深圳市拓普微科技开发有限公司
SHENZHEN TOPWAY TECHNOLOGY CO., LTD.

# LM240160KFW

LCD Module User Manual

| Prepared by: | Checked by: | Approved by: |
|---|---|---|
| **Wei** | | |
| Date: **2014-03-06** | Date: | Date: |

| Rev. | Descriptions | Release Date |
|---|---|---|
| 0.1 | Preliminary release | 2014-03-06 |
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# Table of Content

# 1. Basic Specifications

## 1.1 Display Specifications

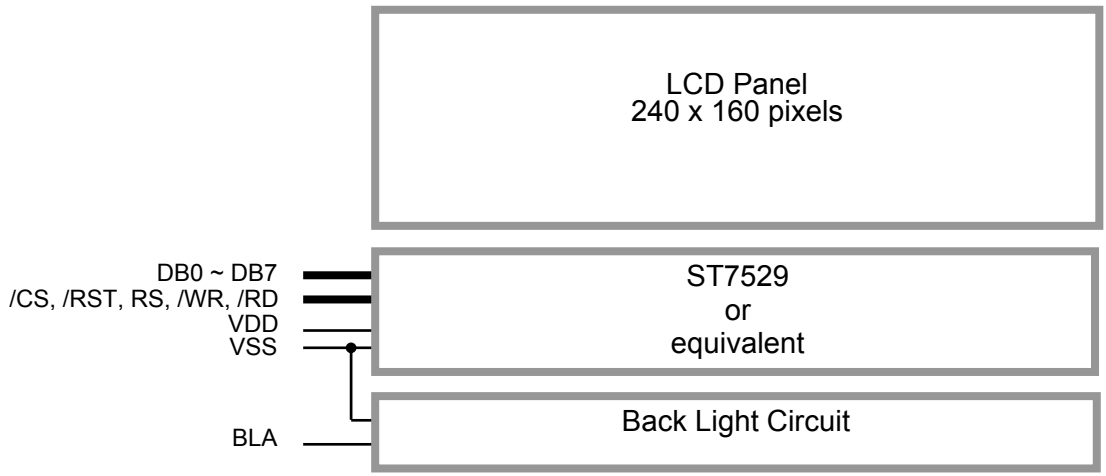
1) LCD Display Mode : STN, Negative, Transmissive
2) Display Color : Display Data = “1” : Light Gray (*1)
: Display Data = “0” : Dark Blue (*2)
3) Viewing Angle : 6H
4) Driving Method : 1/160 duty, 1/12 bias
5) Back Light : White LED backlight

Note:
*1. Color tone may slightly change by Temperature and Driving Condition.
*2. The Color is defined as the inactive / background color
*3. Fine Contrast adjustment function is necessary in the application design for optimal display result

## 1.2 Mechanical Specifications

1) Outline Dimension : 93.0 x 64.2 x 9.8 MAX
(See attached Outline Drawing for details)

## 1.3 Block Diagram



### 1.4 Terminal Functions

| Pin No. | Pin Name | I/O | Descriptions | | |
|---|---|---|---|---|---|
| | | | 8080 mode | 6800 mode | 4Line SPI mode |
| 1 | VDD | Power | Positive Power Supply | | |
| 2 | VSS | Power | 0V Supply, Ground (0V) | | |
| 3 | /CS | Input | Chip Select<br>/CS=LOW : Data IO is enabled | | |
| 4 | RS | Input | Register Select<br>RS=HIGH: data on DB0 to DB7 is display data<br>RS=LOW: data on DB0 to DB7 is control data | | |
| 5 | /WR(R/W) | Input | /WR=L→H, /RD=H;<br>Data or Instruction latch into the LCD module | R/W=H,E=H;<br>Data or Status read from the LCD module<br>R/W=L,E=H→L;<br>Data or Status latch into the LCD module | Not used,<br>connect to VDD |
| 6 | /RD(E) | Input | /WR=H, /RD=L;<br>Data or Status read form the LCD module | | |
| 7 | DB0 | I/O | 8-bit Data bus;<br>Three state I/O terminal for display data or instruction data<br>when /CS=H, DB0~DB7=High Impedance | | Not used,<br>connect to VDD |
| : | : | | | | |
| 13 | DB6(SCL) | | | | Serial clock input |
| 14 | DB7(SI) | | | | Serial data input |
| 15 | /RST | Input | Reset:<br>/RST=LOW: Initialization is executed<br>/RST=HIGH: Normal | | |
| 16 | BLA | Power | Backlight Positive Power Supply | | |

**Interface setting:**

| Setting | 8080 mode(Default) | 6800 mode | 4Line SPI mode |
|---|---|---|---|
| JP1 | CLOSE | OPEN | OPEN |
| JP2 | OPEN | CLOSE | CLOSE |
| JP3 | CLOSE | CLOSE | OPEN |
| JP4 | OPEN | OPEN | CLOSE |
| JP5 | OPEN | CLOSE | OPEN |
| JP6 | CLOSE | OPEN | CLOSE |
| JP8 | OPEN | OPEN | CLOSE |
| JP9 | OPEN | OPEN | CLOSE |

# 2. Absolute Maximum Ratings

| Items | Symbol | Min. | Max. | Unit | Condition |
|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | -0.3 | +4.0 | V | $V_{SS}$ = 0V |
| Input Voltage | $V_{IN}$ | -0.3 | $V_{DD}$+0.3 | V | $V_{SS}$ = 0V |
| Operating Temperature | $T_{OP}$ | -20 | +70 | °C | No Condensation |
| Storage Temperature | $T_{ST}$ | -30 | +80 | °C | No Condensation |

Cautions:
Any Stresses exceeding the Absolute Maximum Ratings may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

# 3. Electrical Characteristics

## 3.1 DC Characteristics

$V_{SS}$=0V, $V_{DD}$=3.3V, $T_{OP}$=25°C

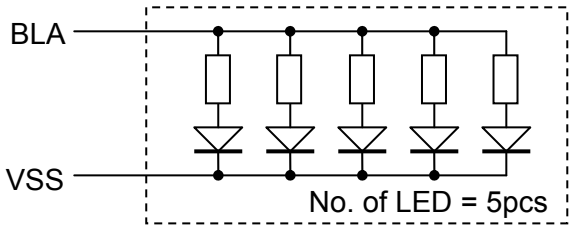
| Items | Symbol | MIN. | TYP. | MAX. | Unit | Condition / Application Pin |
|---|---|---|---|---|---|---|
| Operating Voltage | $V_{DD}$ | 3.1 | 3.3 | 3.6 | V | VDD |
| Input High Voltage | $V_{IH}$ | 0.8x$V_{DD}$ | - | $V_{DD}$ | V | /RST, /CS, RS, /WR, /RD, DB0~DB7 |
| Input Low Voltage | $V_{IL}$ | 0 | - | 0.2x$V_{DD}$ | V | |
| Operating Current | $I_{DD}$ | - | 1.5 | 7.0 | mA | VDD |

## 3.2 LED Backlight Circuit Characteristics

$V_{SS}$=0V, $If_{BLA}$=70mA, $T_{OP}$=25°C

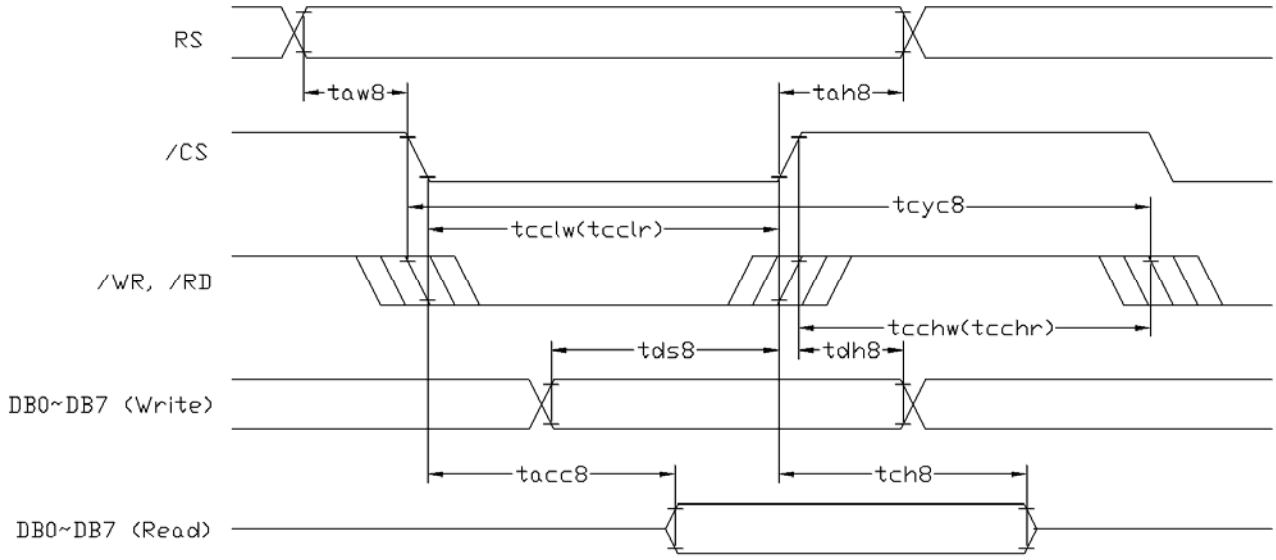
| Items | Symbol | MIN. | TYP. | MAX. | Unit | Applicable Pin |
|---|---|---|---|---|---|---|
| Forward Voltage | $Vf_{BLA}$ | - | 3.3 | - | V | BLA |
| Forward Current | $If_{BLA}$ | - | 70 | 100 | mA | BLA |

Cautions:
Exceeding the recommended driving current could cause substantial damage to the backlight and shorten its lifetime.



## 3.3 AC Characteristics

### 3.3.1 8080 Mode System Bus Timing

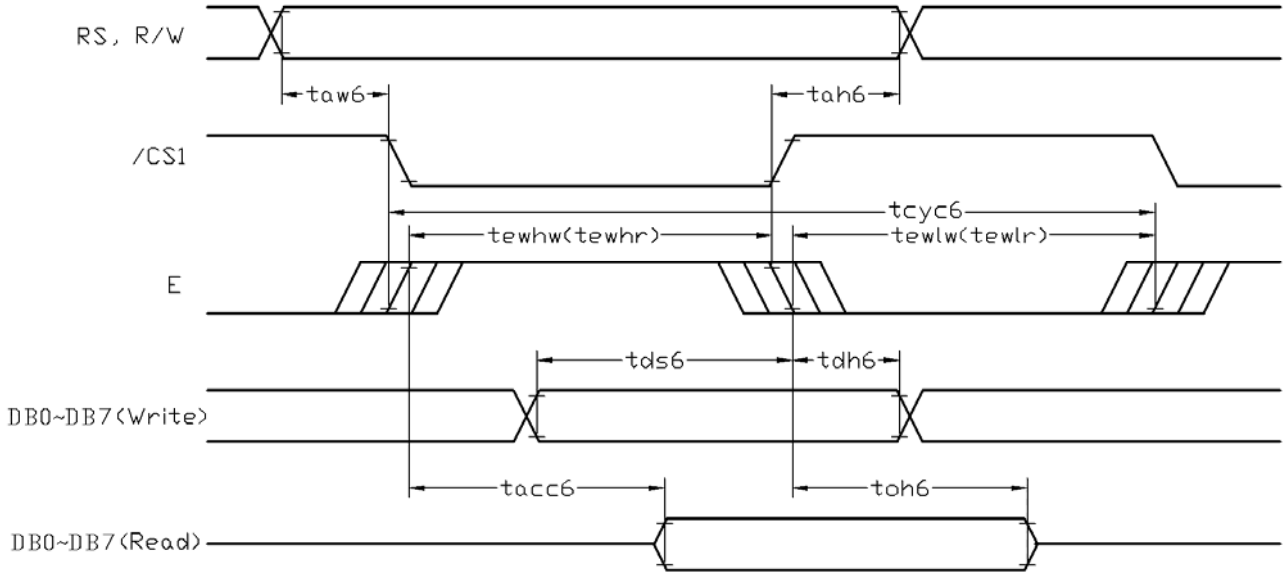



$V_{SS}$=0V, $V_{DD}$=3.3V, $T_{OP}$=25°C

| Item | Symbol | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|
| System cycle time | tcyc8 | 285 | - | - | ns |
| Address setup time (RS) | taw8 | 29 | - | - | ns |
| Address hold time (RS) | tah8 | 29 | - | - | ns |
| Control LOW pulse width (/WR) | tcclw | 143 | - | - | ns |
| Control LOW pulse width (/RD) | tcclr | 143 | - | - | ns |
| Control HIGH pulse width (/WR) | tcchw | 143 | - | - | ns |
| Control HIGH pulse width (/RD) | tcchr | 143 | - | - | ns |
| Data setup time | tds8 | 100 | - | - | ns |
| Data hold time | tdh8 | 29 | - | - | ns |
| /RD access time (*2) | tacc8 | - | - | 57 | ns |
| Output disable time (*2) | tch8 | - | - | 38 | ns |

Note:
*1. Input signal rise/fall time should be less than 12ns
*2. CL=100pF

### 3.3.2 6800 Mode System Bus Timing

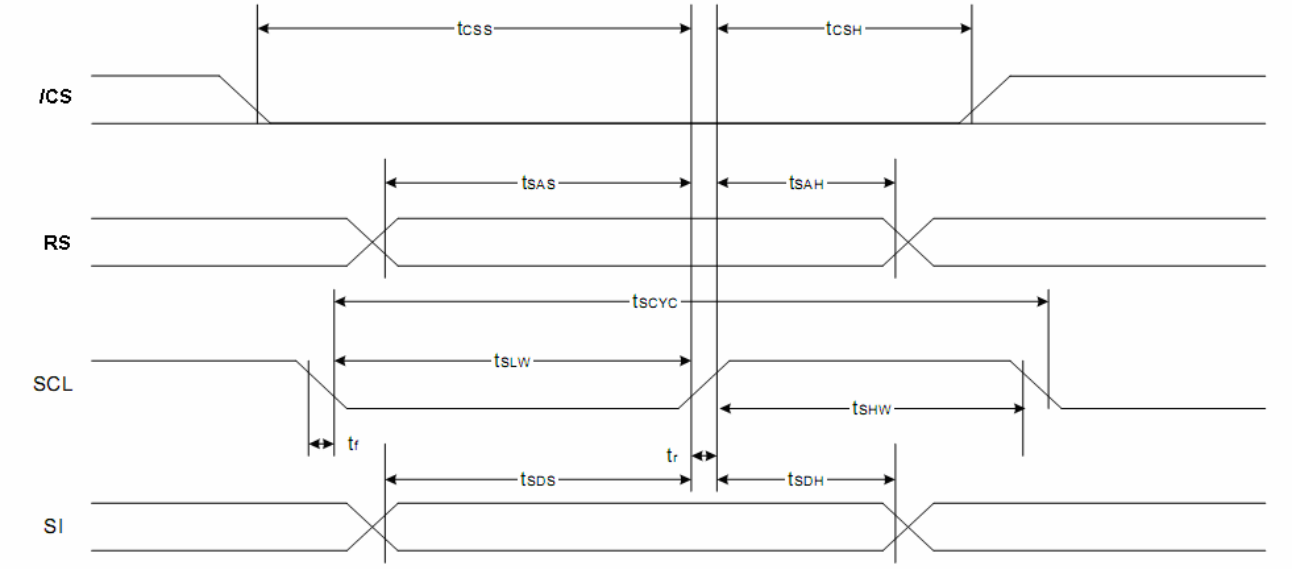



$V_{SS}$=0V, $V_{DD}$=3.3V, $T_{OP}$=25°C

| Item | Symbol | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|
| System cycle time | tcyc6 | 285 | - | - | ns |
| Address setup time (RS) | taw6 | 29 | - | - | ns |
| Address hold time (RS) | tah6 | 29 | - | - | ns |
| Control LOW pulse width (E) | tewlr | 143 | - | - | ns |
| Control LOW pulse width (R/W) | tewlw | 143 | - | - | ns |
| Control HIGH pulse width (E) | tewhr | 143 | - | - | ns |
| Control HIGH pulse width (R/W) | tewhw | 143 | - | - | ns |
| Data setup time | tds6 | 100 | - | - | ns |
| Data hold time | tdh6 | 29 | - | - | ns |
| /RD access time (*2) | tacc6 | - | - | 57 | ns |
| Output disable time (*2) | toh6 | - | - | 38 | ns |

Note:
*1. Input signal rise/fall time should be less than 12ns
*2. CL=100pF

### 3.3.3 SPI Mode System Bus Timing

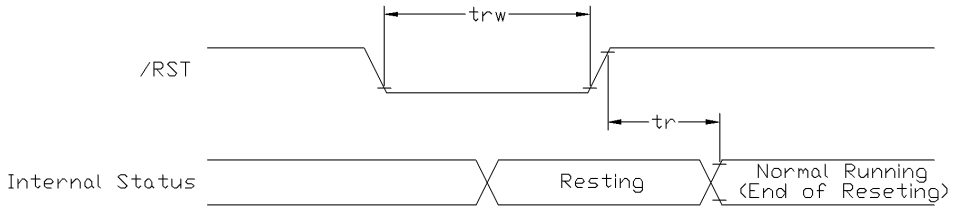



$V_{SS}$=0V, $V_{DD}$=3.3V, $T_{OP}$=25°C

| Item | Symbol | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|
| Serial Clock Period | $t_{SCYC}$ | 100 | - | - | ns |
| SCL “H” pulse width(SCL) | $t_{SHW}$ | 50 | - | - | ns |
| SCL “L” pulse width(SCL) | $t_{SLW}$ | 50 | - | - | ns |
| Address setup time(RS) | $t_{SAS}$ | 40 | - | - | ns |
| Address hold time(RS) | $t_{SAH}$ | 30 | - | - | ns |
| Data setup time(SI) | $t_{SDS}$ | 30 | - | - | ns |
| Data hold time(SI) | $t_{SDH}$ | 30 | - | - | ns |
| /CS-SCL time | $t_{CSS}$ | 20 | - | - | ns |
| /CS-SCL time | $t_{CSH}$ | 50 | - | - | ns |

Note:
*1. Input signal rise/fall time should be less than 12ns .
*2. CL=100pF

### 3.4 Reset Timing




$V_{SS}$=0V, $V_{DD}$=3.3V, $T_{OP}$=25°C

| Item | Symbol | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|
| Reset time | tr | - | - | 2 | μs |
| Reset LOW pulse width | trw | 2 | - | - | μs |

Note:
*1. Input signal rise/fall time should be less than 12ns

# 4. Function Specifications

## 4.1 Adjusting the Display Contrast

- This LCD module equipped with latest digital contrast adjustment function.
- Its display contrast could be adjusted by MCU command. (please see the command tables for details)
- It is recommended to provide a contrast adjustment interface for end-user, where the best display result could meet the individual preference in mass production.

## 4.2 Basic Setting

To drive the LCD module correctly and provide normally display, please use the following setting

- Internal Oscillator = ON
- DC-DC Booster (VB)= ON
- Voltage Follower (VF) = ON
- Reference Voltage (VR) = ON
- Clock Divider (CL) = ½
- Driver duty = 1/160
- FI = 0
- FR Inverse-Set Value (LF) = 0
- COMMON Scan Mode = 001(binary)
- Direction of the Line Address (LI) = Inverse
- Direction of the Column Address (CL) = Normal
- Address-scan direction (C/L) = column direction
- P1, P2, P3 arrangement (CLR) = Normal (P1, P2, P3)
- Gray Scale Display Mode = 3Bit per 3Pixel mode
- OSC Frequency = 19.3kHz
- Booster Efficiency Set = 00(binary)
- LCD Bias Set = 1/12
- Display ON/OFF = ON

Note:
*1. These setting/commands should issue the LCD module while start up.
*2. See the Display Commands section for details.

## 4.3 Resetting the LCD module

The LCD module should be initialized by using /RST terminal.
While turning on the VDD and VSS power supply, maintain /RST terminal at LOW level.
After the power supply stabilized, release the reset terminal (/RST=HIGH)

## 4.4 Display Memory Map

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0,0 (P1) | 1,0 (P2) | 2,0 (P3) | 3,0 (P1) | 4,0 (P2) | --- | --- | 235,0 (P2) | 236,0 (P3) | 237,0 (P1) | 238,0 (P2) | 239,0 (P3) |
| 0,1 (P1) | 1,1 (P2) | 2,1 (P3) | 3,1 (P1) | 4,1 (P2) | --- | --- | 235,1 (P2) | 236,1 (P3) | 237,1 (P1) | 238,1 (P2) | 239,1 (P3) |
| 0,2 (P1) | 1,2 (P2) | 2,2 (P3) | 3,2 (P1) | 4,2 (P2) | --- | --- | 235,2 (P2) | 236,2 (P3) | 237,2 (P1) | 238,2 (P2) | 239,2 (P3) |
| : : : | : : : | : : : | : : : | : : : | : : : | : : : | : : : | : : : | : : : | : : : | : : : |
| 0,157 (P1) | 1,157 (P2) | 2,157 (P3) | 3,157 (P1) | 4,157 (P2) | --- | --- | 235,157 (P2) | 236,157 (P3) | 237,157 (P1) | 238,157 (P2) | 239,157 (P3) |
| 0,158 (P1) | 1,158 (P2) | 2,158 (P3) | 3,158 (P1) | 4,158 (P2) | --- | --- | 235,158 (P2) | 236,158 (P3) | 237,158 (P1) | 238,158 (P2) | 239,158 (P3) |
| 0,159 (P1) | 1,159 (P2) | 2,159 (P3) | 3,159 (P1) | 4,159 (P2) | --- | --- | 235,159 (P2) | 236,159 (P3) | 237,159 (P1) | 238,159 (P2) | 239,159 (P3) |

Pixel mapping (Top View)

Based on the top view of the LCD module,
X = COLUMN, Y = Line
0, 0 (x, y) pixel is the upper-left pixel;
239, 159 (x, y) pixel is the lower-right pixel.

Note:
*1. Based on the Basic Setting

## 4.5 Commands

### 4.5.1 EXT select Commands

| Command | Para-meter | A0 | /RD | /WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX | Descriptions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ext=0 | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 30 | Set Ext=0 |
| Ext=1 | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 31 | Set Ext=1 |

### 4.5.2 EXT=0 Commands

| Command | Para-meter | A0 | /RD | /WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX | Descriptions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISON | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | AF | Display ON |
| DISOFF | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | AE | Display OFF |
| DISNOR | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | A6 | Normal Display |
| DISINV | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | A7 | Inverse Display |
| COMSCN | - | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | BB | COM Scan Direction (with 1 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | * | * | * | CD2 | CD1 | CD0 | ** | 000: C0→C79, C80→C159<br>001: C0→C79, C159→C80<br>010: C79→C0, C80→C159<br>011: C79→C0, C159→C80 |
| DISCTRL | - | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | CA | Display Control (with 3 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | * | 0 | 0 | CLD | 0 | 0 | ** | CLD=0: CLOCK no division, CD=1: CLOCK divide by 2 |
| | PB2 | 1 | 1 | 0 | * | * | DT5 | DT4 | DT3 | DT2 | DT1 | DT0 | ** | DT= (duty no/4 - 1) |
| | PB3 | 1 | 1 | 0 | * | * | * | FI | LF3 | LF2 | LF1 | LF0 | ** | FI=inversion type, LF=n-line inversion |
| SLPIN | - | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 95 | Sleep In |
| SLPOUT | - | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 94 | Sleep Out |
| LASET | - | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 75 | Line Address Set (with 2 Parameter) |
| | PB1 | 1 | 1 | 0 | SL7 | SL6 | SL5 | SL4 | SL3 | SL2 | SL1 | SL0 | ** | Start Line |
| | PB2 | 1 | 1 | 0 | EL7 | EL6 | EL5 | EL4 | EL3 | EL2 | EL1 | EL0 | ** | End Line |
| CASET | - | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 15 | Column Address Set (with 2 Parameter) |
| | PB1 | 1 | 1 | 0 | SC7 | SC6 | SC5 | SC4 | SC3 | SC2 | SC1 | SC0 | ** | Start Column |
| | PB2 | 1 | 1 | 0 | EC7 | EC6 | EC5 | EC4 | EC3 | EC2 | EC1 | EC0 | ** | End Column |
| DATSDR | - | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | BC | Data Scan Direction (with 3 Parameter) |
| | PB1 | 1 | 1 | 0 | * | * | * | * | * | C/L | CI | LI | ** | Address Scan Direction, C/L=0: column dir; C/L=1: line dir<br>Column Address Direction, CI=0: normal; CI=1: reverse<br>Line Address Direction, LI=0: normal; LI=1: inverse |
| | PB2 | 1 | 1 | 0 | * | * | * | * | * | * | * | CLR | ** | Pixel arrangement,<br>CLR=0: P1, P2, P3….<br>CLR=1: P3, P2, P1… |
| | PB3 | 1 | 1 | 0 | * | * | * | * | * | GS2 | GS1 | GS0 | ** | GS=001: 32 Gray Scale 2byte 3pixel mode<br>GS=010: 32 Gray Scale 3byte 3pixel mode |
| RAMWR | - | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 5C | Writing to Memory (with data) |
| | Data | 1 | 1 | 0 | Data to be Write | | | | | | | | ** | Data to be Write |
| | : | : | : | : | : | | | | | | | | : | |
| RAMRD | - | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 5D | Reading from Memory (with data) |
| | Data | 1 | 0 | 1 | Data to be Read | | | | | | | | ** | Data to be Read |
| | : | : | : | : | : | | | | | | | | : | |
| PTLIN | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | A8 | Partial Display In (with 2 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | PTS5 | PTS4 | PTS3 | PTS2 | PTS1 | PTS0 | ** | Start Block Address |
| | PB2 | 1 | 1 | 0 | * | * | PTE5 | PTE4 | PTE3 | PTE2 | PTE1 | PTE0 | ** | End Block Address |
| PTLOUT | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | A9 | Partial Display Out |
| RMWIN | - | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | E0 | Read and Modify Write |
| RMWOUT | - | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | EE | Read and Modify Write End |
| ASCSET | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | AA | Area Scroll Set (with 4 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | TB5 | TB4 | TB3 | TB2 | TB1 | TB0 | ** | Top Block Address |
| | PB2 | 1 | 1 | 0 | * | * | BB5 | BB4 | BB3 | BB2 | BB1 | BB0 | ** | Bottom Block Address |
| | PB3 | 1 | 1 | 0 | * | * | NSB5 | NSB4 | NSB3 | NSB2 | NSB1 | NSB0 | ** | Number of Specified Blocks |
| | PB4 | 1 | 1 | 0 | * | * | * | * | * | * | SCM1 | SCM0 | ** | Area Scroll Mode,<br>00=Center Mode<br>01=Top Mode<br>10=Bottom Mode<br>11=Whole Mode |
| SCSTART | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | AB | Scroll Start Set (with 1 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | SB5 | SB4 | SB3 | SB2 | SB1 | SB0 | ** | Start Block Address |
| OSCON | - | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | D1 | Internal OSC On |
| OSCOFF | - | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | D2 | Internal OSC Off |
| PWRCTRL | - | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 20 | Power Control (with 1 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | * | 0 | VB | 0 | VF | VR | ** | VR=1: Reference Voltage ON<br>VF=1: Voltage Follower ON<br>VB=1: Booster ON |

### 4.5.3 EXT=0 Commands (continue)

| Command | Para-meter | A0 | /RD | /WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX | Descriptions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VOLCTRL | - | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 81 | EC control (with 2 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | VPR5 | VPR4 | VPR3 | VPR2 | VPR1 | VPR0 | ** | VPR[5:0] |
| | PB2 | 1 | 1 | 0 | * | * | * | * | * | VPR8 | VPR7 | BPR6 | ** | VPR[8:6] |
| VOLUP | - | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | D6 | EC increase 1 |
| VOLDOWN | - | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | D7 | EC decrease1 |
| RESERVED | - | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 82 | Not Use |
| EPSRRD1 | - | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 7C | Read Register1 |
| EPSRRD2 | - | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 7D | Read Register2 |
| NOP | - | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 25 | NOP Instruction |
| STREAD | - | 0 | 0 | 1 | Status | | | | | | | | ** | Status Read<br>D7=Area Scroll Mode (SCM1)<br>D6=Area Scroll Mode (SCM0)<br>D5=1:PMW IN; D5=0:PMW OUT<br>D4=1:Line Scan Dir; D4=0:Column Scan Dir<br>D3=1:Display On; D3=0:Display Off<br>D2=1:EEPROM In Access; D2=0:EEPROM Out Access<br>D1=1:Display Normal; D1=0:Display Inverse<br>D0=1:Partial Display On; D0=0:Partial Display Off |
| EPINT | - | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 07 | Initial code (with 1 parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 19 | |

### 4.5.4 EXT=1 Commands

| Command | Para-meter | A0 | /RD | /WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX | Descriptions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gray1 Set | - | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 20 | Odd Frame Gray PWM Set (with 16 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | * | G0F14 | G0F13 | G0F12 | G0F11 | G0F10 | ** | Set Gray Level 0 at Odd Frames |
| | : | : | : | : | * | * | * | : | : | : | : | : | : | : |
| | PB16 | 1 | 1 | 0 | * | * | * | G15F14 | G15F13 | G15F12 | G15F11 | G15F10 | ** | Set Gray level 15 at Odd Frames |
| Gray2 Set | - | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 21 | Even Frame Gray PWM Set (with 16 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | * | G0F24 | G0F23 | G0F22 | G0F21 | G0F20 | ** | Set Gray Level 0 at Even Frames |
| | : | : | : | : | * | * | * | : | : | : | : | : | : | : |
| | PB16 | 1 | 1 | 0 | * | * | * | G15F24 | G15F23 | G15F22 | G15F21 | G15F20 | ** | Set Gray Level 15 at Even Frames |
| ANASET | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 32 | Analog Circuit Set (with 3 parameter) |
| | PB1 | 1 | 1 | 0 | * | * | * | * | * | OSF2 | OSF1 | OSF0 | ** | OSC Frequency Adjustment<br>000=12.7kHz, 100=13.2kHz, 010=14.3kHz,<br>110=15.7kHz, 001=17.3kHz, 101=19.3kHz<br>011=21.9kHz, 111=25.4kHz |
| | PB2 | 1 | 1 | 0 | * | * | * | * | * | * | BE1 | BE0 | ** | Booster Efficiency Set<br>00=3kHz, 01=6kHz, 10=12kHz, 11=24kHz |
| | PB3 | 1 | 1 | 0 | * | * | * | * | * | BS2 | BS1 | BS0 | ** | Bias Set<br>000=1/14bias, 001=1/13bias, 010=1/12bias,<br>011=1/11bias, 100=1/10bias, 101=1/9bias,<br>110=1/7bias, 111=1/5bias |
| SWINT | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 34 | Software Initial |
| EPCTIN | - | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | CD | Control EEPROM (with 1 parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | EEWR | 0 | 0 | 0 | 0 | 0 | ** | EEW=1, EEPROM Write Enable<br>EEW=0, EEPROM Read Enable |
| EPCOUT | - | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | CC | Cancel EEPROM |
| EPMWR | - | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | FC | Write to EEPROM |
| EPMRD | - | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | FD | Read from EEPROM |

Note: Please refer to ST7529 datasheet for details

### 4.5.5 Power off the LCD Module

It recommends that enter sleep mode before power off the LCD module.

### 4.5.6 Refreshing The LCD Module

It recommends that the operating modes and display contents be refreshed periodically to prevent the effect of unexpected noise.

### 4.5.7 Using Read EEPROM function for contrast

It recommends to use EPMRD function to ensure the contrast consistencyin batch.
Please refer to ST7529 datasheet for the details of operation.

### 4.6 Basic Operating Sequence (example)

The following setting should be issue to LCD module after hardware reset.
(It is an example only; it could be adjusted if necessary.)

| Command | Para-meter | A0 | /RD | /WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX | Descriptions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hard Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | Hardware Reset by pulling the /RST pin to low |
| Delay | - | - | - | - | - | - | - | - | - | - | - | - | - | Wait until Reset Routine to be finish |
| Ext=0 | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 30 | Set Ext=0 |
| SLPOUT | - | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 94 | Sleep Out |
| OSCON | - | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | D1 | Internal OSC On |
| PWRCTRL | - | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 20 | Power Control (with 1 parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 08 | Booster ON |
| Delay | - | - | - | - | - | - | - | - | - | - | - | - | - | Wait for booster fully on |
| PWRCTRL | - | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 20 | Power Control (with 1 parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0B | Booster ON, Reference Voltage ON, Voltage Follower ON |
| VOLCTRL | - | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 81 | EC control (with 2 parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0F | VPR=040F |
| | PB2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 04 | |
| DISCTRL | - | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | CA | Display Control (with 3 parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 04 | CLD=0: CLOCK no division, CD=1: CLOCK divide by 2 |
| | PB2 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 27 | DT= (duty no/4 - 1) |
| | PB3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | FI=0, LF=0 |
| COMSCN | - | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | BB | COM Scan Direction (with 1 parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 01 | 001: C0→C79, C159→C80 |
| DATSDR | - | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | BC | Data Scan Direction (with 3 Parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 01 | C/L=0, Address Scan Direction by column<br>CI=0, Column Address Direction is normal<br>LI=1, Line Address Direction is inverse |
| | PB2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | CLR=0: Pixel arrangement are P1, P2, P3…. |
| | PB3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 02 | GS=010: 32 Gray Scale 3byte 3pixel mode |
| Ext=1 | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 31 | Set Ext=1 |
| ANASET | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 32 | Analog Circuit Set (with 3 parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 05 | OSF=101, OSC Frequency Adjustment101=19.3kHz |
| | PB2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | BE=00, Booster Efficiency Set 3kHz |
| | PB3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 02 | BS=010, Bias Set 1/12bias |
| Ext=0 | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 30 | Set Ext=0 |
| INITIAL CODE1 | - | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 07 | Generate ACK |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 19 | Read for use ACK funtion |
| Ext=1 | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 31 | Set Ext=1 |
| CONTROL EEPROM | - | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | CD | |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | Enable EEPROM |
| delay 100ms | | | | | | | | | | | | | | |
| READ EEPROM | - | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | FD | Read data from EEPROM |
| delay 100ms | | | | | | | | | | | | | | |
| CANEL EEPROM | - | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | CC | Canel operation EEPROM |
| CANEL EEPROM | - | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | CC | Canel operation EEPROM |
| Ext=0 | - | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 30 | Set Ext=0 |
| DISON | - | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | AF | Display ON |
| CASET | - | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 15 | Column Address Set (with 2 Parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | Start at 00 |
| | PB2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 4F | End at (240/3)-1=79 |
| LASET | - | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 75 | Line Address Set (with 2 Parameter) |
| | PB1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 | Start at 00 |
| | PB2 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 9F | End at 160-1=159 |
| RAMWR | - | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 5C | Writing to Memory (with data) |
| | Data | 1 | 1 | 0 | Data to be Write | | | | | | | | ** | Display Data to be Write |
| | : | : | : | : | : | | | | | | | | : | : |

Note: Please refer to ST7529 datasheet for details

Design and Handling Precaution

1. The LCD panel is made by glass. Any mechanical shock (eg. dropping form high place) will damage the LCD module.
2. Do not add excessive force on the surface of the display, which may cause the Display color change abnormally.
3. The polarizer on the LCD is easily get scratched. If possible, do not remove the LCD protective film until the last step of installation.
4. Never attempt to disassemble or rework the LCD module.
5. Only Clean the LCD with Isopropyl Alcohol or Ethyl Alcohol. Other solvents (eg. water) may damage the LCD.
6. When mounting the LCD module, make sure that it is free form twisting, warping and distortion.
7. Ensure to provide enough space (with cushion) between case and LCD panel to prevent external force adding on it, or it may cause damage to the LCD or degrade the display result.
8. Only hold the LCD module by its side. Never hold LCD module by add force on the heat seal or TAB.
9. Never add force to component of the LCD module. It may cause invisible damage or degrade of the reliability.
10. LCD module could be easily damaged by static electricity. Be careful to maintain an optimum anti-static work environment to protect the LCD module.
11. When peeling off the protective film from LCD, static charge may cause abnormal display pattern. It is normal and will resume to normal in a short while.
12. Take care and prevent get hurt by the LCD panel sharp edge.
13. Never operate the LCD module exceed the absolute maximum ratings.
14. Keep the signal line as short as possible to prevent noisy signal applying to LCD module.
15. Never apply signal to the LCD module without power supply.
16. IC chip (eg. TAB or COG) is sensitive to the light. Strong lighting environment could possibly cause malfunction. Light sealing structure casing is recommend.
17. LCD module reliability may be reduced by temperature shock.
18. When storing the LCD module, avoid exposure to the direct sunlight, high humidity, high temperature or low temperature. They may damage or degrade the LCD module