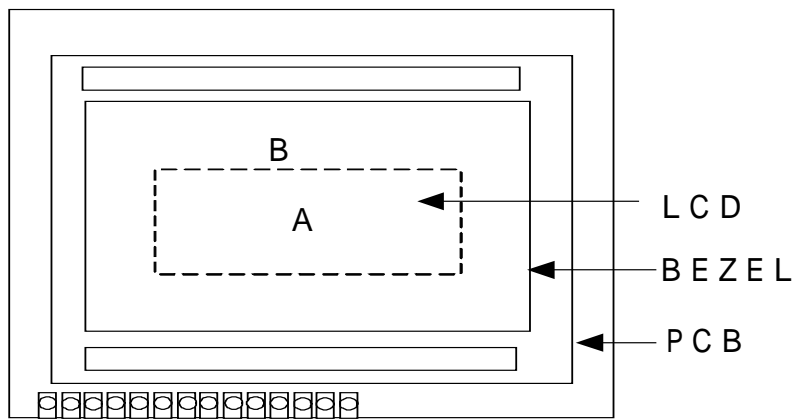
10. Quality Assurance

10.1 Inspection conditions

The LCD shall be inspected under 40W white fluorescent light.



Definition of applicable Zones

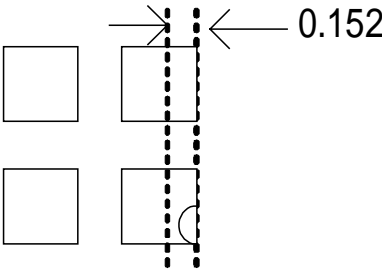
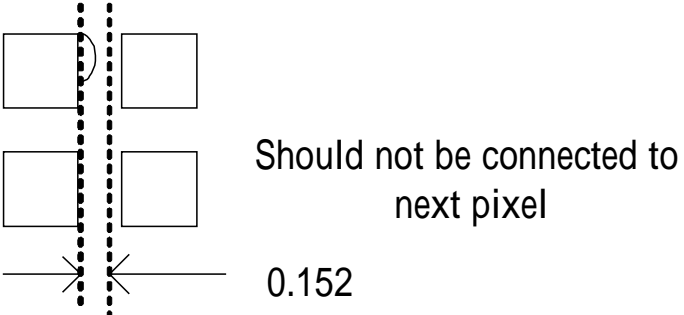
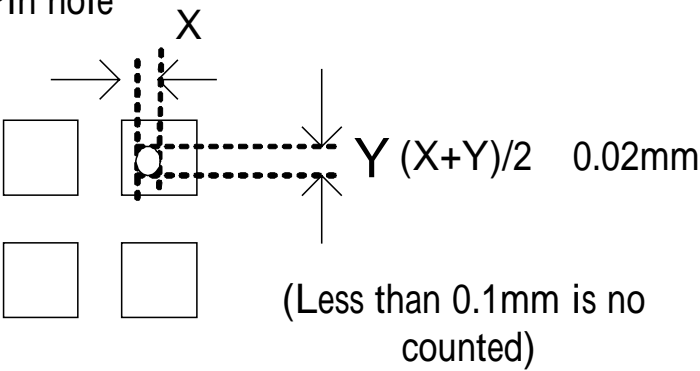
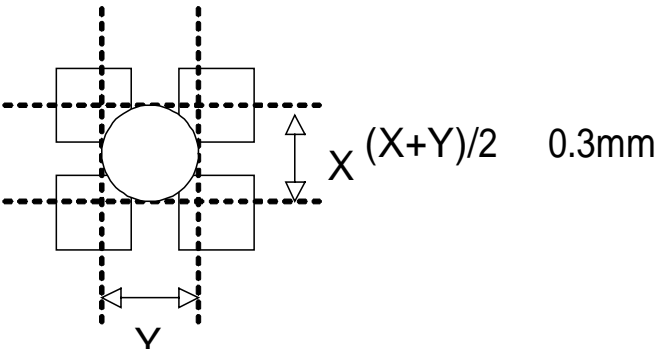


A : Display Area

B : Non-Display Area

10.2 Inspection Parameters

| NO. | Parameter | Criteria | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------|---|---|---------------------|-------|-------------------|------------------|------------------|------------------|---|---|----------|--------|---|---|-------|-----|---------------|--------|---|---|------------|--------|---|---|-------|---------|---|---|
| 1 | Black or White spots | <table border="1"> <thead> <tr> <th colspan="2" data-bbox="592 555 823 703" rowspan="2">Zone Dimension</th> <th colspan="2" data-bbox="823 555 999 651">Acceptable Number</th> <th data-bbox="999 555 1158 703" rowspan="2">Class Of Defects</th> <th data-bbox="1158 555 1318 703" rowspan="2">Acceptable Level</th> </tr> <tr> <th data-bbox="823 651 911 703">A</th> <th data-bbox="911 651 999 703">B</th> </tr> </thead> <tbody> <tr> <td data-bbox="592 703 823 752">D < 0.15</td> <td></td> <td data-bbox="823 703 911 752">*</td> <td data-bbox="911 703 999 752">*</td> <td data-bbox="999 703 1158 902" rowspan="4">Minor</td> <td data-bbox="1158 703 1318 902" rowspan="4">2.5</td> </tr> <tr> <td data-bbox="592 752 823 801">0.15 D 0.2</td> <td></td> <td data-bbox="823 752 911 801">4</td> <td data-bbox="911 752 999 801">4</td> </tr> <tr> <td data-bbox="592 801 823 851">0.2 D 0.25</td> <td></td> <td data-bbox="823 801 911 851">2</td> <td data-bbox="911 801 999 851">2</td> </tr> <tr> <td data-bbox="592 851 823 902">D 0.3</td> <td></td> <td data-bbox="823 851 911 902">0</td> <td data-bbox="911 851 999 902">1</td> </tr> </tbody> </table> <p data-bbox="592 902 1318 954">D=(Long + Short)/2 *: Disregard</p> | Zone Dimension | | Acceptable Number | | Class Of Defects | Acceptable Level | A | B | D < 0.15 | | * | * | Minor | 2.5 | 0.15 D 0.2 | | 4 | 4 | 0.2 D 0.25 | | 2 | 2 | D 0.3 | | 0 | 1 |
| Zone Dimension | | Acceptable Number | | | Class Of Defects | Acceptable Level | | | | | | | | | | | | | | | | | | | | | | |
| | | A | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| D < 0.15 | | * | * | Minor | 2.5 | | | | | | | | | | | | | | | | | | | | | | | |
| 0.15 D 0.2 | | 4 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.2 D 0.25 | | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| D 0.3 | | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Scratch, Substances | <table border="1"> <thead> <tr> <th colspan="2" data-bbox="592 1003 855 1173" rowspan="2">Zone X(mm) Y(mm)</th> <th colspan="2" data-bbox="855 1003 1031 1099">Acceptable Number</th> <th data-bbox="1031 1003 1158 1173" rowspan="2">Class Of Defects</th> <th data-bbox="1158 1003 1318 1173" rowspan="2">Acceptable Level</th> </tr> <tr> <th data-bbox="855 1099 943 1173">A</th> <th data-bbox="943 1099 1031 1173">B</th> </tr> </thead> <tbody> <tr> <td data-bbox="592 1173 711 1223">*</td> <td data-bbox="711 1173 855 1223">0.04 W</td> <td data-bbox="855 1173 943 1223">*</td> <td data-bbox="943 1173 1031 1223">*</td> <td data-bbox="1031 1173 1158 1373" rowspan="4">Minor</td> <td data-bbox="1158 1173 1318 1373" rowspan="4">2.5</td> </tr> <tr> <td data-bbox="592 1223 711 1272">3.0 L</td> <td data-bbox="711 1223 855 1272">0.06 W</td> <td data-bbox="855 1223 943 1272">4</td> <td data-bbox="943 1223 1031 1272">4</td> </tr> <tr> <td data-bbox="592 1272 711 1321">2.0 L</td> <td data-bbox="711 1272 855 1321">0.08 W</td> <td data-bbox="855 1272 943 1321">2</td> <td data-bbox="943 1272 1031 1321">3</td> </tr> <tr> <td data-bbox="592 1321 711 1373">-</td> <td data-bbox="711 1321 855 1373">0.1 < W</td> <td data-bbox="855 1321 943 1373">0</td> <td data-bbox="943 1321 1031 1373">1</td> </tr> </tbody> </table> <p data-bbox="592 1373 1318 1424">X: Length Y : Width * : Disregard</p> <p data-bbox="592 1424 1318 1480">Total defects should not exceed 4/module</p> | Zone X(mm) Y(mm) | | Acceptable Number | | Class Of Defects | Acceptable Level | A | B | * | 0.04 W | * | * | Minor | 2.5 | 3.0 L | 0.06 W | 4 | 4 | 2.0 L | 0.08 W | 2 | 3 | - | 0.1 < W | 0 | 1 |
| Zone X(mm) Y(mm) | | Acceptable Number | | | Class Of Defects | Acceptable Level | | | | | | | | | | | | | | | | | | | | | | |
| | | A | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| * | 0.04 W | * | * | Minor | 2.5 | | | | | | | | | | | | | | | | | | | | | | | |
| 3.0 L | 0.06 W | 4 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.0 L | 0.08 W | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| - | 0.1 < W | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Air Bubbles (between glass & polarizer) | <table border="1"> <thead> <tr> <th colspan="2" data-bbox="592 1529 823 1677" rowspan="2">Zone Dimension</th> <th colspan="2" data-bbox="823 1529 999 1626">Acceptable Number</th> <th data-bbox="999 1529 1158 1677" rowspan="2">Class Of Defects</th> <th data-bbox="1158 1529 1318 1677" rowspan="2">Acceptable Level</th> </tr> <tr> <th data-bbox="823 1626 911 1677">A</th> <th data-bbox="911 1626 999 1677">B</th> </tr> </thead> <tbody> <tr> <td data-bbox="592 1677 823 1727">D 0.15</td> <td></td> <td data-bbox="823 1677 911 1727">*</td> <td data-bbox="911 1677 999 1727">*</td> <td data-bbox="999 1677 1158 1827" rowspan="3">Minor</td> <td data-bbox="1158 1677 1318 1827" rowspan="3">2.5</td> </tr> <tr> <td data-bbox="592 1727 823 1776">0.15 < D 0.25</td> <td></td> <td data-bbox="823 1727 911 1776">2</td> <td data-bbox="911 1727 999 1776">*</td> </tr> <tr> <td data-bbox="592 1776 823 1827">0.25 < D</td> <td></td> <td data-bbox="823 1776 911 1827">0</td> <td data-bbox="911 1776 999 1827">1</td> </tr> </tbody> </table> <p data-bbox="592 1827 1318 1883">*: Disregard</p> <p data-bbox="592 1883 1318 1966">Total defects shall not excess 3/module.</p> | Zone Dimension | | Acceptable Number | | Class Of Defects | Acceptable Level | A | B | D 0.15 | | * | * | Minor | 2.5 | 0.15 < D 0.25 | | 2 | * | 0.25 < D | | 0 | 1 | | | | |
| Zone Dimension | | Acceptable Number | | | Class Of Defects | Acceptable Level | | | | | | | | | | | | | | | | | | | | | | |
| | | A | B | | | | | | | | | | | | | | | | | | | | | | | | | |
| D 0.15 | | * | * | Minor | 2.5 | | | | | | | | | | | | | | | | | | | | | | | |
| 0.15 < D 0.25 | | 2 | * | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.25 < D | | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | |
|----------|-------------------|--|
| <p>4</p> | <p>Uniformity</p> | <p>(1) Pixel shape (with Dent)</p>  <p>(2) Pixel shape (With Projection)</p>  <p>(3) Pin hole</p>  <p>(4) Deformation</p>  <p>Total acceptable number : 1/pixel,5/cell</p> |
|----------|-------------------|--|

11. Reliability

Content of Reliability Test

| Environmental Test | | | | |
|--------------------|--------------------------------------|--|--|---------------------|
| No. | Test Item | Content of Test | Test Condition | Applicable Standard |
| 1 | High Temperature storage | Endurance test applying the high storage temperature for a long time. | 60 200hrs | — |
| 2 | Low Temperature storage | Endurance test applying the high storage temperature for a long time. | -20 200hrs | — |
| 3 | High Temperature Operation | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time. | 50 200hrs | — |
| 4 | Low Temperature Operation | Endurance test applying the electric stress under low temperature for a long time. | 0 200hrs | — |
| 5 | High Temperature/ Humidity Storage | Endurance test applying the high temperature and high humidity storage for a long time. | 60 ,90%RH 96hrs | — |
| 6 | High Temperature/ Humidity Operation | Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time. | 40 ,90%RH 96hrs | — |
| 7 | Temperature Cycle | Endurance test applying the low and high temperature cycle. <div style="text-align: center;"> <p style="margin: 0;">-20 25 60</p> <p style="margin: 0;">←—————→</p> <p style="margin: 0;">30min 5min 30min</p> <p style="margin: 0;">—————</p> <p style="margin: 0;">1 cycle</p> </div> | -20 /60 10 cycles | — |
| Mechanical Test | | | | |
| 8 | Vibration test | Endurance test applying the vibration during transportation and using. | 10~22Hz 1.5mmp-p 22~500Hz 1.5G Total 0.5hrs | — |
| 9 | Shock test | Constructional and mechanical endurance test applying the shock during transportation. | 50G Half sign wave 11 msdc 3 times of each direction | — |
| 10 | Atmospheric pressure test | Endurance test applying the atmospheric pressure during transportation by air. | 115mbar 40hrs | — |
| Others | | | | |
| 11 | Static electricity test | Endurance test applying the electric stress to the terminal. | VS=800V,RS=1.5k CS=100pF 1 time | — |

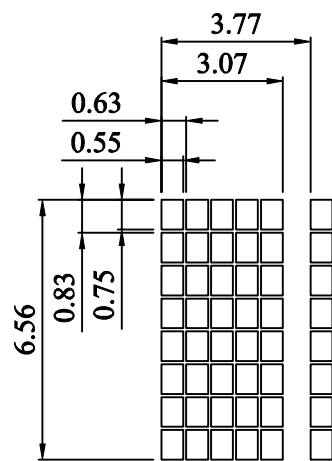
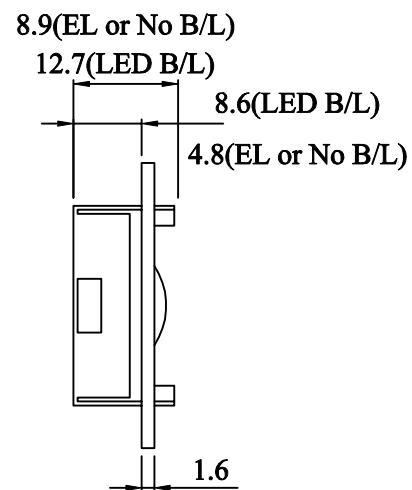
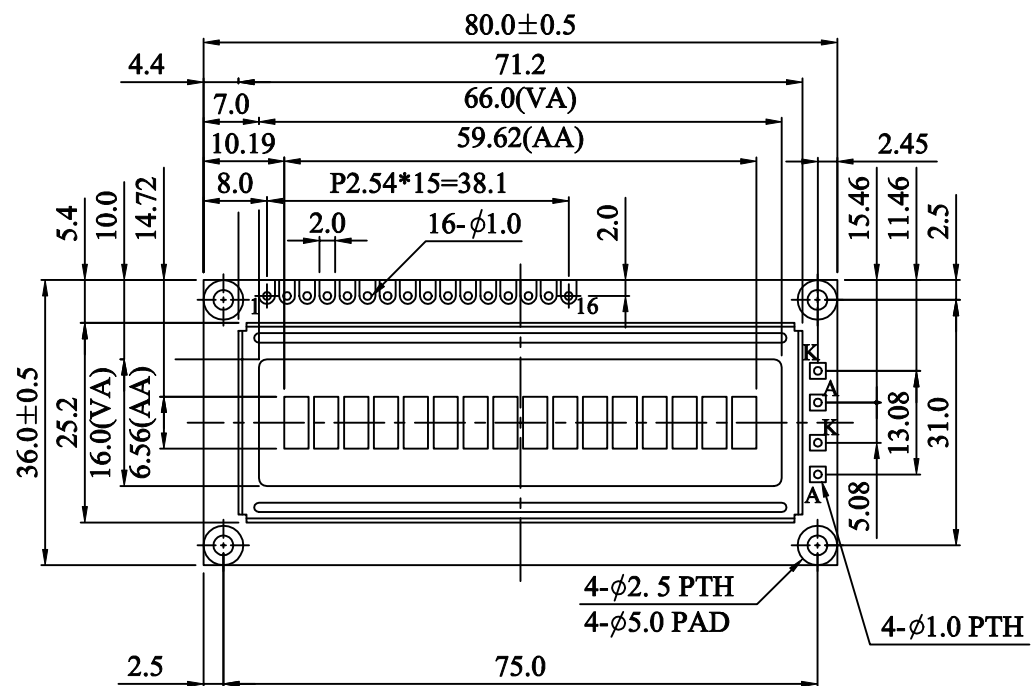
***Supply voltage for logic system=5V. Supply voltage for LCD system =Operating voltage at 25

Bolymin, Inc.

12. Appendix (Drawing , EL inverter data , KS0066 controller data)

12-1 Drawing

As shown on next page



DOT SIZE
SCALE 5/1

| PIN NO. | SYMBOL |
|---------|-----------------|
| 1 | V _{ss} |
| 2 | V _{dd} |
| 3 | V _o |
| 4 | RS |
| 5 | R/ \bar{W} |
| 6 | E |
| 7 | DB0 |
| 8 | DB1 |
| 9 | DB2 |
| 10 | DB3 |
| 11 | DB4 |
| 12 | DB5 |
| 13 | DB6 |
| 14 | DB7 |
| 15 | A/NV |
| 16 | K |

Bolymin, Inc.

12-2 EL inverter data (P/N:IVEL-01)

As shown on next page

Bolymin, Inc.

EL Inverter Specification

P/N: IVEL-01

| | | | | | |
|----------|---------|------|----------------|---------|---|
| Customer | | Date | 99/12/03 | Rev | A |
| Part No | IVEL-01 | Item | DC/AC INVERTER | Dwg. No | |

●Specification

| Input(V/Dc) | Output(V/Ac) | Frequency(Hz) | Input(mA/Dc) | El range(c m ²) | Test Dummy Load=El(cm ²) |
|-------------|--------------|---------------|--------------|-----------------------------|--------------------------------------|
| 5V/DC±10% | 80V±15% | 600Hz±20% | 60mA TYP. | 30~80 c m ² | 22nF//66.6KΩ |
| | | | | | |

●Test Condition: @25°C. Dc 5V & Standard Dummy Load.

●Test equipment :

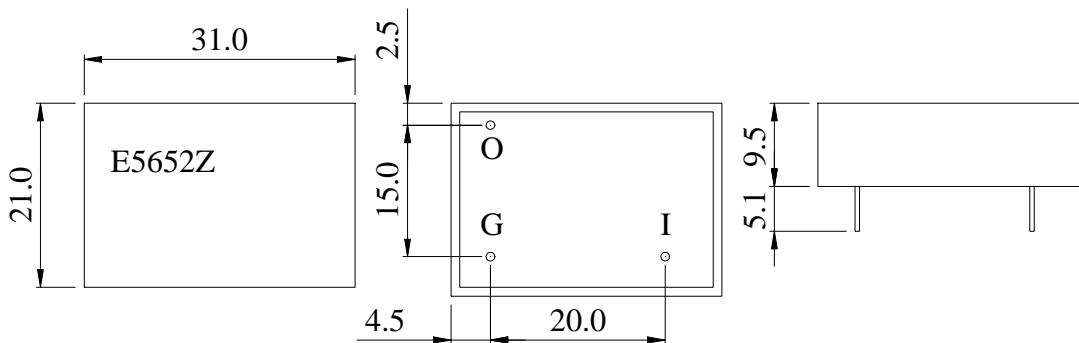
1. Millimeter : FLUKE 87S Millimeter.
2. Oscilloscope : Tektronic TDS210 Digital Oscilloscope.
3. Power supply : Gw GPC-3030D Dc Power Supply.
4. Load : EPI – LOAD – 01 Multi Range Load.

● Operation Temperature : -10°C ~ +70°C

● Storage Temperature : -30°C ~ +80°C

Note :

1. Warning : output do not open or short . Inverter may be burnout.



| PIN | Description |
|-----|--------------------|
| I | Input DC Voltage. |
| G | DC/AC ground. |
| O | Output AC Voltage. |

Tolerance: ±0.5mm

Prepare:

Checked:

Approval:

12-3. KS0066 controller data

12-3.1 Function description

The LCD display Module is built in a LSI controller, the controller has two 8-bit registers, an instruction register (IR) and a data register (DR).

The IR stores instruction codes, such as display clear and cursor shift, and address information for display data RAM (DDRAM) and character generator (CGRAM). The IR can only be written from the MPU. The DR temporarily stores data to be written or read from DDRAM or CGRAM. When address information is written into the IR, then data is stored into the DR from DDRAM or CGRAM. By the register selector (RS) signal, these two registers can be selected.

| RS | R/W | Operation |
|----|-----|---|
| 0 | 0 | IR write as an internal operation (display clear, etc.) |
| 0 | 1 | Read busy flag (DB7) and address counter (DB0 to DB7) |
| 1 | 0 | Write data to DDRAM or CGRAM (DR to DDRAM or CGRAM) |
| 1 | 1 | Read data from DDRAM or CGRAM (DDRAM or CGRAM to DR) |

Busy Flag (BF)

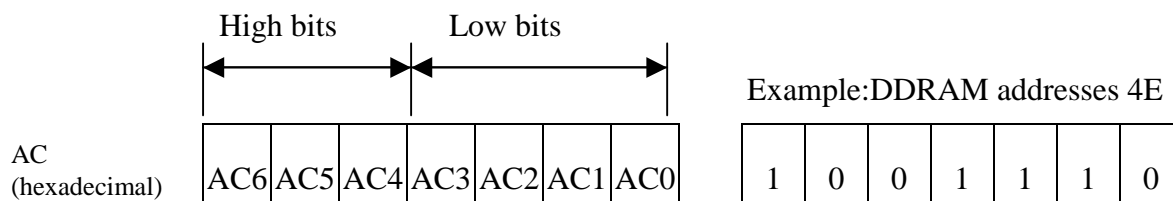
When the busy flag is 1, the controller LSI is in the internal operation mode, and the next instruction will not be accepted. When RS=0 and R/W=1, the busy flag is output to DB7. The next instruction must be written after ensuring that the busy flag is 0.

Address Counter (AC)

The address counter (AC) assigns addresses to both DDRAM and CGRAM

Display Data RAM (DDRAM)

This DDRAM is used to store the display data represented in 8-bit character codes. Its extended capacity is 80x8 bits or 80 characters. Below figure is the relationship between DDRAM addresses and positions on the liquid crystal display.



DDRAM Address

Display position DDRAM address

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

| | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F |

Example: 2-Line by 16-Character Display

Character Generator ROM (CGROM)

The CGROM generate 5×8 dot or 5×10 dot character patterns from 8-bit character codes. See Table 2.

Character Generator RAM (CGRAM)

In CGRAM, the user can rewrite character by program. For 5×8 dots, eight character patterns can be written, and for 5×10 dots, four character patterns can be written.

Write into DDRAM the character code at the addresses shown as the left column of table 1. To show the character patterns stored in CGRAM.

Relationship between CGRAM Addresses, Character Codes (DDRAM) and Character Patterns (CGRAM Data)

For 5 * 8 dot character patterns

| Character Codes (DDRAM data) | | | | | | | | CGRAM Address | | | | | | Character Patterns (CGRAM data) | | | | | | | | | | | | | | | |
|--------------------------------|---|---|---|-----|---|---|---|---------------|--|--|-----|--|--|-----------------------------------|---|---|---|-----|---|---|---|-------|-----------|--|--|--|----------------|------------------------|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 5 | | | 4 | | | 3 | | | 2 | | | 1 | | | 0 | | | | | | |
| High | | | | Low | | | | High | | | Low | | | High | | | | Low | | | | | | | | | | | |
| 0 0 0 0 * 0 0 0 | | | | | | | | 0 0 0 | | | | | | 0 | 0 | 0 | * | 0 | 0 | 0 | 0 | * * * | 0 | | | | 0 | Character pattern(1) | |
| | | | | | | | | | | | | | | 0 | 0 | 1 | * | 0 | 0 | 0 | 0 | * * * | 0 0 0 | | | | 0 | | |
| | | | | | | | | | | | | | | 0 | 1 | 0 | * | 0 | 0 | 0 | 0 | * * * | 0 0 0 | | | | 0 | | |
| | | | | | | | | | | | | | | 0 | 1 | 1 | * | 0 | 0 | 0 | 0 | * * * | 0 | | | | 0 0 0 | | 0 |
| | | | | | | | | | | | | | | 1 | 0 | 0 | * | 0 | 0 | 0 | 0 | * * * | 0 0 | | | | 0 0 0 | | 0 |
| | | | | | | | | | | | | | | 1 | 0 | 1 | * | 0 | 0 | 0 | 0 | * * * | 0 0 0 | | | | 0 | | 0 |
| | | | | | | | | | | | | | | 1 | 1 | 0 | * | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 | | | | 0 | | 0 |
| | | | | | | | | | | | | | | 1 | 1 | 1 | * | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 0 | | | | 0 | | 0 |
| | | | | | | | | | | | | | | 0 | 0 | 0 | * | 0 | 0 | 0 | 0 | * * * | 0 | | | | 0 0 0 0 | | 0 |
| | | | | | | | | | | | | | | 0 | 0 | 1 | * | 0 | 0 | 0 | 0 | * * * | 0 | | | | 0 0 0 0 | | 0 |
| 0 0 0 0 * 0 0 1 | | | | | | | | 0 0 1 | | | | | | 0 | 1 | 1 | * | 0 | 0 | 0 | 1 | * * * | 0 0 | | | | 0 0 0 | Character pattern(2) | |
| | | | | | | | | | | | | | | 1 | 0 | 0 | * | 0 | 0 | 0 | 1 | * * * | 0 0 0 | | | | 0 0 0 | | |
| | | | | | | | | | | | | | | 1 | 0 | 1 | * | 0 | 0 | 0 | 1 | * * * | 0 0 0 | | | | 0 0 0 | | |
| | | | | | | | | | | | | | | 1 | 1 | 0 | * | 0 | 0 | 0 | 1 | * * * | 0 0 0 | | | | 0 0 0 | | |
| 0 0 0 0 * 1 1 1 | | | | | | | | 1 1 1 | | | | | | 1 | 0 | 0 | * | 1 | 1 | 1 | 1 | * * * | 0 0 0 0 0 | | | | Cursor pattern | | |
| | | | | | | | | | | | | | | 1 | 0 | 1 | * | 1 | 1 | 1 | 1 | * * * | 0 0 0 0 0 | | | | | | |
| | | | | | | | | | | | | | | 1 | 1 | 0 | * | 1 | 1 | 1 | 1 | * * * | 0 0 0 0 0 | | | | | | |
| | | | | | | | | | | | | | | 1 | 1 | 1 | * | 1 | 1 | 1 | 1 | * * * | 0 0 0 0 0 | | | | | | |

For 5 * 10 dot character patterns

| Character Codes (DDRAM data) | | | | | | | | | | CGRAM Address | | | | | | | | | | Character Patterns (CGRAM data) | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------------|---|---|---|---|-----|---|---|---|--|---------------|--|--|---|--|-----|--|--|---|--|-----------------------------------|---|---|---|---|-----|---|---|---|---|-------|-------------|--|---|--|--|-----------|--|--|--|--|----------------|--|--|--|--|-------------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 5 | | | | | 4 | | | | | 3 | | | | | 2 | | | | | 1 | | | | | 0 | | | | | | | | | | | | | |
| High | | | | | Low | | | | | High | | | | | Low | | | | | High | | | | | Low | | | | | | | | | | | | | | | | | | | | | |
| 0 0 0 0 * 0 0 0 | | | | | | | | | | 0 0 | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 0 0 | | | | | 0 | | | | | 0 | | | | | Character pattern |
| | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 0 0 | | | | | 0 | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 | | | | | 0 0 0 0 | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 | | | | | 0 0 0 0 | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 | | | | | 0 0 0 0 | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 | | | | | 0 0 0 0 | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 | | | | | 0 0 0 0 | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 | | | | | 0 0 0 0 | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 | | | | | 0 0 0 0 | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | * * * | 0 0 0 0 | | | | | 0 0 0 0 | | | | | 0 | | | | | |
| 1 1 1 1 | | | | | | | | | | 1 1 1 1 | | | | | | | | | | 1 | 0 | 1 | 0 | * | 1 | 1 | 1 | 1 | 1 | * * * | * * * * * | | | | | * * * * * | | | | | Cursor pattern | | | | | |
| | | | | | | | | | | | | | | | | | | | | 1 | 0 | 1 | 0 | * | 1 | 1 | 1 | 1 | 1 | * * * | * * * * * | | | | | * * * * * | | | | | | | | | | |

■ : " High "

12-3.2 C.G ROM table. table 2

Code J: English – Japanese Font

| Upper 4 bit Lower 4 bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|----------------------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL | CG RAM (1) | | | 0 | 1 | 2 | 3 | 4 | | | | 5 | 6 | 7 | 8 | 9 |
| LLLH | (2) | ! | 0 | 1 | 2 | 3 | 4 | | | 5 | 6 | 7 | 8 | 9 | 0 | 1 |
| LLHL | (3) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| LLHH | (4) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| LHLL | (5) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| LHLH | (6) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| LHHL | (7) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| LHHH | (8) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| HLLL | (1) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| HLLH | (2) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| HLHL | (3) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| HLHH | (4) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| HHLL | (5) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| HHLH | (6) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| HHHL | (7) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
| HHHH | (8) | | ! | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 | 0 |

Bolymin, Inc.

Code E: English - European Font

| Upper 4 bit Lower 4 bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|----------------------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL | CG RAM (1) | ! | " | # | \$ | % | & | ' | (|) | * | + | , | - | . | : |
| LLLH | CG RAM (2) | ; | < | = | > | ?@ | AB | CD | EF | GH | IK | LM | NO | PQ | RS | TU |
| LLHL | CG RAM (3) | V | W | X | Y | Z | [|] | ^ | _ | ` | a | b | c | d | e |
| LLHH | CG RAM (4) | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t |
| LHLL | CG RAM (5) | u | v | w | x | y | z | { | } | ~ | ` | aa | bb | cc | dd | ee |
| LHLH | CG RAM (6) | ff | gg | hh | ii | jj | kk | ll | mm | nn | oo | pp | qq | rr | ss | tt |
| LHHL | CG RAM (7) | uu | vv | ww | xx | yy | zz | { | } | ~ | ` | aaa | bbb | ccc | ddd | eee |
| LHHH | CG RAM (8) | fff | ggg | hhh | iii | jjj | kkk | lll | mmm | nnn | ooo | ppp | qqq | rrr | sss | ttt |
| HLLL | CG RAM (1) | uuu | vvv | www | xxx | yyy | zzz | { | } | ~ | ` | uuu | vvv | www | xxx | yyy |
| HLLH | CG RAM (2) | zzz | aaa | bbb | ccc | ddd | eee | fff | ggg | hhh | iii | jjj | kkk | lll | mmm | nnn |
| HLHL | CG RAM (3) | ooo | ppp | qqq | rrr | sss | ttt | uuu | vvv | www | xxx | yyy | zzz | aaa | bbb | ccc |
| HLHH | CG RAM (4) | ddd | eee | fff | ggg | hhh | iii | jjj | kkk | lll | mmm | nnn | ooo | ppp | qqq | rrr |
| HHLL | CG RAM (5) | rrr | sss | ttt | uuu | vvv | www | xxx | yyy | zzz | aaa | bbb | ccc | ddd | eee | fff |
| HHLH | CG RAM (6) | ggg | hhh | iii | jjj | kkk | lll | mmm | nnn | ooo | ppp | qqq | rrr | sss | ttt | uuu |
| HHHL | CG RAM (7) | ttt | uuu | vvv | www | xxx | yyy | zzz | aaa | bbb | ccc | ddd | eee | fff | ggg | hhh |
| HHHH | CG RAM (8) | uuu | vvv | www | xxx | yyy | zzz | aaa | bbb | ccc | ddd | eee | fff | ggg | hhh | iii |

Bolymin, Inc.

Code C: English - Cyrillic Font

| Upper 4 bit Lower 4 bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|----------------------------------|------------------|------|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL | CG RAM (1) | | | 0 | 1 | 2 | 3 | 4 | | | 5 | 6 | 7 | 8 | 9 | 0 |
| LLLH | CG RAM (2) | | ! | 1 | 2 | 3 | 4 | | | | 5 | 6 | 7 | 8 | 9 | 0 |
| LLHL | CG RAM (3) | | !" | 2 | 3 | 4 | 5 | | | | 6 | 7 | 8 | 9 | 0 | 1 |
| LLHH | CG RAM (4) | | !"# | 3 | 4 | 5 | 6 | | | | 7 | 8 | 9 | 0 | 1 | 2 |
| LHLL | CG RAM (5) | | !"#\$ | 4 | 5 | 6 | 7 | | | | 8 | 9 | 0 | 1 | 2 | 3 |
| LHLH | CG RAM (6) | | !"#\$% | 5 | 6 | 7 | 8 | | | | 9 | 0 | 1 | 2 | 3 | 4 |
| LHHL | CG RAM (7) | | !"#\$%& | 6 | 7 | 8 | 9 | | | | 0 | 1 | 2 | 3 | 4 | 5 |
| LHHH | CG RAM (8) | | !"#\$%&' | 7 | 8 | 9 | 0 | | | | 1 | 2 | 3 | 4 | 5 | 6 |
| HLLL | CG RAM (1) | | !"#\$%&'(| 8 | 9 | 0 | 1 | | | | 2 | 3 | 4 | 5 | 6 | 7 |
| HLLH | CG RAM (2) | | !"#\$%&'() | 9 | 0 | 1 | 2 | | | | 3 | 4 | 5 | 6 | 7 | 8 |
| HLHL | CG RAM (3) | | !"#\$%&'() | 0 | 1 | 2 | 3 | | | | 4 | 5 | 6 | 7 | 8 | 9 |
| HLHH | CG RAM (4) | | !"#\$%&'() | 1 | 2 | 3 | 4 | | | | 5 | 6 | 7 | 8 | 9 | 0 |
| HHLL | CG RAM (5) | | !"#\$%&'() | 2 | 3 | 4 | 5 | | | | 6 | 7 | 8 | 9 | 0 | 1 |
| HHLH | CG RAM (6) | | !"#\$%&'() | 3 | 4 | 5 | 6 | | | | 7 | 8 | 9 | 0 | 1 | 2 |
| HHHL | CG RAM (7) | | !"#\$%&'() | 4 | 5 | 6 | 7 | | | | 8 | 9 | 0 | 1 | 2 | 3 |
| HHHH | CG RAM (8) | | !"#\$%&'() | 5 | 6 | 7 | 8 | | | | 9 | 0 | 1 | 2 | 3 | 4 |

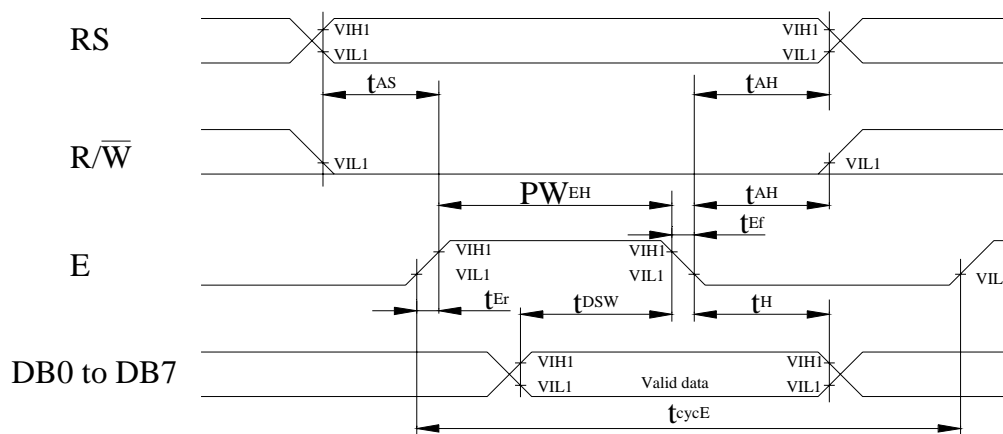
12-3.3 Instruction table

| Instruction | Instruction Code | | | | | | | | | | Description | Execution time (fosc=270 Khz) | |
|----------------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------------|--|--------|
| | RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | | | |
| Clear Display | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Write "00H" to DDRAM and set DDRAM address to "00H" from AC | 1.53ms |
| 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. | 1.53ms |
| Entry Mode Set | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | SH | Assign cursor moving direction and enable the shift of entire display. | 39 μs |
| Display ON/OFF Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | Set display (D), cursor (C), and blinking of cursor (B) on/off control bit. | 39 μs |
| Cursor or Display Shift | 0 | 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. | 39 μs |
| Function Set | 0 | 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:5×11 dots/5×8 dots) | 39 μs |
| Set CGRAM Address | 0 | 0 | 0 | 1 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | | Set CGRAM address in address counter. | 39 μs |
| Set DDRAM Address | 0 | 0 | 1 | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | | Set DDRAM address in address counter. | 39 μs |
| Read Busy Flag and Address | 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. | 0 μs |
| Write Data to RAM | 1 | 0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | Write data into internal RAM (DDRAM/CGRAM). | 43 μs |
| Read Data from RAM | 1 | 1 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | Read data from internal RAM (DDRAM/CGRAM). | 43 μs |

* " - " : don't care

12-3.4 Timing characteristics

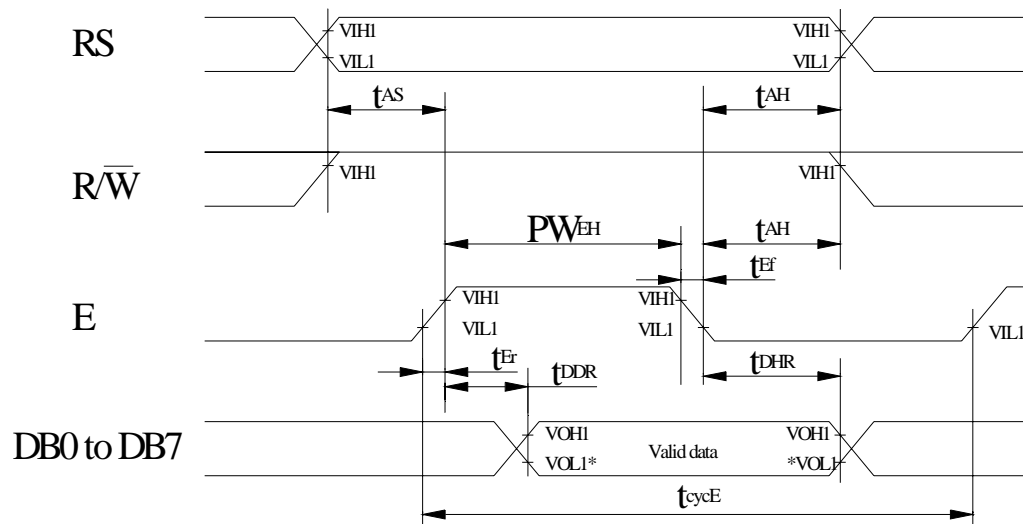
12-3.4.1 Write Operation



$T_a=25$, $V_{dd}=5.0\pm 0.5V$

| Item | Symbol | Min | Typ | Max | Unit |
|------------------------------------|------------------|-----|-----|-----|------|
| Enable cycle time | t_{cycE} | 500 | - | - | ns |
| Enable pulse width (high level) | PW_{EH} | 230 | - | - | ns |
| Enable rise/fall time | t_{Er}, t_{Ef} | - | - | 20 | ns |
| Address set-up time (RS, R/W to E) | t_{AS} | 40 | - | - | ns |
| Address hold time | t_{AH} | 10 | - | - | ns |
| Data set-up time | t_{DSW} | 80 | - | - | ns |
| Data hold time | t_H | 10 | - | - | ns |

12-3.4.2 Read Operation



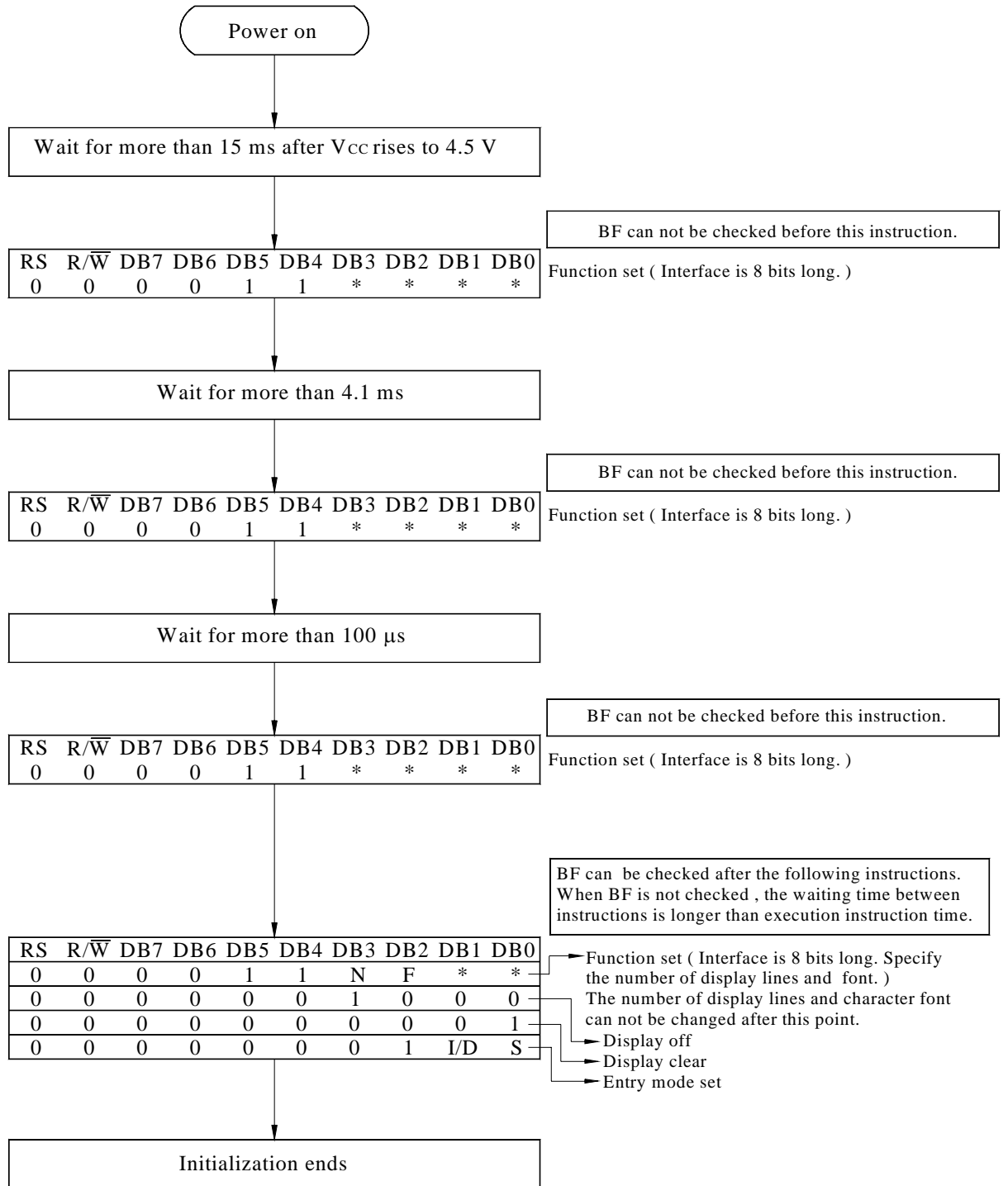
NOTE: *VOL1 is assumed to be 0.8V at 2 MHz operation.

Ta=25 , Vdd=5.0±0.5V

| Item | Symbol | Min | Typ | Max | Unit |
|------------------------------------|-------------------|-----|-----|-----|------|
| Enable cycle time | t_{cycE} | 500 | - | - | ns |
| Enable pulse width (high level) | PW_{EH} | 230 | - | - | ns |
| Enable rise/fall time | t_{Er}, t_{Efc} | - | - | 20 | ns |
| Address set-up time (RS, R/W to E) | t_{AS} | 40 | - | - | ns |
| Address hold time | t_{AH} | 10 | - | - | ns |
| Data delay time | t_{DDR} | - | - | 100 | ns |
| Data hold time | t_{DHR} | 5 | - | - | ns |

12-3.5 Initializing soft ware of LCM

12-3.5.1 8-bit interface



8-Bit Ineterface

12-3.5.2 4-bit interface

