

# SPECIFICATION FOR LCD MODULE

Model No. TM128160CKFWG

|                      |              |
|----------------------|--------------|
| <b>Prepared by:</b>  | <b>Date:</b> |
| <b>Checked by :</b>  | <b>Date:</b> |
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| <b>Approved by:</b>  | <b>Date:</b> |

**TIANMA MICROELECTRONICS CO., LTD**

**REVISION RECORD**

| <b>Date</b> | <b>Ver.</b> | <b>Ref. Page</b> | <b>Revision No.</b> | <b>Revision Items</b> |
|-------------|-------------|------------------|---------------------|-----------------------|
|             |             |                  |                     |                       |

## 1. General Specifications:

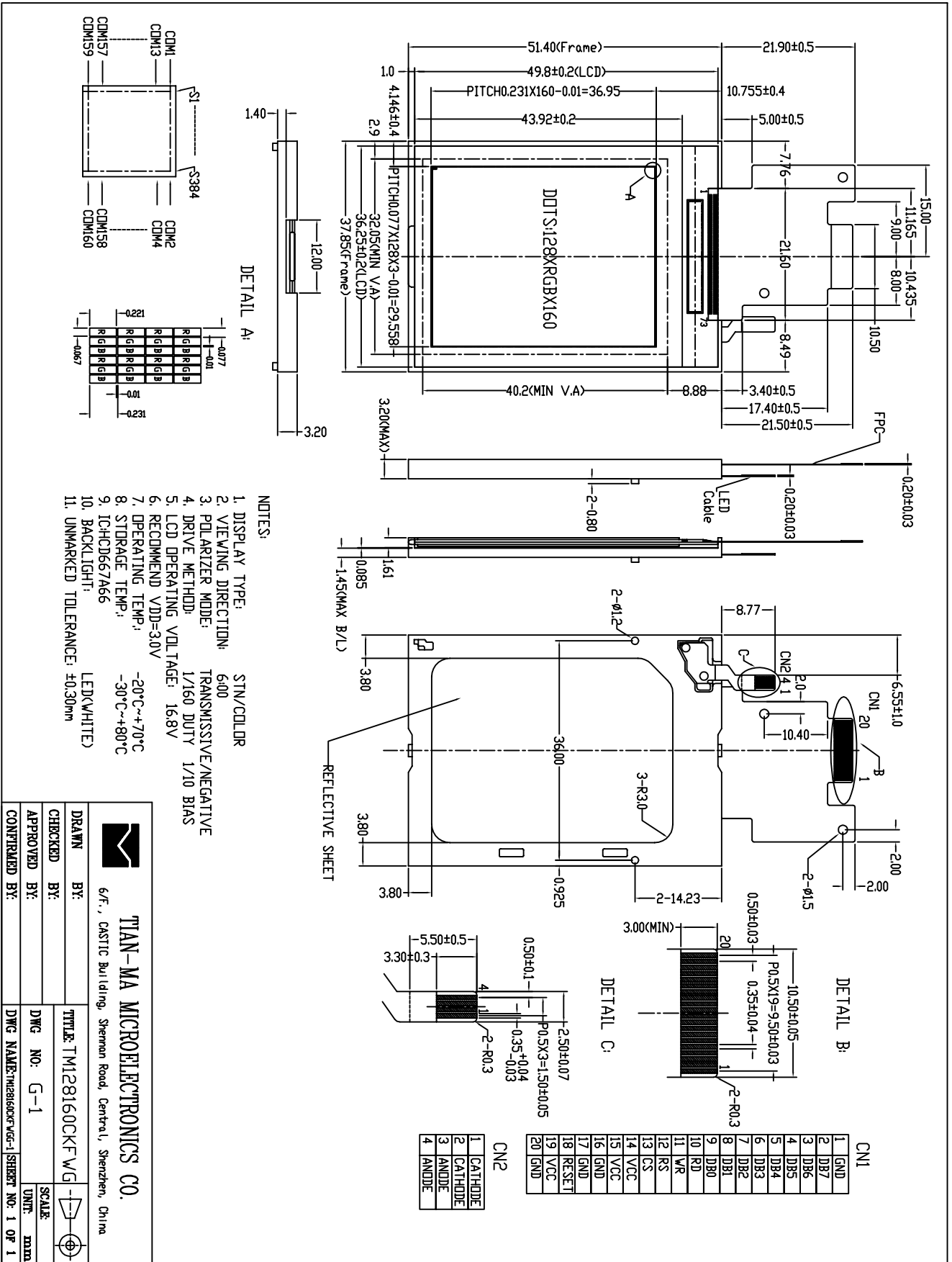
- 1.1 Display type: COLOR STN
- 1.2 Display color\*<sup>1</sup>:
  - Display color: 65K COLOR
  - Background\*<sup>2</sup>: Black (Red, Green, Blue dots are off state)
- 1.3 Polarizer mode: Transmissive/Negative
- 1.4 Viewing Angle: 6:00
- 1.5 Driving Method: 1/160 Duty 1/10 Bias
- 1.6 Backlight Type: LED (3 LAMPS)
  - Backlight Color: WHITE
- 1.7 Controller: HCD667A66
- 1.8 Data Transfer: 8 Bit Parallel
- 1.9 Operating Temperature: -20----+70
  - Storage Temperature: -30----+80
- 1.10 Power Supply Voltage: VDD=3.0V
- 1.11 LCD Operating Voltage: VLCD=16.8V
- 1.12 Outline Dimensions: Refer to outline drawing on next page
- 1.13 Dot Matrix: 128 X 3 (RGB) X 160 Dots
- 1.14 Dot Size: 0.221(R+G+B) × 0.221(mm<sup>2</sup>)
- 1.15 Dot Pitch: 0.231 × 0.231 (mm<sup>2</sup>)
- 1.16 Weight: TBD\*<sup>3</sup>

\*<sup>1</sup> Color tone is slightly changed by temperature and driving voltage.

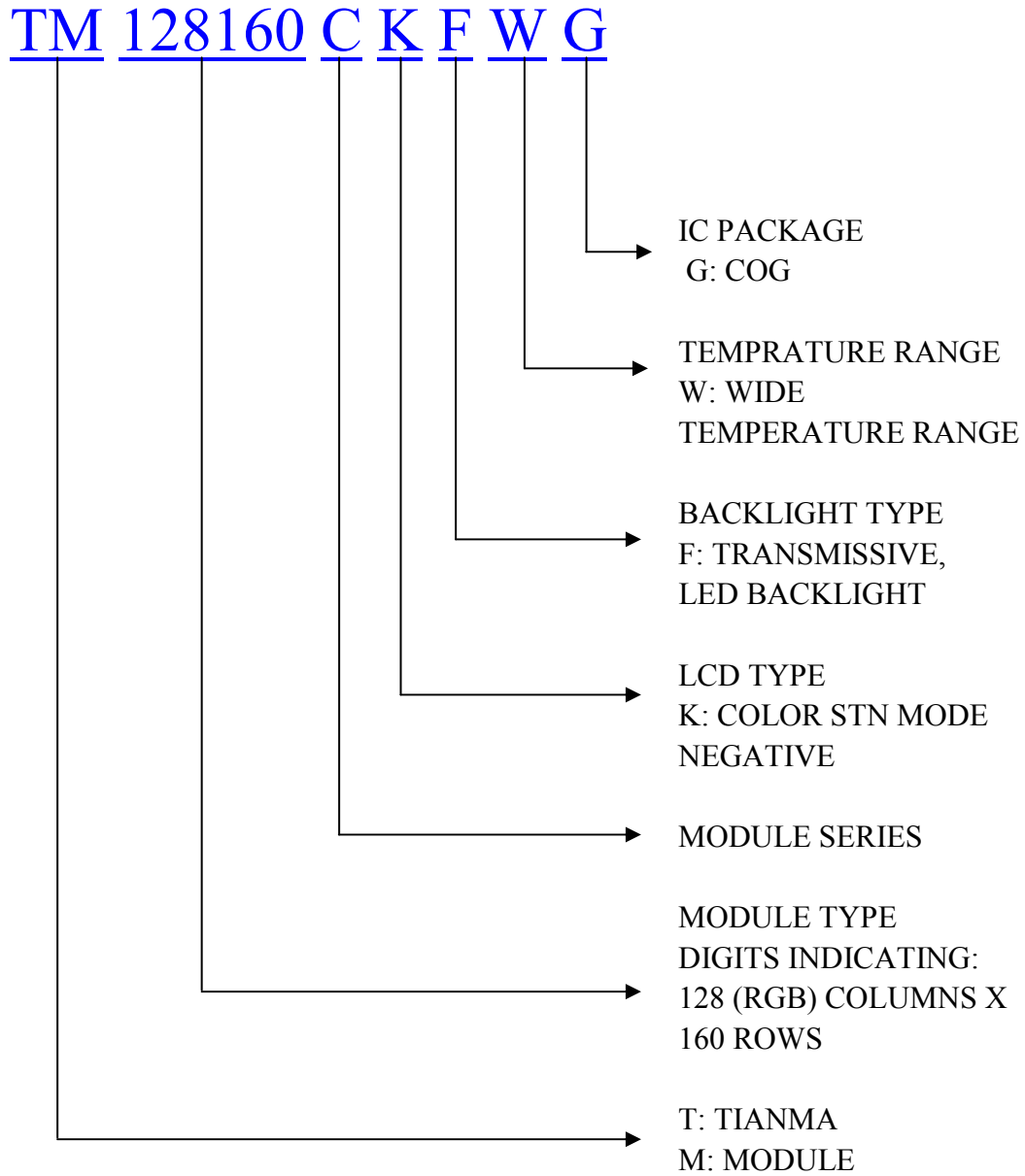
\*<sup>2</sup> Color tone will be changed by backlight.

\*<sup>3</sup> TBD: To Be Determined.

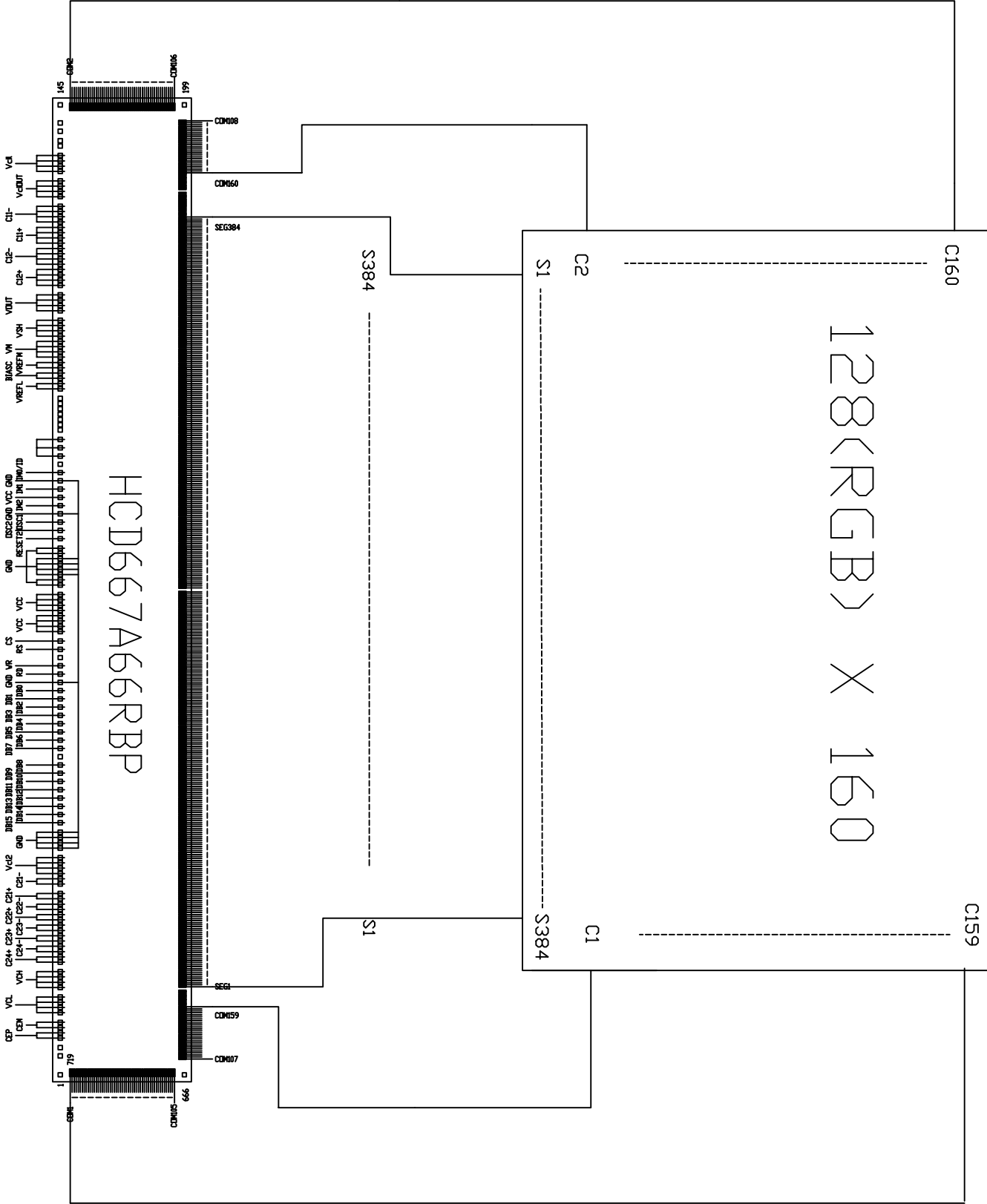
## 2. Outline Drawing



### 3. LCD Module Part Numbering System



# 4. Circuit Block Diagram



## 5. Absolute Maximum Ratings

Ta=25

| Item                        | Symbol                            | Min. | Max.  | Unit | Remark             |
|-----------------------------|-----------------------------------|------|-------|------|--------------------|
| Power Supply Voltage        | V <sub>DD</sub> - V <sub>SS</sub> | -0.3 | +4.6  | V    |                    |
| LCD Driving Voltage         | V <sub>LCD</sub>                  | -0.3 | +20.0 |      |                    |
| Operating Temperature Range | T <sub>OP</sub>                   | -20  | +70   |      | No<br>Condensation |
| Storage Temperature Range   | T <sub>ST</sub>                   | -30  | +80   |      |                    |

## 6. Electrical Specifications and Instruction Code

### 6.1 Electrical characteristics

$V_{SS}=0V$ ,  $T_a=25$

| Item                          | Symbol                               | Min.        | Typ. | Max.         | Unit |
|-------------------------------|--------------------------------------|-------------|------|--------------|------|
| Supply Voltage<br>(Logic)     | $V_{DD}-V_{SS}$                      | +2.91       | +3.0 | +3.09        | V    |
| Supply Voltage<br>(LCD Drive) | $V_{LCD}$                            | -           | 16.8 | -            | V    |
| Input<br>Signal<br>Voltage    | High<br>$V_{IH}$<br>( $V_{DD}=3.0$ ) | $0.8V_{DD}$ | -    | $V_{DD}$     | V    |
|                               | Low<br>$V_{IL}$<br>( $V_{DD}=3.0$ )  | 0           | -    | $0.2 V_{DD}$ | V    |
| Supply current<br>(Logic)     | $I_{DD}$<br>( $V_{DD}-V_{SS}=3.0V$ ) | -           | -    | 2.5          | mA   |
| Operating current             | $I_{op}$                             | -           | -    | 60           | mA   |
| Oscillator<br>frequency range | $f_{osc}$                            | 220         | -    | 330          | KHz  |
| Supply Voltage<br>(LED)       | $V_{LED}$                            | -           | 9.9  | -            | V    |
| Supply current<br>(LED)       | $I_{LED}$                            |             | 15.0 | 20.0         | mA   |



## 6.2 Interface Signals

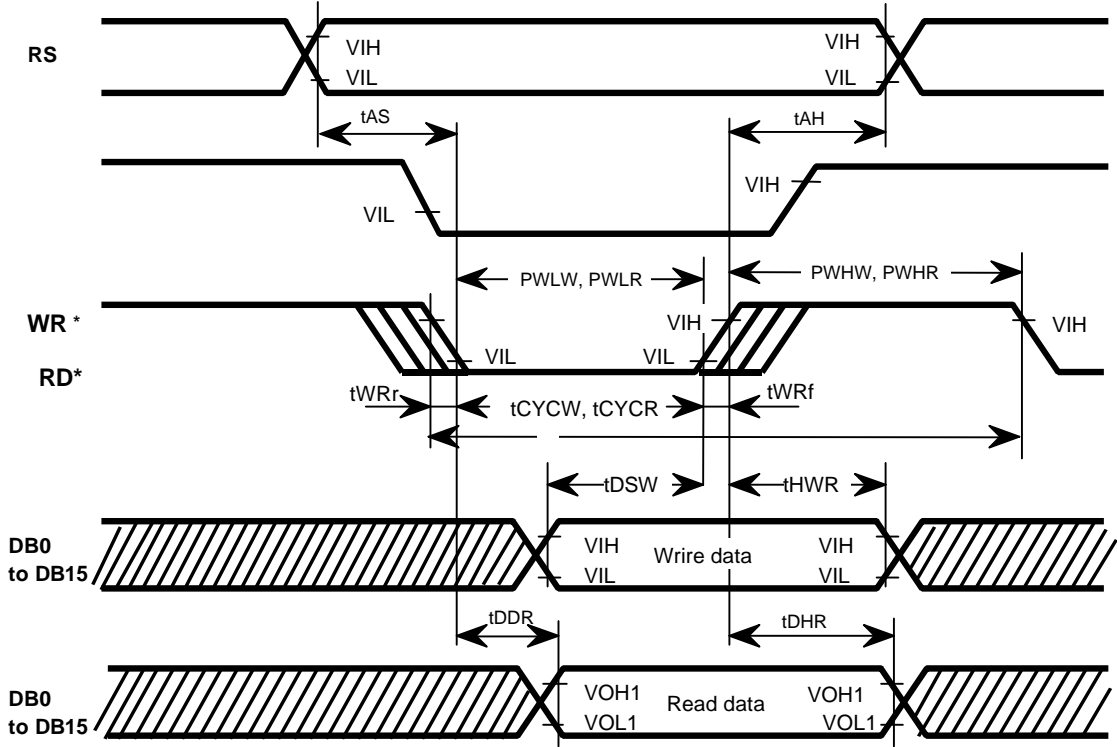
### 6.2.1 CN1

| Pin No. | Symbol | Level | Description                                      |
|---------|--------|-------|--|
| 1       | GND    | 0V    | Ground   |
| 2       | DB7    | H/L   | Data bus bit 7                                   |
| 3       | DB6    | H/L   | Data bus bit 6                                   |
| 4       | DB5    | H/L   | Data bus bit 5                                   |
| 5       | DB4    | H/L   | Data bus bit 4                                   |
| 6       | DB3    | H/L   | Data bus bit 3                                   |
| 7       | DB2    | H/L   | Data bus bit 2                                   |
| 8       | DB1    | H/L   | Data bus bit 1                                   |
| 9       | DB0    | H/L   | Data bus bit 0                                   |
| 10      | RD     | H/L   | Signal to select data read operation(80-system)  |
| 11      | WR     | H/L   | Signal to select data write operation(80-system) |
| 12      | RS     | H/L   | Index register / Data command select             |
| 13      | CS     | H/L   | Chip select: Low active                          |
| 14      | VCC    | 3.0V  | Logic circuit power supply                       |
| 15      | VCC    | 3.0V  | Logic circuit power supply                       |
| 16      | GND    | 0V    | Ground   |
| 17      | GND    | 0V    | Ground   |
| 18      | RESET  | H/L   | Reset pin: Low active                            |
| 19      | VCC    | 3.0V  | Logic circuit power supply                       |
| 20      | GND    | 0V    | Ground   |

### 6.2.2 CN2

| Pin No. | Symbol  | Level | Description |
|---------|---------|-------|-------------|
| 1, 2    | CATHODE | 0V    | LED CATHODE |
| 3, 4    | ANODE   | 9.9V  | LED ANODE   |

### 6.3 Interface Timing Chart



## 80-system Bus Interface Timing Characteristics

### Normal Write Mode (HWM=0) (Vcc = 2.2 to 2.4 V)

| Item                              |       | Symbol         | Unit | Test Condition | Min | Typ | Max |
|-----------------------------------|-------|----------------|------|----------------|-----|-----|-----|
| Bus cycle time                    | Write | $t_{CYCW}$     | ns   | Figure 2       | 600 | —   | —   |
|                                   | Read  | $t_{CYCR}$     | ns   | Figure 2       | 800 | —   | —   |
| Write low-level pulse width       |       | $PW_{LW}$      | ns   | Figure 2       | 90  | —   | —   |
| Read low-level pulse width        |       | $PW_{LR}$      | ns   | Figure 2       | 350 | —   | —   |
| Write high-level pulse width      |       | $PW_{HW}$      | ns   | Figure 2       | 300 | —   | —   |
| Read high-level pulse width       |       | $PW_{HR}$      | ns   | Figure 2       | 400 | —   | —   |
| Write/Read rise/fall time         |       | $t_{WRr, WRf}$ | ns   | Figure 2       | —   | —   | 25  |
| Set up time (RS to CS*, WR*, RD*) |       | $t_{AS}$       | ns   | Figure 2       | 10  | —   | —   |
| Address hold time                 |       | $t_{AH}$       | ns   | Figure 2       | 5   | —   | —   |
| Write data setup time             |       | $t_{DSW}$      | ns   | Figure 2       | 60  | —   | —   |
| Write data hold time              |       | $t_H$          | ns   | Figure 2       | 15  | —   | —   |
| Read data delay time              |       | $t_{DDR}$      | ns   | Figure 2       | —   | —   | 200 |
| Read data hold time               |       | $t_{DHR}$      | ns   | Figure 2       | 5   | —   | —   |

### High-Speed Write Mode (HWM=1) (Vcc = 2.2 to 2.4V)

| Item                              |       | Symbol         | Unit | Test Condition | Min | Typ | Max |
|-----------------------------------|-------|----------------|------|----------------|-----|-----|-----|
| Bus cycle time                    | Write | $t_{CYCW}$     | ns   | Figure 2       | 200 | —   | —   |
|                                   | Read  | $t_{CYCR}$     | ns   | Figure 2       | 800 | —   | —   |
| Write low-level pulse width       |       | $PW_{Lw}$      | ns   | Figure 2       | 90  | —   | —   |
| Read low-level pulse width        |       | $PW_{LR}$      | ns   | Figure 2       | 350 | —   | —   |
| Write high -level pulse width     |       | $PW_{HW}$      | ns   | Figure 2       | 90  | —   | —   |
| Read high -level pulse width      |       | $PW_{HR}$      | ns   | Figure 2       | 400 | —   | —   |
| Write/Read rise/fall time         |       | $t_{WRr, WRf}$ | ns   | Figure 2       | —   | —   | —   |
| Set up time (RS to CS*, WR*, RD*) |       | $t_{AS}$       | ns   | Figure 2       | 10  | —   | —   |
| Address hold time                 |       | $t_{AH}$       | ns   | Figure 2       | 5   | —   | —   |
| Write data set up time            |       | $t_{DSW}$      | ns   | Figure 2       | 60  | —   | —   |
| Write data hold time              |       | $t_H$          | ns   | Figure 2       | 15  | —   | —   |
| Read data delay time              |       | $t_{DDR}$      | ns   | Figure 2       | —   | —   | —   |
| Read data hold time               |       | $t_{DHR}$      | ns   | Figure 2       | 5   | —   | —   |

**Normal Write Mode (HWM=0) (Vcc = 2.4 to 3.6 V)**

**Table 50**

| Item                              |       | Symbol         | Unit | Test Condition | Min | Typ | Max |
|-----------------------------------|-------|----------------|------|----------------|-----|-----|-----|
| Bus cycle time                    | Write | $t_{CYCW}$     | ns   | Figure 2       | 200 | —   | —   |
|                                   | Read  | $t_{CYCR}$     | ns   | Figure 2       | 300 | —   | —   |
| Write low-level pulse width       |       | $PW_{Lw}$      | ns   | Figure 2       | 40  | —   | —   |
| Read low-level pulse width        |       | $PW_{LR}$      | ns   | Figure 2       | 150 | —   | —   |
| Write high -level pulse width     |       | $PW_{HW}$      | ns   | Figure 2       | 100 | —   | —   |
| Read high -level pulse width      |       | $PW_{HR}$      | ns   | Figure 2       | 100 | —   | —   |
| Write/Read rise/fall time         |       | $t_{WRr}, WRf$ | ns   | Figure 2       | —   | —   | 25  |
| Set up time (RS to CS*, WR*, RD*) |       | $t_{AS}$       | ns   | Figure 2       | 10  | —   | —   |
| Address hold time                 |       | $t_{AH}$       | ns   | Figure 2       | 2   | —   | —   |
| Write data set up time            |       | $t_{DSW}$      | ns   | Figure 2       | 60  | —   | —   |
| Write data hold time              |       | $t_H$          | ns   | Figure 2       | 2   | —   | —   |
| Read data delay time              |       | $t_{DDR}$      | ns   | Figure 2       | —   | —   | 200 |
| Read data hold time               |       | $t_{DHR}$      | ns   | Figure 2       | 5   | —   | —   |

**High-Speed Write Mode (HWM=1) (Vcc = 2.4 to 3.6 V)**

| Item                              |       | Symbol         | Unit | Test Condition | Min | Typ | Max |
|-----------------------------------|-------|----------------|------|----------------|-----|-----|-----|
| Bus cycle time                    | Write | $t_{CYCW}$     | ns   | Figure 2       | 100 | —   | —   |
|                                   | Read  | $t_{CYCR}$     | ns   | Figure 2       | 300 | —   | —   |
| Write low-level pulse width       |       | $PW_{Lw}$      | ns   | Figure 2       | 40  | —   | —   |
| Read low-level pulse width        |       | $PW_{LR}$      | ns   | Figure 2       | 150 | —   | —   |
| Write high -level pulse width     |       | $PW_{HW}$      | ns   | Figure 2       | 40  | —   | —   |
| Read high -level pulse width      |       | $PW_{HR}$      | ns   | Figure 2       | 100 | —   | —   |
| Write/Read rise/fall time         |       | $t_{WRr}, WRf$ | ns   | Figure 2       | —   | —   | 25  |
| Set up time (RS to CS*, WR*, RD*) |       | $t_{AS}$       | ns   | Figure 2       | 10  | —   | —   |
| Address hold time                 |       | $t_{AH}$       | ns   | Figure 2       | 2   | —   | —   |
| Write data set up time            |       | $t_{DSW}$      | ns   | Figure 2       | 60  | —   | —   |
| Write data hold time              |       | $t_H$          | ns   | Figure 2       | 2   | —   | —   |
| Read data delay time              |       | $t_{DDR}$      | ns   | Figure 2       | —   | —   | 100 |
| Read data hold time               |       | $t_{DHR}$      | ns   | Figure 2       | 5   | —   | —   |

# 6.4 Instruction code

## Instruction List

| Reg. No. | Register Name                           | R/W | RS | Upper Code |      |      |      |      |      |      |      | Lower Code |      |      |      |      |      |      |      | Description   | Execution Cycle              |       |       |
|----------|---|-----|----|------------|------|------|------|------|------|------|------|------------|------|------|------|------|------|------|------|---|------------------------------|-------|-------|
|          |   |     |    | DB15       | DB14 | DB13 | DB12 | DB11 | DB10 | DB9  | DB8  | DB7        | DB6  | DB5  | DB4  | DB3  | DB2  | DB1  | DB0  |   |                              |       |       |
| IR       | Index                                   | 0   | 0  | *          | *    | *    | *    | *    | *    | *    | *    | *          | ID6  | ID5  | ID4  | ID3  | ID2  | ID1  | ID0  | Sets the index register value.  | 0                            | Note1 |       |
| SR       | Status read                             | 1   | 0  | L7         | L6   | L5   | L4   | L3   | L2   | L1   | L0   | 0          | C6   | C5   | C4   | C3   | C2   | C1   | C0   | Reads the driving raster-row position (L7-0) and contrast setting (C6-0).   | 0                            |       |       |
| R00h     | Start oscillation                       | 0   | 1  | *          | *    | *    | *    | *    | *    | *    | *    | *          | *    | *    | *    | *    | *    | *    | *    | 1   | Starts the oscillation mode. | 10 ms | Note1 |
|          | Device code read                        | 1   | 1  | 0          | 0    | 0    | 0    | 0    | 1    | 1    | 1    | 0          | 1    | 1    | 0    | 0    | 1    | 1    | 0    | Reads 0766H.  | 0                            |       |       |
| R01h     | Driver output control                   | 0   | 1  | 0          | 0    | 0    | 0    | 0    | 0    | CM   | SGS  | 0          | 0    | 0    | NL4  | NL3  | NL2  | NL1  | NL0  | Sets the common driver shift direction (CMS), segment driver shift direction (SGS) and driving duty ratio (NL4-0).  | 0                            |       |       |
| R02h     | LCD-driving-waveform control            | 0   | 1  | 0          | 0    | 0    | 0    | 0    | RST  | B/C  | EOR  | 0          | 0    | NW   | NW   | NW   | NW   | NW   | 0    | Sets LCD drive AC waveform (B/C), and EOR output (EOR) or the number of n-raster-rows (NW5-0) at C-pattern AC drive.  | 0                            |       |       |
| R03h     | Power control 1                         | 0   | 1  | BS3        | BS2  | BS1  | BS0  | BT3  | BT2  | BT1  | BT0  | 0          | DC2  | DC1  | DC0  | AP1  | AP0  | SLP  | STB  | Sets the sleep mode (SLP), standby mode (STB), LCD power on (AP1-0), boosting cycle (DC2-0), boosting output multiplying factor (BT2-0), operation of voltage inverting circuit (BT3) and LCD drive bias value (BS3-0). | 0                            |       |       |
| R04h     | Contrast control                        | 0   | 1  | 0          | 0    | 0    | 0    | 0    | VR2  | VR1  | VR0  | 0          | CT6  | CT5  | CT4  | CT3  | CT2  | CT1  | CT0  | Sets the regulator adjustment (VR2-0) and contrast adjustment (CT6-0).  | 0                            |       |       |
| R05h     | Entry mode                              | 0   | 1  | SPR        | 0    | 0    | 0    | 0    | 0    | HWM  | 0    | 0          | 0    | I/D1 | I/D0 | AM   | LG2  | LG1  | LG0  | Specifies AC counter mode (AM), increment/decrement mode (I/D1-0), high-speed write mode (HWM).   | 0                            | Note2 |       |
| R06h     | Compare Resister                        | 0   | 1  | CP15       | CP14 | CP13 | CP12 | CP11 | CP10 | CP9  | CP8  | CP7        | CP6  | CP5  | CP4  | CP3  | CP2  | CP1  | CP0  | Specifies the compare resister (CP15-0).  | 0                            |       |       |
| R07h     | Display control                         | 0   | 1  | 0          | 0    | 0    | 0    | 0    | VLE2 | VLE1 | SPT  | 0          | 0    | 0    | 0    | B/W  | REV  | D1   | D0   | Specifies display on (D1-0), black-and-white reversed display (REV), pixel on/off mode (ALB), screen division driving (SPT) and vertical scroll (VLE2-1).   | 0                            |       |       |
| R08h     | Frame frequency control                 | 0   | 1  | 0          | 0    | 0    | 0    | 0    | 0    | DIV1 | DIV0 | 0          | 0    | 0    | 0    | RTN3 | RTN2 | RTN1 | RTN0 | Specifies the line retrace period (RTN3-0) and operating clock frequency division ratio (DIV1-0).   | 0                            |       |       |
| R0Ch     | Power control 2                         | 0   | 1  | 0          | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0          | 0    | 0    | 0    | 0    | VC2  | VC1  | VC0  | Sets the adjustment factor for the Vci voltage (VC2-0).   | 0                            |       |       |
| R11h     | Vertical scroll control                 | 0   | 1  | VL27       | VL26 | VL25 | VL24 | VL23 | VL22 | VL21 | VL20 | VL17       | VL16 | VL15 | VL14 | VL13 | VL12 | VL11 | VL10 | Sets the 1 <sup>st</sup> screen display start raster-row (VL17-10) and 2 <sup>nd</sup> screen display start raster-row (VL27-20).   | 0                            |       |       |
| R14h     | 1 <sup>st</sup> screen driving position | 0   | 1  | SE17       | SE16 | SE15 | SE14 | SE13 | SE12 | SE11 | SE10 | SE17       | SE16 | SE15 | SE14 | SE13 | SE12 | SE11 | SE10 | Sets the 1 <sup>st</sup> screen driving start position (SS17-10) and 1 <sup>st</sup> screen driving end position (SE17-10).   | 0                            |       |       |
| R15h     | 2 <sup>nd</sup> screen driving position | 0   | 1  | SE27       | SE26 | SE25 | SE24 | SE23 | SE22 | SE21 | SE20 | SE27       | SE26 | SE25 | SE24 | SE23 | SE22 | SE21 | SE20 | Sets 2 <sup>nd</sup> screen driving start position (SS27-20) and 2 <sup>nd</sup> screen driving end position (SE27-20).   | 0                            |       |       |
| R16h     | Horizontal RAM address position         | 0   | 1  | HEA7       | HEA6 | HEA5 | HEA4 | HEA3 | HEA2 | HEA1 | HEA0 | HSA7       | HSA6 | HSA5 | HSA4 | HSA3 | HSA2 | HSA1 | HSA0 | Sets start (HSA7-0) and end (HEA7-0) of the horizontal RAM address range.   | 0                            |       |       |
| R17h     | Vertical RAM address position           | 0   | 1  | VEA7       | VEA6 | VEA5 | VEA4 | VEA3 | VEA2 | VEA1 | VEA0 | VSA7       | VSA6 | VSA5 | VSA4 | VSA3 | VSA2 | VSA1 | VSA0 | Sets start (VSA7-0) and end (VEA7-0) of the vertical RAM address range.   | 0                            |       |       |
| R20h     | RAM write data mask                     | 0   | 1  | WM15       | WM14 | WM13 | WM12 | WM11 | WM10 | WM9  | WM8  | WM7        | WM6  | WM5  | WM4  | WM3  | WM2  | WM1  | WM0  | Specifies write data mask (WM15-0) at RAM write.  | 0                            |       |       |

## Instruction List (cont.)

| Reg. No. | Register Name                  | R/W | RS | Upper Code |       |        |        |        |        |        |        | Lower Code |      |        |        |        |        |        |                    | Description                      | Execution Cycle |  |  |  |  |  |  |  |  |  |  |                    |  |   |
|----------|--------------------------------|-----|----|------------|-------|--------|--------|--------|--------|--------|--------|------------|------|--------|--------|--------|--------|--------|--------------------|----------------------------------|-----------------|--|--|--|--|--|--|--|--|--|--|--------------------|--|---|
|          |                                |     |    | DB 15      | DB 14 | DB 13  | DB 12  | DB 11  | DB 10  | DB 9   | DB 8   | DB 7       | DB 6 | DB 5   | DB 4   | DB 3   | DB 2   | DB 1   | DB 0               |                                  |                 |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R21h     | RAM address set                | 0   | 1  |            |       |        |        |        |        |        |        |            |      |        |        |        |        |        | AD15–8 (upper)     |                                  |                 |  |  |  |  |  |  |  |  |  |  | AD6–0 (lower)      | Initially set the RAM address to the address counter (AC). | 0 |
| R22      | RAM data write                 | 0   | 1  |            |       |        |        |        |        |        |        |            |      |        |        |        |        |        | Write data (upper) |                                  |                 |  |  |  |  |  |  |  |  |  |  | Write data (lower) | Writes data to the RAM.                                    | 0 |
|          | RAM data read                  | 1   | 1  |            |       |        |        |        |        |        |        |            |      |        |        |        |        |        | Read data (upper)  |                                  |                 |  |  |  |  |  |  |  |  |  |  | Read data (lower)  | Reads data from the RAM.                                   | 0 |
| R30h     | Grayscale palette control (1)  | 0   | 1  | 0          | 0     | PK15   | PK14   | PK13   | PK12   | PK11   | PK10   | 0          | 0    | PK05   | PK04   | PK03   | PK02   | PK01   | PK00               | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R31h     | Grayscale palette control (2)  | 0   | 1  | 0          | 0     | PK35   | PK34   | PK33   | PK32   | PK31   | PK30   | 0          | 0    | PK25   | PK24   | PK23   | PK22   | PK21   | PK20               | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R32h     | Grayscale palette control (3)  | 0   | 1  | 0          | 0     | PK55   | PK54   | PK53   | PK52   | PK51   | PK50   | 0          | 0    | PK45   | PK44   | PK43   | PK42   | PK41   | PK40               | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R33h     | Grayscale palette control (4)  | 0   | 1  | 0          | 0     | PK75   | PK74   | PK73   | PK72   | PK71   | PK70   | 0          | 0    | PK65   | PK64   | PK63   | PK62   | PK61   | PK60               | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R34h     | Grayscale palette control (5)  | 0   | 1  | 0          | 0     | PK95   | PK94   | PK93   | PK92   | PK91   | PK90   | 0          | 0    | PK85   | PK84   | PK83   | PK82   | PK81   | PK80               | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R35h     | Grayscale palette control (6)  | 0   | 1  | 0          | 0     | PK 115 | PK 114 | PK 113 | PK 112 | PK 111 | PK 110 | 0          | 0    | PK 105 | PK 104 | PK 103 | PK 102 | PK 101 | PK 100             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R36h     | Grayscale palette control (7)  | 0   | 1  | 0          | 0     | PK 135 | PK 134 | PK 133 | PK 132 | PK 131 | PK 130 | 0          | 0    | PK 125 | PK 124 | PK 123 | PK 122 | PK 121 | PK 120             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R37h     | Grayscale palette control (8)  | 0   | 1  | 0          | 0     | PK 155 | PK 154 | PK 153 | PK 152 | PK 151 | PK 150 | 0          | 0    | PK 145 | PK 144 | PK 143 | PK 142 | PK 141 | PK 140             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R38h     | Grayscale palette control (9)  | 0   | 1  | 0          | 0     | PK 175 | PK 174 | PK 173 | PK 172 | PK 171 | PK 170 | 0          | 0    | PK 165 | PK 164 | PK 163 | PK 162 | PK 161 | PK 160             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R39h     | Grayscale palette control (10) | 0   | 1  | 0          | 0     | PK 195 | PK 194 | PK 193 | PK 192 | PK 191 | PK 190 | 0          | 0    | PK 185 | PK 184 | PK 183 | PK 182 | PK 181 | PK 180             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R3Ah     | Grayscale palette control (11) | 0   | 1  | 0          | 0     | PK 215 | PK 214 | PK 213 | PK 212 | PK 211 | PK 210 | 0          | 0    | PK 205 | PK 204 | PK 203 | PK 202 | PK 201 | PK 200             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R3Bh     | Grayscale palette control (12) | 0   | 1  | 0          | 0     | PK 235 | PK 234 | PK 233 | PK 232 | PK 231 | PK 230 | 0          | 0    | PK 225 | PK 224 | PK 223 | PK 222 | PK 221 | PK 220             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R3Ch     | Grayscale palette control (13) | 0   | 1  | 0          | 0     | PK 255 | PK 254 | PK 253 | PK 252 | PK 251 | PK 250 | 0          | 0    | PK 245 | PK 244 | PK 243 | PK 242 | PK 241 | PK 240             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R3Dh     | Grayscale palette control (14) | 0   | 1  | 0          | 0     | PK 275 | PK 274 | PK 273 | PK 272 | PK 271 | PK 270 | 0          | 0    | PK 265 | PK 264 | PK 263 | PK 262 | PK 261 | PK 260             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R3Eh     | Grayscale palette control (15) | 0   | 1  | 0          | 0     | PK 295 | PK 294 | PK 293 | PK 292 | PK 291 | PK 290 | 0          | 0    | PK 285 | PK 284 | PK 283 | PK 282 | PK 281 | PK 280             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |
| R3Fh     | Grayscale palette control (16) | 0   | 1  | 0          | 0     | PK 315 | PK 314 | PK 313 | PK 312 | PK 311 | PK 310 | 0          | 0    | PK 305 | PK 304 | PK 303 | PK 302 | PK 301 | PK 300             | Specifies the grayscale palette. | 0               |  |  |  |  |  |  |  |  |  |  |                    |  |   |

- Note:
1. “\*” means doesn’t matter.
  2. High-speed write mode is available only for the RAM writing.

## 7. Optical Characteristics

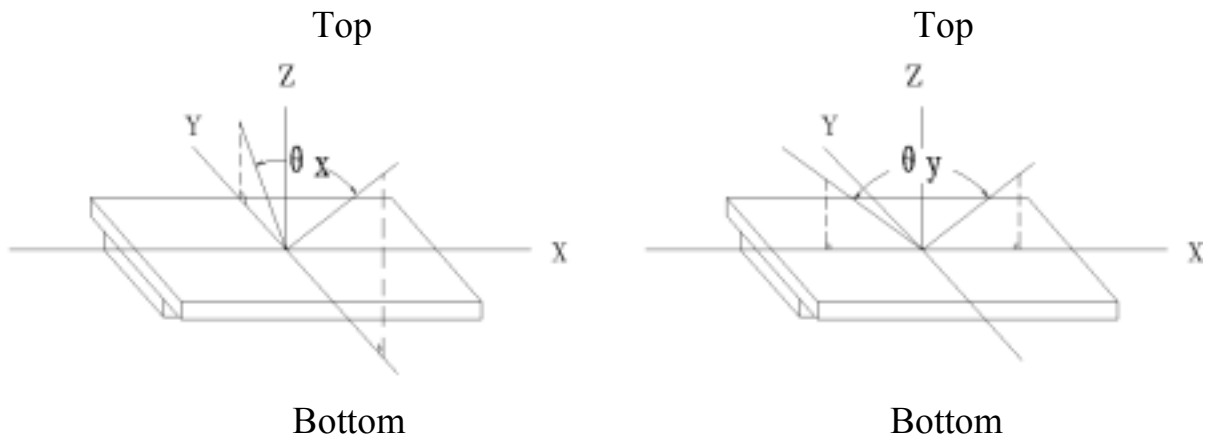
### 7.1 Optical Characteristics

V<sub>LCD</sub>=16.8V Ta=25

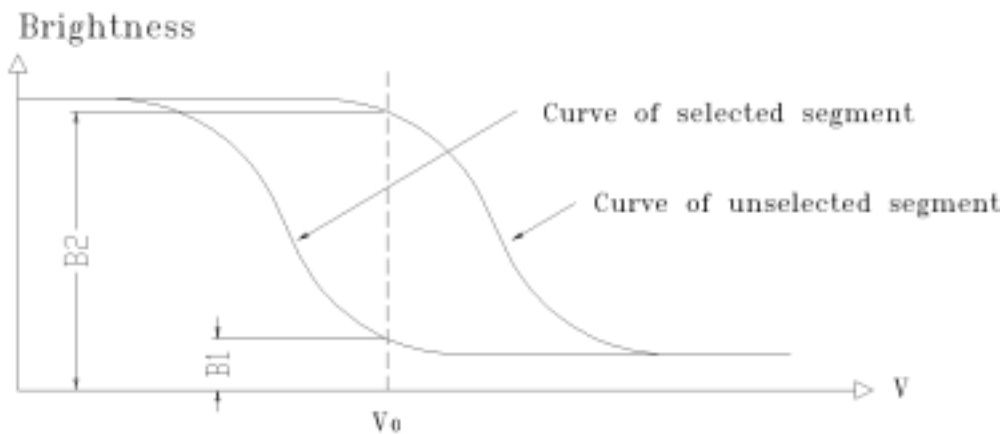
| Item                     |          | Symbol | Condition      | Min.  | Typ.       | Max. | Unit              |
|--------------------------|----------|--------|----------------|-------|------------|------|-------------------|
| Viewing Angle            |          | x      | Cr≥2           | y=0 ° | -40 -- +35 |      | Deg               |
|                          |          | y      |                | x=0 ° | -30 -- +30 |      |                   |
| Contrast Ratio           |          | Cr     | x=0 °<br>y=0 ° | 15    | -          | -    |                   |
| Response Time            | Turn on  | Ton    | x=0 °<br>y=0 ° | -     | -          | 200  | ms                |
|                          | Turn off | Toff   |                | -     | -          | 200  |                   |
| Color Of CIE Coord-Inate | Red      | Y      | x=0 °<br>y=0 ° | -     | TBD        | -    | cd/m <sup>2</sup> |
|                          |          | x      |                | -     | TBD        | -    |                   |
|                          |          | y      |                | -     | TBD        | -    |                   |
|                          | Green    | Y      | x=0 °<br>y=0 ° | -     | TBD        | -    | cd/m <sup>2</sup> |
|                          |          | x      |                | -     | TBD        | -    |                   |
|                          |          | y      |                | -     | TBD        | -    |                   |
|                          | Blue     | Y      | x=0 °<br>y=0 ° | -     | TBD        | -    | cd/m <sup>2</sup> |
|                          |          | x      |                | -     | TBD        | -    |                   |
|                          |          | y      |                | -     | TBD        | -    |                   |

## 7.2 Definition of Optical Characteristics

### 7.2.1 Definition of Viewing Angle



### 7.2.2 Definition of Contrast Ratio

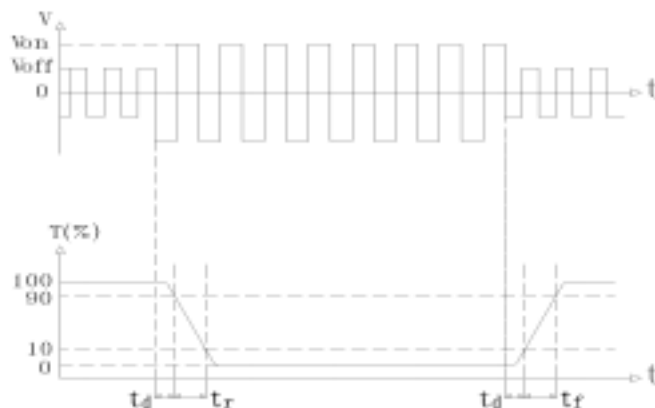


$$\text{Contrast Ratio} = B2/B1 = \frac{\text{unselected state brightness}}{\text{selected state brightness}}$$

Measuring Conditions:

- 1) Ambient Temperature: 25 ; 2) Frame frequency: 70.0Hz

### 7.2.3 Definition of Response time



Turn on time:  $t_{on} = t_d + t_r$       Turn off time:  $t_{off} = t_d + t_r$

Measuring Condition:

- 1) Operating Voltage: 16.8V    2) Frame frequency: 70.0Hz



### 7.3 Brightness Characteristic

| Item       | Symbol | Condition | Min. | Typ. | Max. | Unit              |
|------------|--------|-----------|------|------|------|-------------------|
| Brightness | Bp     | Ta=25 ±3  | 65   | -    | -    | cd/m <sup>2</sup> |
| Uniformity | Bp     | 30-80%RH  | -    | -    | 60   | %                 |

Note:

1. The data is measured after CCFLs are turned on for 5 minutes.
2. Testing conditions    CCFL: V<sub>CF</sub> = 270 V (AC)  
                                  LCD: All dots are on (White color)
3. Brightness in the center of the LCD panel.
4. Definition of Uniformity ( Bp)  
        $Bp = Bp (\text{Min.}) / Bp (\text{Max.}) \times 100 (\%)$   
       Bp (Max.) = Maximum brightness in 9 measurement spots  
       Bp (Min.) = Minimum brightness in 9 measurement spots

## 8. Reliability

### 8.1 Content of Reliability Test

Ta=25

| No. | Test Item                          | Content of Test  | Test condition                                    |
|-----|------------------------------------|--|---|
| 1   | High Temperature Storage           | Endurance test applying the high storage temperature for a long time   | 80 ±2 240H<br>Restore 4H at 25                    |
| 2   | Low Temperature Storage            | Endurance test applying the low storage temperature for a long time  | -30 ±2 240H<br>Restore 4H at 25                   |
| 3   | High Temperature /Humidity Storage | Endurance test applying the high temperature and high humidity storage for a long time                         | 70 ±2 90%RH<br>240H<br>Restore 4H at 25           |
| 4   | Temperature Cycle                  | Endurance test applying the low and high temperature cycle<br>-30 25 80 25<br>30min 5min 30min 5min<br>1 cycle | -30 /80<br>10 cycles<br>Restore 4H at 25          |
| 5   | Vibration Test (package state)     | Endurance test applying the vibration during transportation  | 10Hz~150Hz,<br>100m/s <sup>2</sup> ,<br>120min    |
| 6   | Shock Test (package state)         | Endurance test applying the shock during transportation  | Half- sine wave,<br>300m/s <sup>2</sup> ,<br>18ms |
| 7   | Atmospheric Pressure Test          | Endurance test applying the atmospheric pressure during transportation by air                                  | 25kPa 16H<br>Restore 2H                           |

## 8.2 Failure Judgment Criterion

| Criterion Item           | Test Item No.  |   |   |   |   |   |   |   |   | Failure Judgement Criterion         |
|--------------------------|--|---|---|---|---|---|---|---|---|-------------------------------------|
|                          | 1  | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |                                     |
| Basic Specification      | √  | √ | √ | √ | √ | √ | √ | √ | √ | Out of the basic Specification      |
| Electrical specification | √  | √ | √ | √ | √ |   |   |   |   | Out of the electrical specification |
| Mechanical Specification |  |   |   |   |   |   | √ | √ |   | Out of the mechanical specification |
| Optical Characteristic   | √  | √ | √ | √ | √ | √ |   |   | √ | Out of the optical specification    |
| Note                     | For test item refer to 8.1   |   |   |   |   |   |   |   |   |                                     |
| Remark                   | Basic specification = Optical specification + Mechanical specification |   |   |   |   |   |   |   |   |                                     |

## 9. Quality Level

| Examination or Test   | At $T_a=25$<br>(unless otherwise stated)   | Inspection     |      |      |    |                              |
|---|--|----------------|------|------|----|------------------------------|
|   |  | Min.           | Max. | Unit | IL | AQL                          |
| External Visual Inspection  | Under normal illumination and eyesight condition, the distance between eyes and LCD is 25cm. | See Appendix A |      |      | II | Major<br>1.0<br>Minor<br>2.5 |
| Display Defects   | Under normal illumination and eyesight condition, display on inspection.                     | See Appendix B |      |      | II | Major<br>1.0<br>Minor<br>2.5 |
| Note: Major defects: Open segment or common, Short, Serious damages, Leakage<br>Miner defects: Others<br>Sampling standard conforms to GB2828 |  |                |      |      |    |                              |

## 10. Precautions for Use of LCD Modules

### 10.1 Handling Precautions

10.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

10.1.2 If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.

10.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

10.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

10.1.5 If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:

- Isopropyl alcohol
- Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

- Water
- Ketone
- Aromatic solvents

10.1.6 Do not attempt to disassemble the LCD Module.

10.1.7 If the logic circuit power is off, do not apply the input signals.

10.1.8 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- a. Be sure to ground the body when handling the LCD Modules.
- b. Tools required for assembly, such as soldering irons, must be properly ground.
- c. To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
- d. The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

## 10.2 Storage precautions

10.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

10.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:

Temperature :           0    ~  40



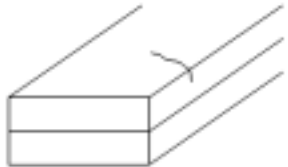
Relatively humidity:   80%

10.2.3 The LCD modules should be stored in the room without acid, alkali and harmful gas.

10.3 The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.

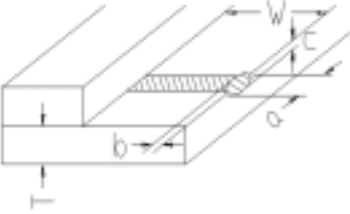
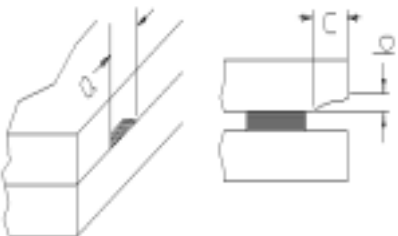
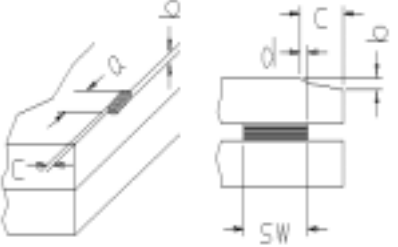
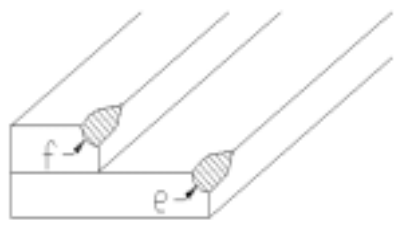
## Appendix A

### Inspection items and criteria for appearance defects

| Items                           | Contents  | Criteria                        |                            |                              |
|---------------------------------|---|---------------------------------|----------------------------|------------------------------|
| Leakage                         |   | Not permitted                   |                            |                              |
| Rainbow                         |   | According to the limit specimen |                            |                              |
| Polarizer                       | Wrong polarizer attachment  | Not permitted                   |                            |                              |
|                                 | Bubble between polarizer and glass  | Not counted                     | Max. 3 defects allowed     |                              |
|                                 |   | $\phi < 0.3\text{mm}$           | 0.3mm $\phi$ 0.5mm         |                              |
| Scratches of polarizer          | According to the limit specimen   |                                 |                            |                              |
| Black spot<br>(in viewing area) |  | Not counted                     | Max. 3 spots allowed       | Max. 3 spots (lines) allowed |
|                                 |   | $X < 0.2\text{mm}$              | 0.2mm X 0.5mm              |                              |
|                                 |   | $X = (a+b)/2$                   |                            |                              |
| Black line<br>(in viewing area) |  | Not counted                     | Max. 3 lines allowed       | Max. 3 spots (lines) allowed |
|                                 |   | $a < 0.02\text{mm}$             | 0.02mm a 0.05mm<br>b 2.0mm |                              |
| Progressive cracks              |  | Not permitted                   |                            |                              |

## Appendix A

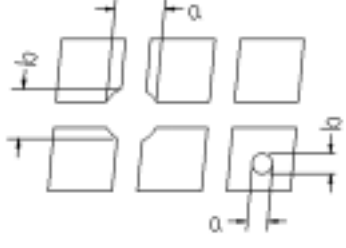
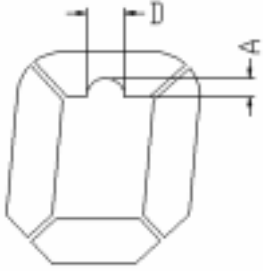
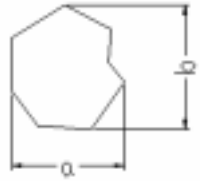
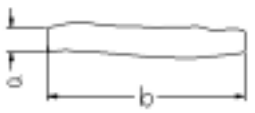
### Inspection item and criteria for appearance defects (continued)

| Items  | Contents  | Criteria                           |               |                       |                       |                       |  |  |  |
|--|---|------------------------------------|---------------|-----------------------|-----------------------|-----------------------|--|--|--|
| Glass Cracks   | Cracks on pads<br>               | a                                  | b             | c                     | Max. 2 cracks allowed | Max. 5 cracks allowed |  |  |  |
|  |   | 3mm                                | W/5           | T/2                   |                       |                       |  |  |  |
|  |   | 2mm                                | W/5           | $T/2 < C < T$         |                       |                       |  |  |  |
|  | Cracks on contact side<br>      | a                                  | b             |                       | Max. 2 cracks allowed |                       |  |  |  |
|  |   | 3mm                                | T/2           |                       |                       |                       |  |  |  |
|  |   | 2mm                                | $T/2 < b < T$ |                       |                       |                       |  |  |  |
|  |   | C shall be not reach the seal area |               |                       |                       |                       |  |  |  |
|  | Cracks on non-contact side<br> | a                                  | b             |                       | Max. 2 cracks allowed |                       |  |  |  |
|  |   | 3mm                                | T/2           |                       |                       |                       |  |  |  |
|  |   | 2mm                                | $T/2 < b < T$ |                       |                       |                       |  |  |  |
|  | C 0.5mm   |                                    |               |                       |                       |                       |  |  |  |
|  | d SW/3  |                                    |               |                       |                       |                       |  |  |  |
| Corner cracks<br> | $e < 2.0\text{mm}^2$<br>$f < 2.0\text{mm}^2$  |                                    |               | Max. 3 cracks allowed |                       |                       |  |  |  |



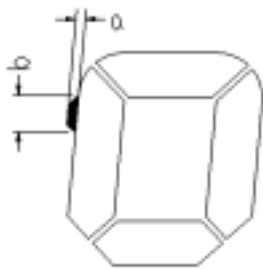
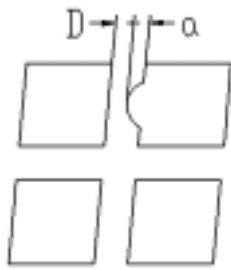
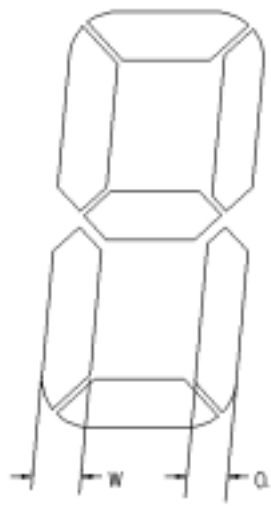
## Appendix B

### Inspection items and criteria for display defects

| Items                                 | Contents  | Criteria                             |                            |  |                             |
|---------------------------------------|---|--------------------------------------|----------------------------|--|-----------------------------|
| Open segment or open common           |   | Not permitted                        |                            |  |                             |
| Short                                 |   | Not permitted                        |                            |  |                             |
| Wrong viewing angle                   |   | Not permitted                        |                            |  |                             |
| Contrast ratio uneven                 |   | According to the limit specimen      |                            |  |                             |
| Crosstalk                             |   | According to the limit specimen      |                            |  |                             |
| Pin holes and cracks in segment (DOT) |   | Not counted                          | Max.3 dots allowed         |  | Max.3 dots allowed          |
|                                       |   | $X < 0.1\text{mm}$                   | 0.1mm X 0.2mm              |  |                             |
|                                       |   | $X = (a+b)/2$                        |                            |  |                             |
|                                       |  | Not counted                          | Max.2 dots allowed         |  |                             |
| $A < 0.1\text{mm}$                    |   | 0.1mm A 0.2mm<br>$D < 0.25\text{mm}$ |                            |  |                             |
| Black spot (in viewing area)          |  | Not counted                          | Max.3 spots allowed        |  | Max.3 spots (lines) allowed |
|                                       |   | $X < 0.1\text{mm}$                   | 0.1mm X 0.2mm              |  |                             |
|                                       |   | $X = (a+b)/2$                        |                            |  |                             |
| Black line (in viewing area)          |  | Not counted                          | Max.3 lines allowed        |  |                             |
|                                       |   | $a < 0.02\text{mm}$                  | 0.02mm a 0.05mm<br>b 0.5mm |  |                             |

## Appendix B

### Inspection items and criteria for display defects (continued)

| Items                     | Content   | Criteria  |                          |                       |  |
|---------------------------|---|---|--------------------------|-----------------------|--|
| Transformation of segment |    | Not counted   | Max. 2 defects allowed   | Max.3 defects allowed |  |
|                           |   | $x < 0.1\text{mm}$  | 0.1mm x 0.2mm            |                       |  |
|                           |   | $x = (a+b)/2$   |                          |                       |  |
|                           |   | Not counted   | Max. 1 defects allowed   |                       |  |
|                           |   | $a < 0.1\text{mm}$  | 0.1mm a 0.2mm<br>$D > 0$ |                       |  |
|                           |  | Max.2 defects allowed<br>$0.8W \leq a \leq 1.2W$<br><br>a=measured value of width<br>W=nominal value of width |                          |                       |  |