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# *Crystalfontz America, Inc.*

| | | |
|---|---|---|
| **CUSTOMER** | | |
| **MODEL** | **CFAH1602B-TMC-JP** | |
| **APPROVAL** | **BY:** | **DATA:** |

| SALES BY | APPROVED BY | CHECKED BY | PREPARED BY |
|---|---|---|---|
| | | | |

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# Contents

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# 1.Module Classification Information

CFA H 1602 B－T M C－ JP
① ② ③ ④ ⑤ ⑥ ⑦ ⑧

| | | | |
|---|---|---|---|
| ① | Brand: CRYSTALFONTZ AMERICA, INCORPORATED | | |
| ② | Display Type: **H→Character Type**, G→Graphic Type | | |
| ③ | Display's logical dimensions: **16** columns by **02** lines | | |
| ④ | Model serials no. | | |
| ⑤ | Backlight Type: | N→Without backlight<br>B→EL, Blue green<br>D→EL, Green<br>W→EL, White<br>F→CCFL, White<br>**T→LED, White** | Y→LED, Yellow Green<br>A→LED, Amber<br>R→LED, Red<br>O→LED, Orange<br>G→LED, Green |
| ⑥ | LCD Mode: | B→TN Positive, Gray<br>N→TN Negative,<br>G→STN Positive, Gray<br>Y→STN Positive, Yellow Green | **M→STN Negative, Blue**<br>F→FSTN Positive<br>T→FSTN Negative |
| ⑦ | LCD Polarizer Type, Temperature range, Viewing direction: | A→Reflective, N.T, 6:00<br>D→Reflective, N.T, 12:00<br>G→Reflective, W. T, 6:00<br>J→Reflective, W. T, 12:00<br>B→Transflective, N.T,6:00<br>E→Transflective, N.T.12:00 | H→Transflective, W.T,6:00<br>K→Transflective, W.T,12:00<br>**C→Transmissive, N.T,6:00**<br>F→Transmissive, N.T,12:00<br>I→Transmissive, W. T, 6:00<br>L→Transmissive, W.T,12:00 |
| ⑧ | Special Code: | **JP→English and Japanese standard font** | |

# 2.Precautions in use of LCD Modules

(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.

# 3.General Specification

| ITEM | STANDARD VALUE | UNIT |
|---|---|---|
| Number of Characters: | 16 characters×2 Lines | |
| Module dimension: | 80.0×36.0×13.5(MAX)mm | mm |
| View area: | 66.0×16.0mm | mm |
| Active area: | 56.2×11.5mm | mm |
| Character size: | (L)2.95×(W)5.55mm | mm |
| Character pitch: | (L)3.55×(W)5.95mm | mm |
| LCD type: | STN, Negative ,transmissive, Blue | |
| Duty: | 1/16 | |
| View direction: | 6 o'clock | |
| Backlight: | LED White | |

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# 4.Absolute Maximum Ratings

| ITEM | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|
| Operating Temperature | $T_{OP}$ | 0 | — | +50 | ℃ |
| Storage Temperature | $T_{ST}$ | -10 | — | +60 | ℃ |
| Input Voltage | $V_I$ | $V_{SS}$ | — | $V_{DD}$ | V |
| Supply Voltage For Logic | $V_{DD}$-$V_{SS}$ | -0.3 | — | 7 | V |
| Supply Voltage For LCD | $V_{DD}$-$V_0$ | -0.3 | — | Vdd+0.3 | V |
| Supply current FOR LED B/L | $I_{LED}$ | — | — | 25 | mA |

# 5.Electrical Characteristics

| ITEM | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Supply Voltage For Logic | $V_{DD}$-$V_{SS}$ | — | 4.5 | — | 5.5 | V |
| Supply Voltage For LCD | $V_{DD}$-$V_0$ | Ta=0℃ | — | 4.2 | 4.5 | V |
| | | Ta=25℃ | — | | — | V |
| | | Ta=50℃ | 3.8 | | — | V |
| Input High Vol | $V_{IH}$ | — | 2.2 | — | $V_{DD}$ | V |
| Input Low Vol | $V_{IL}$ | — | — | — | 0.6 | V |
| Output High Vol | $V_{OH}$ | — | 2.4 | — | — | V |
| Output Low Vol. | $V_{OL}$ | — | — | — | 0.4 | V |
| Supply Current | $I_{DD}$ | $V_{DD}$=5V | — | 1.2 | — | mA |

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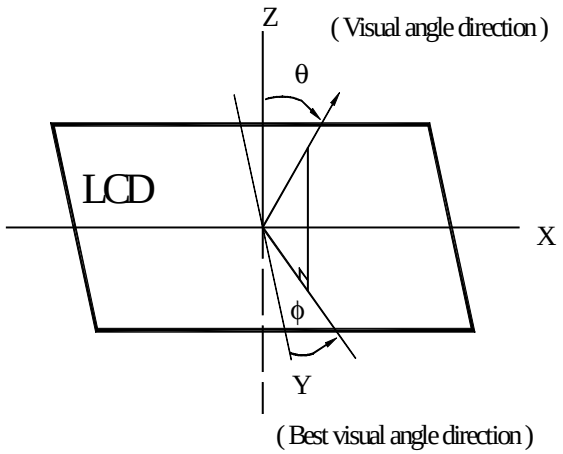
# 6.Optical Characteristics

| ITEM | SYMBAL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| View Angle | (V) $\theta$ | CR≧3 | 10 | | 105 | deg |
| | (H) $\varphi$ | CR≧3 | -30 | | 30 | deg |
| Contrast Ratio | CR | — | | 5 | | — |
| Response Time | T rise | — | | 200 | 300 | ms |
| | T fall | — | | 200 | 300 | ms |

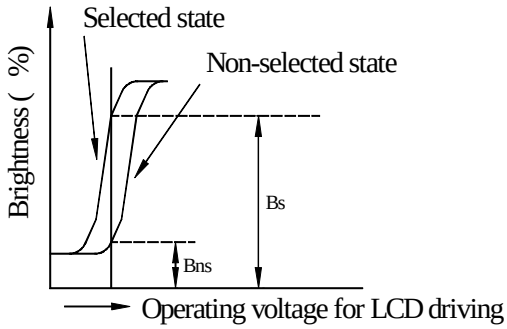
## 6.1 Definitions

**■View Angles**

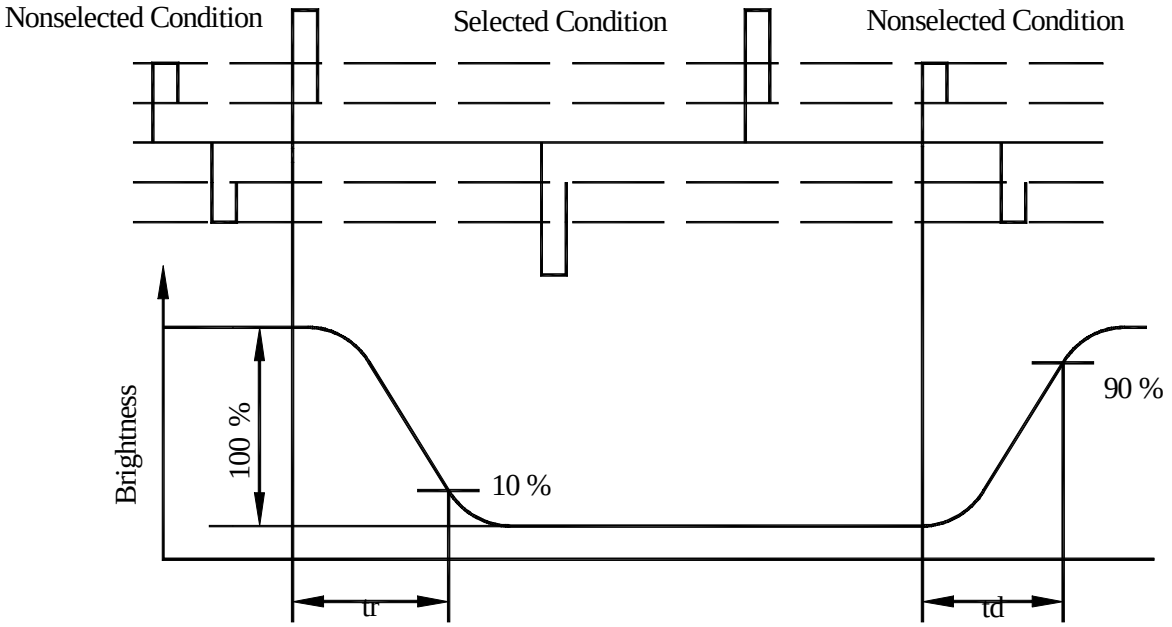



**■Contrast Ratio**

$$CR = \frac{\text{Brightness at selected state ( BS )}}{\text{Brightness at non-selected state ( Bns )}}$$




**■Response Time**



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# 7.Interface Pin Function

| Pin No. | Symbol | Level | Description |
|---|---|---|---|
| 1 | $V_{SS}$ | 0V | Ground |
| 2 | $V_{DD}$ | 5.0V | Supply Voltage for logic |
| 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 | — | Power supply for LED backlight ( + ) |
| 16 | K | — | Power supply for LED backlight ( - ) |

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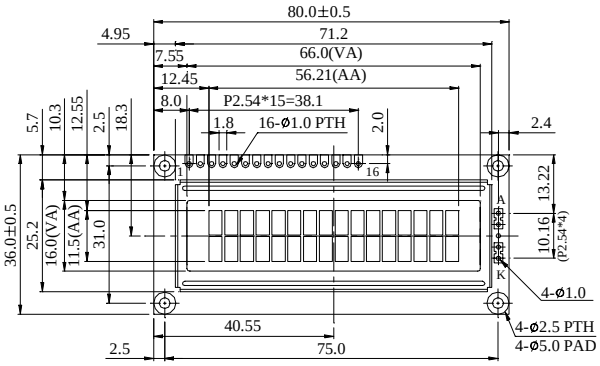
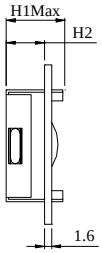
# 8.Counter drawing

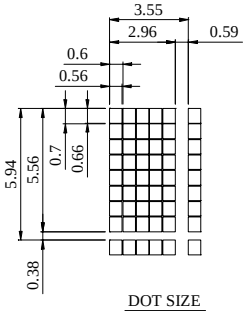



| PIN NO. | SYMBOL |
|---|---|
| 1 | Vss |
| 2 | Vdd |
| 3 | Vo |
| 4 | RS |
| 5 | R/$\overline{W}$ |
| 6 | E |
| 7 | DB0 |
| 8 | DB1 |
| 9 | DB2 |
| 10 | DB3 |
| 11 | DB4 |
| 12 | DB5 |
| 13 | DB6 |
| 14 | DB7 |
| 15 | A/Vee |
| 16 | K |

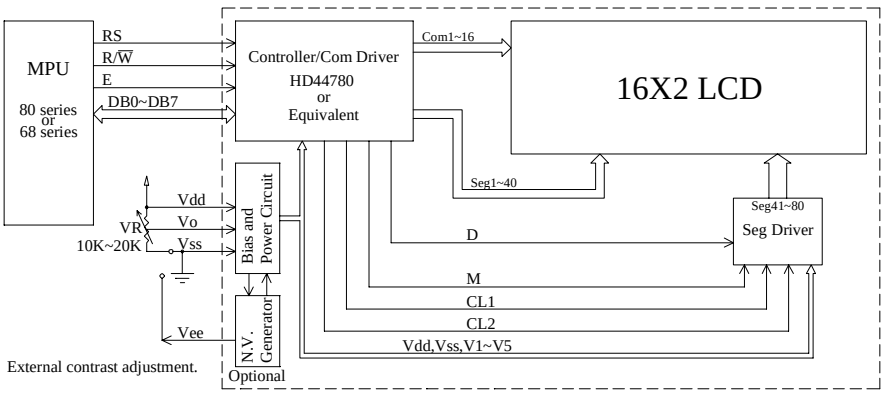
LED H/L B/L

| | High | |
|---|---|---|
| H1 | 13.2 | |
| H2 | 8.6 | |



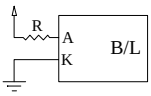

DOT SIZE

The non-specified tolerance of dimension is ±0.3mm.

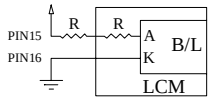



LED B/L Drive Method

1.Drive from A,K

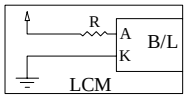



2.Drive from pin15, pin16




(Will never get Vee output from pin15)

3.Drive from Vdd,Vss




(Contrast performance may go down.)

Recommanded Value

$V_{LED}$= 3.3V, $I_{LED}$=25mA

| Character located | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DDRAM address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |
| DDRAM address | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F |

# 9.Backlight Information

## 9.1 Specification

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT | TEST CONDITION |
|---|---|---|---|---|---|---|
| Supply Current | ILED | — | 25 | | mA | V=3.3V |
| Supply Voltage | V | — | 3.3 | 3.6 | V | |
| Reverse Voltage | VR | — | — | 8 | V | |
| Luminous Intensity | IV | 20 | — | — | $CD/M^2$ | ILED=25mA |
| Wave Length | $\lambda$ p | | | | nm | ILED=25mA |
| Life Time | | — | 100000 | — | Hr. | V≦3.6V |
| Color | White | | | | | |

# 10.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)

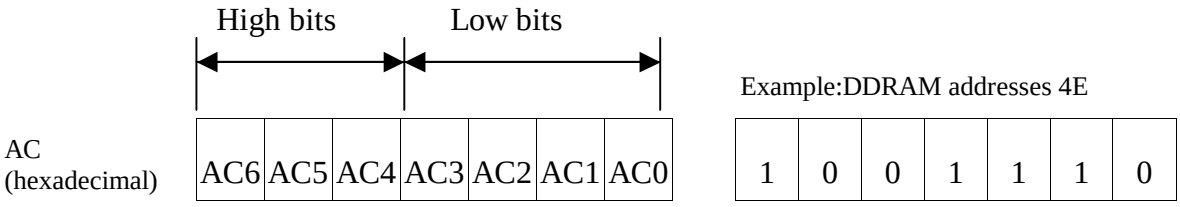
When the busy flag is 1, the controller LSI is in the internal operation mode, and the next instruction will not be accepted. When RS=0 and R/W=1, the busy flag is output to DB7. The next instruction must be written after ensuring that the busy flag is 0.

## 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 80×8 bits or 80 characters. Below figure is the relationships 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 |

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.

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

**Table 1.**

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 | 7 6 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 | Character pattern( 1 ) |
| | 0 0 1 | * * * ■ 0 0 0 ■ | |
| | 0 1 0 | * * * ■ 0 0 0 ■ | |
| | 0 1 1 | * * * ■■■■ 0 | |
| | 1 0 0 | * * * ■ 0 ■ 0 0 | |
| | 1 0 1 | * * * ■ 0 0 ■ 0 | |
| | 1 1 0 | * * * ■ 0 0 0 ■ | |
| | 1 1 1 | * * * 0 0 0 0 0 | Cursor pattern |
| 0 0 0 0 * 0 0 1 | 0 0 1 0 0 0 | * * * ■ 0 0 0 ■ | Character pattern( 2 ) |
| | 0 0 1 | * * * 0 ■ 0 ■ 0 | |
| | 0 1 0 | * * * ■■■■■ | |
| | 0 1 1 | * * * 0 0 ■ 0 0 | |
| | 1 0 0 | * * * ■■■■■ | |
| | 1 0 1 | * * * 0 0 ■ 0 0 | |
| | 1 1 0 | * * * 0 0 ■ 0 0 | |
| | 1 1 1 | * * * 0 0 0 0 0 | Cursor pattern |
| | 0 0 0 | * * * | |
| | 0 0 1 | | |
| 0 0 0 0 * 1 1 1 | 1 1 1 1 0 0 | | |
| | 1 0 1 | | |
| | 1 1 0 | | |
| | 1 1 1 | * * * | |

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 | 7 6 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 |
| | 0 0 0 1 | * * * 0 0 0 0 0 | |
| | 0 0 1 0 | * * * ■ 0 ■■■ 0 | |
| | 0 0 1 1 | * * * ■■ 0 0 ■ | |
| | 0 1 0 0 | * * * ■ 0 0 0 | |
| | 0 1 0 1 | * * * ■ 0 0 0 | |
| | 0 1 1 0 | * * * ■■■■ 0 | |
| | 0 1 1 1 | * * * ■ 0 0 0 0 | |
| | 1 0 0 0 | * * * ■ 0 0 0 0 | |
| | 1 0 0 1 | * * * ■ 0 0 0 0 | |
| | 1 0 1 0 | * * * 0 0 0 0 0 | Cursor pattern |
| | | | |
| | 1 1 1 1 | * * * * * * * * | |

■ : " High "

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# 11. Character Generator ROM Pattern

**Table.2**

| 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 | (2) | | | | | | | | | | | | | | | |
| LLHL | (3) | | | | | | | | | | | | | | | |
| LLHH | (4) | | | | | | | | | | | | | | | |
| LHLL | (5) | | | | | | | | | | | | | | | |
| LHLH | (6) | | | | | | | | | | | | | | | |
| LHHL | (7) | | | | | | | | | | | | | | | |
| LHHH | (8) | | | | | | | | | | | | | | | |
| HLLL | (1) | | | | | | | | | | | | | | | |
| HLLH | (2) | | | | | | | | | | | | | | | |
| HLHL | (3) | | | | | | | | | | | | | | | |
| HLHH | (4) | | | | | | | | | | | | | | | |
| HHLL | (5) | | | | | | | | | | | | | | | |
| HHLH | (6) | | | | | | | | | | | | | | | |
| HHHL | (7) | | | | | | | | | | | | | | | |
| HHHH | (8) | | | | | | | | | | | | | | | |

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# 12. Instruction Table

| Instruction | Instruction Code | | | | | | | | | | Description | Execution time (fosc=270Khz) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | | |
| Clear Display | 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 | 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 | 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 | 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 | 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 | 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

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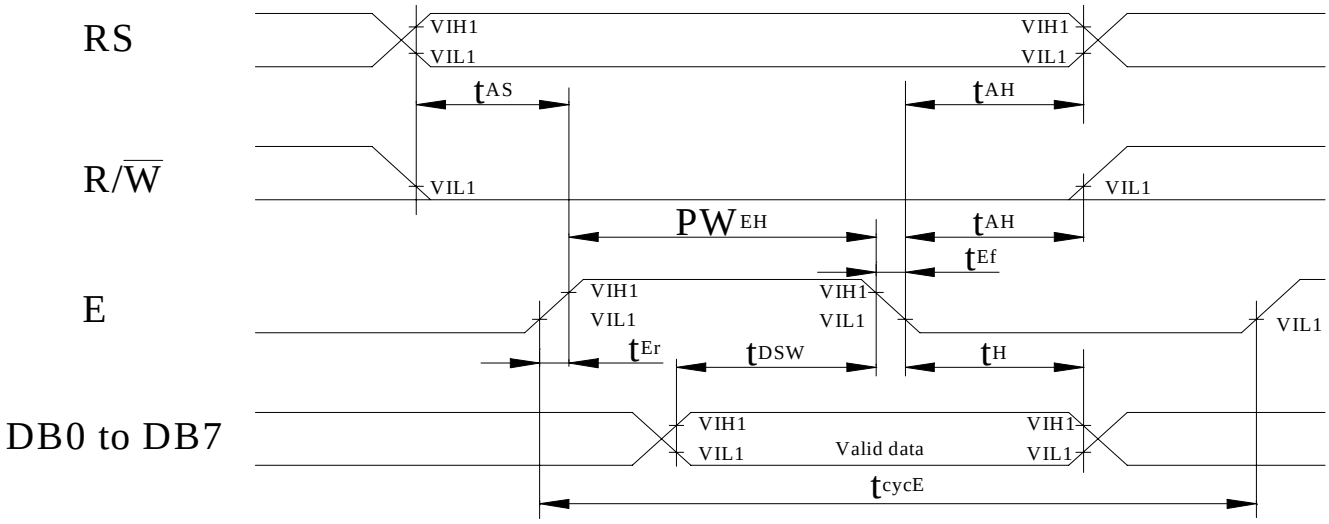
# 13. Timing Characteristics

## 13.1 Write Operation




| 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 |

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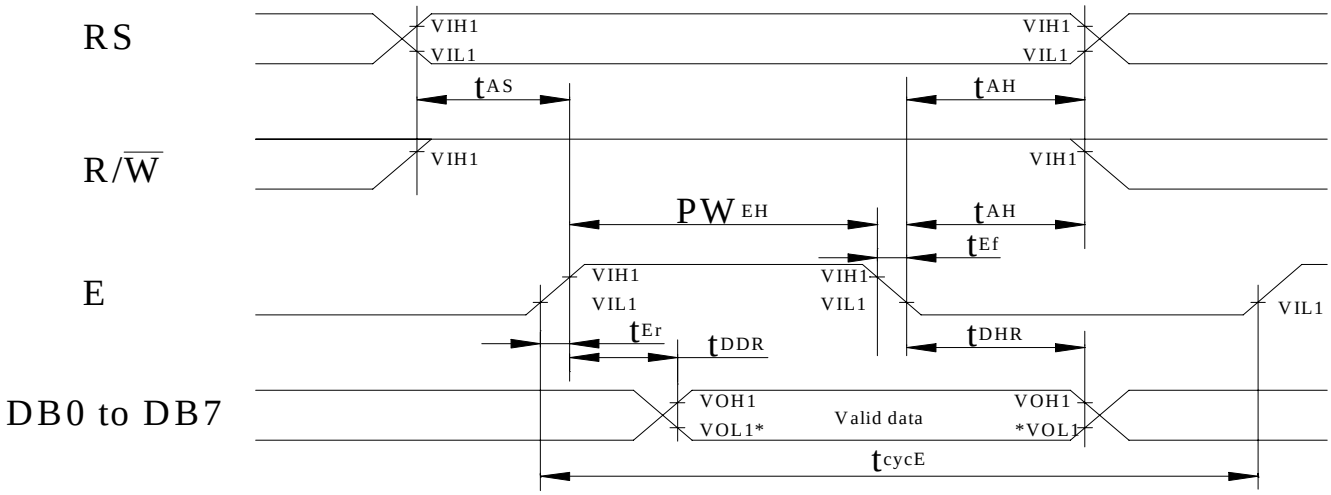
## 13.2 Read Operation




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

| 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 delay time | $t_{DDR}$ | — | — | 160 | ns |
| Data hold time | $t_{DHR}$ | 5 | — | — | ns |

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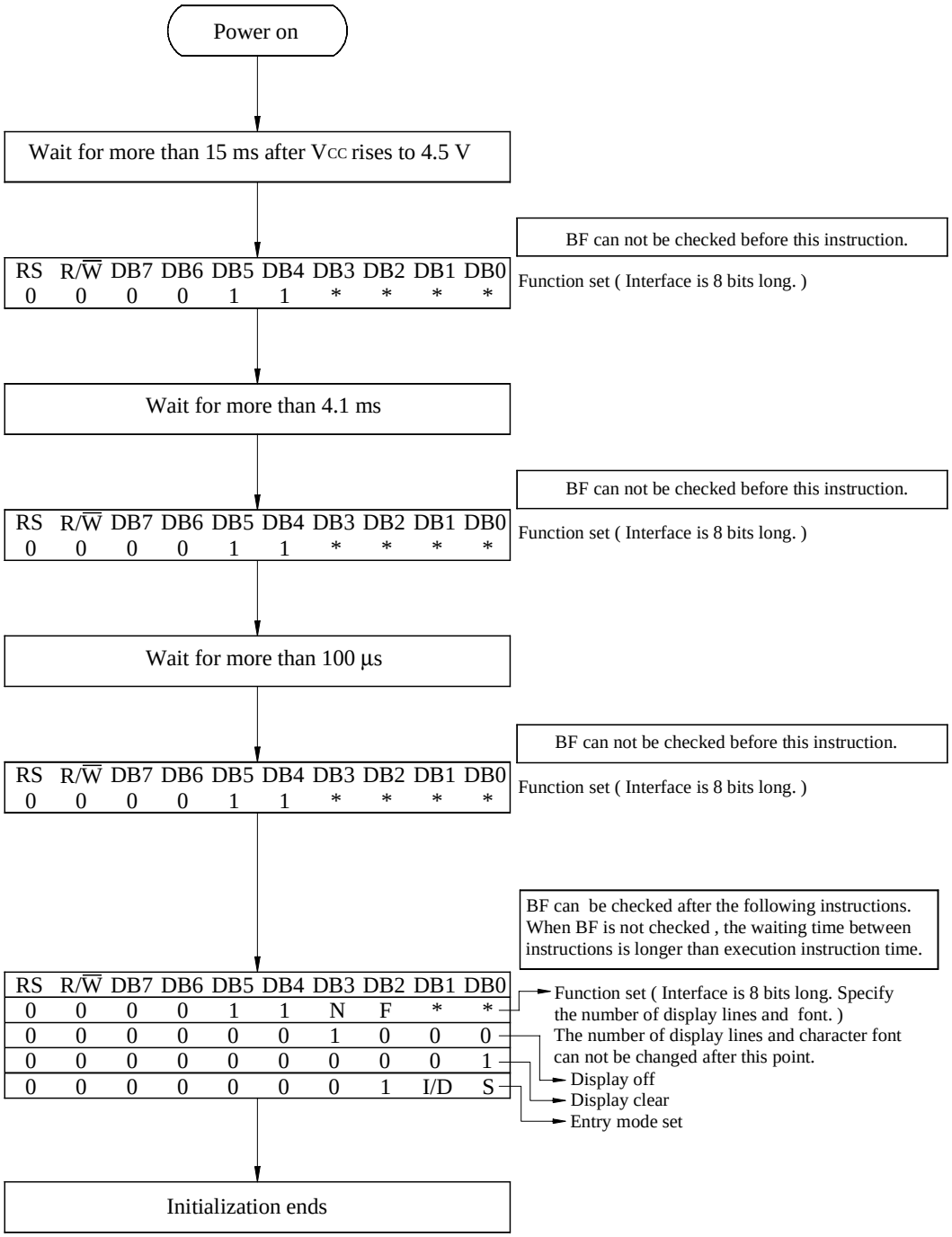
# 14. Initializing of LCM




8-Bit Ineterface

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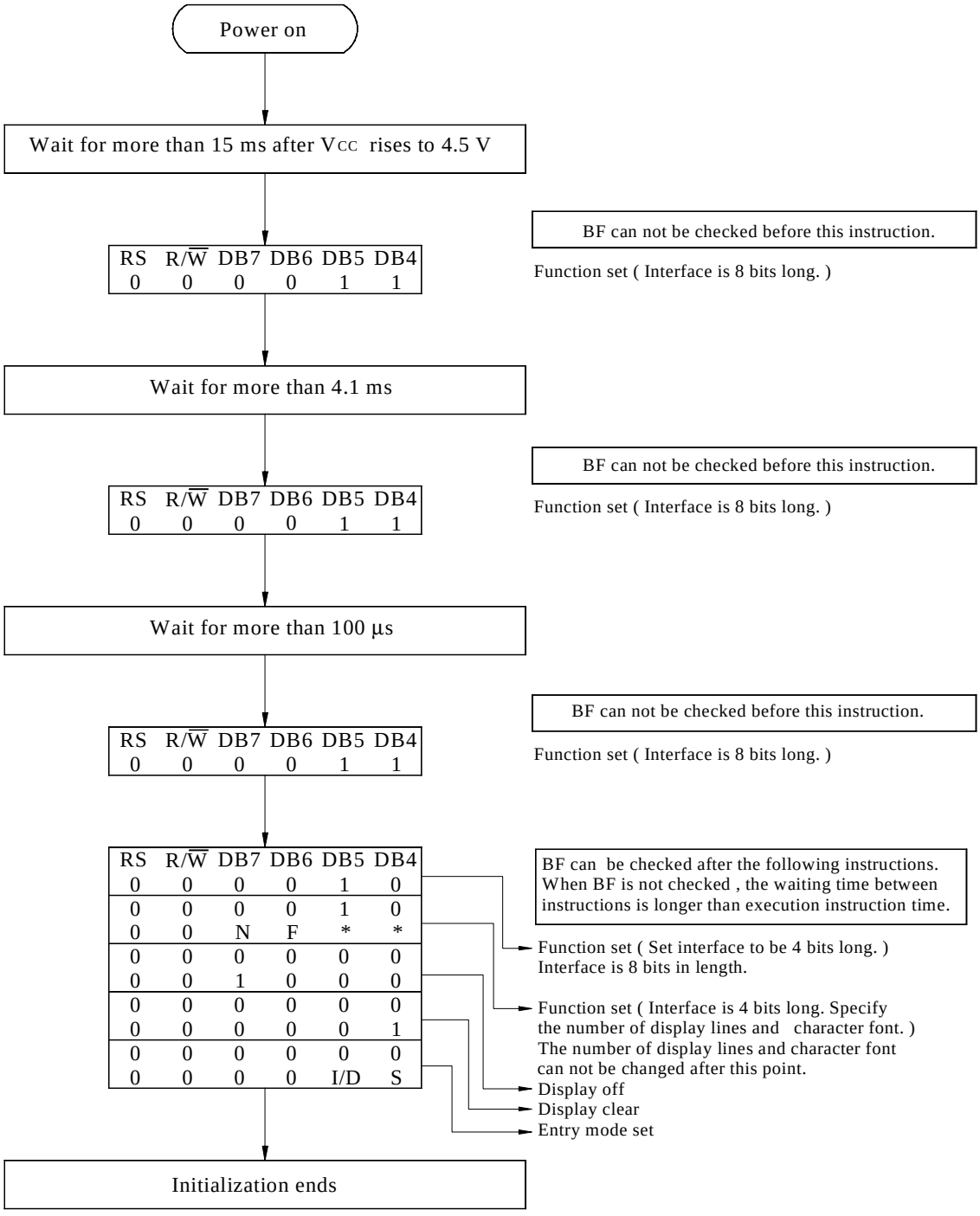


4-Bit Ineterface

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# 15. Quality Assurance

### ◆ Screen Cosmetic Criteria

| No. | Defect | Judgement Criterion | Partition |
|---|---|---|---|
| 1 | Spots | A)Clear<br>Size:d mm — Acceptable Qty in active area<br>d ≦0.1 — Disregard<br>0.1<d≦0.2 — 6<br>0.2<d≦0.3 — 2<br>0.3<d — 0<br>Note:Including pin holes and defective dots which must be within one pixel size.<br>B)Unclear<br>Size:d mm — Acceptable Qty in active area<br>d ≦0.2 — Disregard<br>0.2<d≦0.5 — 6<br>0.5<d≦0.7 — 2<br>0.7<d — 0 | Minor |
| 2 | Bubbles in Polarizer | Size:d mm — Acceptable Qty in active area<br>d≦0.3 — Disregard<br>0.3<d≦1.0 — 3<br>1.0<d≦1.5 — 1<br>1.5<d — 0 | Minor |
| 3 | Scratch | In accordance with spots cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable. | Minor |
| 4 | Allowable Density | Above defects should be separated more than 30mm each other. | Minor |
| 5 | Coloration | Not to be noticeable coloration in the viewing area of the LCD panels.<br>Back-light type should be judged with back-light on state only. | Minor |

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# 16. 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℃<br>200hrs | —— |
| 2 | Low Temperature storage | Endurance test applying the high storage temperature for a long time. | -10℃<br>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℃<br>200hrs | —— |
| 4 | Low Temperature Operation | Endurance test applying the electric stress under low temperature for a long time. | 0℃<br>200hrs | —— |
| 5 | High Temperature/ Humidity Storage | Endurance test applying the high temperature and high humidity storage for a long time. | 60℃,90%RH<br>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. | 50℃,90%RH<br>96hrs | —— |
| 7 | Temperature Cycle | Endurance test applying the low and high temperature cycle.<br>-10℃ 25℃ 60℃<br>◄——————►<br>30min 5min 30min<br>1 cycle | -10℃/60℃<br>10 cycles | —— |
| Mechanical Test | | | | |
| 8 | Vibration test | Endurance test applying the vibration during transportation and using. | 10~22Hz→1.5mmp-p<br>22~500Hz→1.5G<br>Total 0.5hrs | —— |
| 9 | Shock test | Constructional and mechanical endurance test applying the shock during transportation. | 50G Half sign wave 11 msedc<br>3 times of each direction | —— |
| 10 | Atmospheric pressure test | Endurance test applying the atmospheric pressure during transportation by air. | 115mbar<br>40hrs | —— |
| Others | | | | |
| 11 | Static electricity test | Endurance test applying the electric stress to the terminal. | VS=800V,RS=1.5kΩ<br>CS=100pF<br>1 time | —— |

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