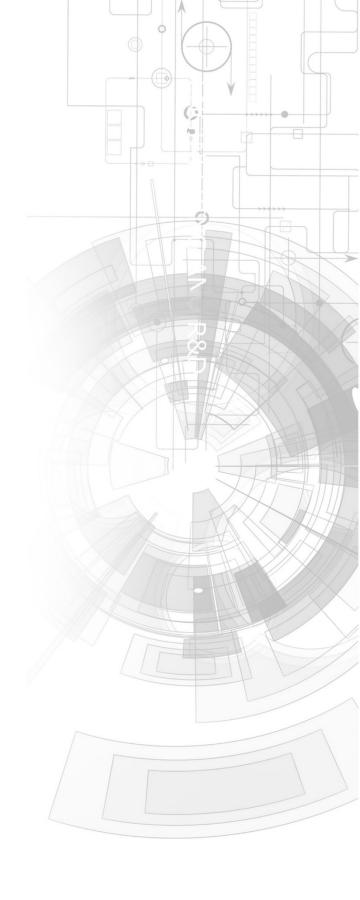
4DLCD-144



Datasheet

Revision 1.3

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Content may change at any time. Please refer to the resource centre for latest documentation.

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4DLCD-144 General Specification

1. General Specification

4DLCD-144ST is a colour active matrix LCD module incorporating amorphous silicon TFT (Thin Film Transistor). It is composed of a colour TFT-LCD panel, driver IC, Solder Type FPC and a back light unit. The module display area contains 128x128 pixels. This product accords with RoHS environmental criterion.

| ITEM | CONTENTS | UNIT |
|----------------------------------|--|---------|
| LCD Type | TFT / Transmissive / Normally white | |
| Size | 1.44 | Inch |
| Viewing Direction | 12:00 (without image inversion) | O'Clock |
| Gray Scale InversionDirection | 6:00 | O'Clock |
| LCD (W × H x D) | 30.9 x 36.51 x 2.9 | mm |
| Active Area (W × H) | 25.5 × 26.5 | mm |
| Dot Pitch (W × H) | 0.199 × 0.207 | mm |
| Number of Dots (Pixels) | 128 (RGB) × 128 | |
| Driver IC | ST7735S | |
| Backlight Type | 1 LED | |
| Surface Luminance | 120 (typical) | cd/m2 |
| Interface Type | MCU-8bit | |
| Color Depth | 262K | |
| Pixel Arrangement | RGB Vertical Stripe | |
| Surface Treatment | AG | |
| Weight | 4 | g |
| Physical Connection Type | Solder Type FPC - 0.8mm pitch, see drawing (Solders direct to PCB, no connector) | |



4DLCD - 4DLCD LCD Display

144ST - 1.44 inch, 128 x 128 Resolution, Standard Model

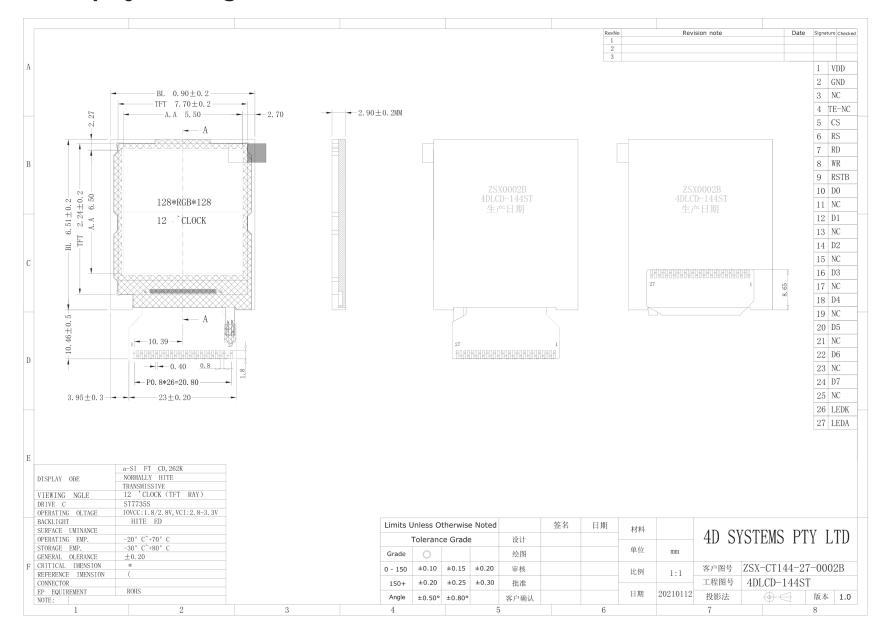


Note

- 1. RoHS compliant
- 2. LCD weight tolerance: \pm 5%.

4DLCD-144 TFT LCD Display Drawing

2. TFT LCD Display Drawing



3. Absolute Maximum Ratings

| Absolute Maximum Ratings | | | | | | |
|-----------------------------------|--------|------|----------------|------|--|--|
| PARAMETER | SYMBOL | MIN | MAX | UNIT | | |
| Supply Voltage for LCD Logic | VDD | -0.3 | 4.6 | V | | |
| LED forward current (each LED) | IF | - | 25 | mA | | |
| Operating Temperature | TOP | -20 | 70 | °C | | |
| Storage Temperature | TST | -30 | 80 | °C | | |
| Humidity | RH | 10% | 90% (Max 60°C) | RH | | |

4. Electrical Characteristics

| Electrical Characteristics | | | | | | |
|----------------------------|--------|--------|-----|--------|------|--|
| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT | |
| Power Voltage | VDD | 2.6 | 2.8 | 3.3 | V | |
| Input Current (Logic) | IVDD | - | 10 | - | mA | |
| Input Voltage 'H' Level | VIH | 0.7VDD | - | VDD | V | |
| Input Voltage 'L' Level | VIL | 0 | - | 0.2VDD | V | |

5. Backlight Characteristics

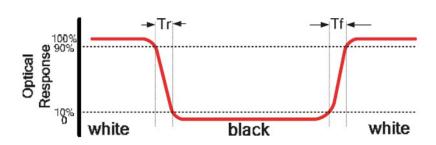
| Backlight Characteristics | | | | | | |
|------------------------------|--------|-------|-----|-----|------|--|
| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT | |
| Voltage for LED backlight | VI | - | 2.8 | 3.1 | V | |
| Current for LED backlight | II | - | 20 | 25 | mA | |
| LED Life Time | - | 30000 | - | - | Hrs | |



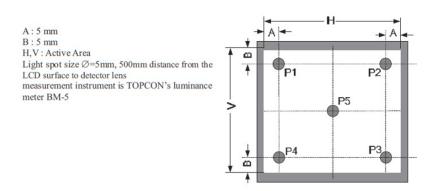
The LED life time is defined as the module brightness decrease to 50% of original brightness at Ta=25°C.

6. Electro-Optical Characteristics

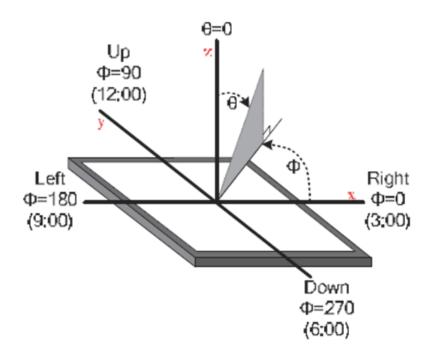
| Electro-Op | tical Chara | cteristics | | | | | | |
|-------------------------|-------------|------------|-----------|-------|-------|-------|-------|------------|
| ITEM | | SYM | CONDITION | MIN | TYP | MAX | UNIT | REMARK |
| Response Time | | Tr+Tf | θ=0 | - | 25 | - | ms | see figure |
| Contrast Ratio | | Cr | O | - | 350 | - | - | see figure |
| Luminance Uniformity | | δ WHITE | Ø=0 | 75 | 80 | - | % | see figure |
| Surface Luminance | | Lv | 20mA | - | 120 | - | cd/m2 | see figure |
| Viewing Angle Range | | θ | Ø = 90° | - | 35 | - | deg | see figure |
| | | | Ø = 270° | - | 15 | - | deg | |
| | | | Ø = 0° | - | 45 | - | deg | |
| | | | Ø = 180° | - | 45 | - | deg | |
| CIE (x,y) Cromacity | Red | × | | 0.558 | 0.608 | 0.628 | | see figure |
| | | У | | 0.296 | 0.316 | 0.336 | | |
| | Green | X | θ=0° | 0.285 | 0.305 | 0.325 | | |
| | | У | Ø=0° | 0.536 | 0.556 | 0.576 | | |
| | Blue | Х | Ta=25 | 0.115 | 0.135 | 0.155 | | |
| | | У | | 0.117 | 0.137 | 0.157 | | |
| | White | Х | | 0.285 | 0.305 | 0.325 | | |
| | | У | | 0.314 | 0.334 | 0.354 | | |
| Transmittance | | Т | | - | 6 | - | % | |



The definition of response time



Measuring method for Contrast ratio, surface luminance, Luminance uniformity, CIE (x, y) chromaticity



The definition of viewing angle

Note

1. Contrast Ratio(CR) is defined mathematically as below, for more information see figure.

Contrast Ratio = $\frac{\text{Average Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}{\text{Average Surface Luminance with all black pixels (P1, P2, P3, P4, P5)}}$

2. Surface luminance is the LCD surface from the surface with all pixels displaying white. For more information, see figure.

Lv = Average Surface Luminance with all white pixels (P1, P2, P3, P4, P5)

3. The uniformity in surface luminance δ WHITE is determined by measuring luminance at each test position 1 through 5, and then dividing the maximum luminance of 5 points luminance by the minimum luminance of 5 points luminance. For more information, see figure.

 $\delta \text{WHITE} = \frac{\text{Minimum Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}{\text{Maximum Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}$

- 4. Response time is the time required for the display to transition from white to black (Rise Time, Tr) and from black to white (Decay Time, Tf). For additional information see Figure 1. The test equipment is the Autronic-Melchers ConoScope series.
- 5. CIE (x, y) chromaticity, the x and y value is determined by measuring luminance at each test position 1 through 5, and then making the average value.
- 6. Viewing angle is the angle at which the contrast ratio is greater than 2. For the TFT module, the contrast ratio is greater than 10. The angles are determined for the horizontal or x-axis and the vertical or y-axis to the z-axis which is normal to the LCD surface. For more information, see figure.
- 7. For viewing angle and response time testing, the testing data is based on the Autronic-Melchers ConoScope series. Instruments for Contrast Ratio, Surface Luminance, Luminance Uniformity, and CIE the test data is based on TOPCONs BM-5 photodetector.

4DLCD-144 Interface Descriptions

7. Interface Descriptions

| LCD Interface | | | |
|---------------|----------|------------------------------------|----------------|
| PIN NO. | SYMBOL | DESCRIPTION | REMARK |
| 1 | VDD | Logic Power Supply | |
| 2 | GND | Logic Power GND | |
| 3 | NC | Not Connected | Can tie to GND |
| 4 | TE-NC | Not Connected | Can tie to GND |
| 5 | CS | Chip select input pin (Active Low) | |
| 6 | RS | Data/Command selection pin | |
| 7 | RD | Read Select signal (Active Low) | |
| 8 | WR | Write Select signal (Active Low) | |
| 9 | RESET | LCD Reset Pin (Active Low) | |
| 10 | D0 | Databus Bit 0 | |
| 11 | NC | Not Connected | Leave Open |
| 12 | D0 | Databus Bit 1 | |
| 13 | NC | Not Connected | Leave Open |
| 14 | D0 | Databus Bit 2 | |
| 15 | NC | Not Connected | Leave Open |
| 16 | D0 | Databus Bit 3 | |
| 17 | NC | Not Connected | Leave Open |
| 18 | D0 | Databus Bit 4 | |
| 19 | NC | Not Connected | Leave Open |
| 20 | D0 | Databus Bit 5 | |
| 21 | NC | Not Connected | Leave Open |
| 22 | D0 | Databus Bit 6 | |
| 23 | NC | Not Connected | Leave Open |
| 24 | D0 | Databus Bit 7 | |
| 25 | NC | Not Connected | Leave Open |
| 26 | LEDK (-) | Backlight LED Supply -ve | |
| 27 | LEDA (+) | Backlight LED Supply +ve | |

4DLCD-144 Initialisation Codes

8. Initialisation Codes

There are 4 versions of the 4DLCD-144, as the Driver IC has been changed over the years and new init codes are required. ST7735, ST7735S, ST7735S and ILI9163C

8.1. ST7735 Driver IC Version

Sold approximately early 2010 (Initial batch sold only)

| | Value | Remarks | | Value | Remarks |
|---------|-------|------------------|----------|-------|---------|
| NVCTR1 | 0xD9 | unique to ST7735 | COLMOD | ОхЗа | |
| PWCTR6 | OxFC | unique to ST7735 | FRMCTR1 | 0xB1 | |
| VCOM4L | OxFF | unique to ST7735 | FRMCTR2 | 0xB2 | |
| SWRESET | 0x01 | | FRMCTR3 | 0xB3 | |
| RDDID | 0x04 | | INVCTR | 0xB4 | |
| SLPIN | 0x10 | | DISSET5 | 0xB6 | |
| SLPOUT | 0x11 | | PWCTR1 | 0xC0 | |
| PTLON | 0x12 | | PWCTR2 | 0xC1 | |
| DISPOFF | 0x28 | | PWCTR3 | 0xC2 | |
| DISPON | 0x29 | | PWCTR4 | 0xC3 | |
| CASET | 0x2A | | PWCTR5 | 0xC4 | |
| RASET | 0x2B | | VMCTRI | 0xC5 | |
| RAMWR | 0x2C | | GAMCTRP1 | OxEO | |
| RAMRD | 0x2E | | GAMCTRNI | 0xE1 | |
| PTLAR | 0x30 | | F0new | 0xF0 | |
| MADCTL | 0x36 | | F6new | 0xF6 | |

4DLCD-144 ST7735 Driver IC Version

Init Code: (Command, Data1, Data2...DataN)

```
SWRESET,
Delay 10ms,
SLPOUT,
Delay 120ms,
VCOM4L, 0x40, 0x03, 0x1a,
NVCTR1, 0x60, 0xc7, 0x90,
Delay 200ms,
FRMCTR1, 0x04, 0x25, 0x18,
FRMCTR2, 0x04, 0x25, 0x18,
FRMCTR3, 0x04, 0x25, 0x18, 0x04, 0x25, 0x18,
INVCTR, 0x03,
DISSET5, 0x15, 0x02,
PWCTR1, 0x02, 0x70,
PWCTR2, 0x07,
PWCTR3, 0x01, 0x01,
PWCTR4, 0x02, 0x07,
PWCTR5, 0x02, 0x04,
PWCTR6, 0x11, 0x17,
VMCTR1, 0x3c, 0x4f,
MADCTL, 0xc8,
COLMOD, 0x05,
GAMCTRP1, 0x08, 0x19, 0x16, 0x36, 0x38, 0x2d, 0x25, 0x2a, 0x28, 0x26, 0x33, 0x3d, 0x04, 0x06,
0x03, 0x0e,
GAMCTRN1, 0x09, 0x1f, 0x17, 0x36, 0x37, 0x33, 0x2c, 0x32, 0x2f, 0x2c, 0x33, 0x3c, 0x06, 0x06,
0x03, 0x0f,
DISPON,
Delay 10ms,
RAMWR
```

4DLCD-144 ST7735R Driver IC Version

8.2. ST7735R Driver IC Version

Sold approximately 2011 to 2013

| | Value | | Value | | Value |
|---------|-------|---------|-------|----------|-------|
| SWRESET | 0x01 | RAMRD | 0x2E | PWCTR2 | 0xC1 |
| RDDID | 0x04 | PTLAR | 0x30 | PWCTR3 | 0xC2 |
| SLPIN | 0x10 | MADCTL | 0x36 | PWCTR4 | 0xC3 |
| SLPOUT | Ox11 | COLMOD | 0x3a | PWCTR5 | 0xC4 |
| PTLON | Ox12 | FRMCTRI | 0xB1 | VMCTR1 | 0xC5 |
| DISPOFF | 0x28 | FRMCTR2 | 0xB2 | GAMCTRP1 | 0xE0 |
| DISPON | 0x29 | FRMCTR3 | 0xB3 | GAMCTRN1 | 0xE1 |
| CASET | 0x2A | INVCTR | 0xB4 | F0new | 0xF0 |
| RASET | 0x2B | DISSET5 | 0xB6 | F6new | 0xF6 |
| RAMWR | 0x2C | PWCTRI | 0xC0 | | |

Init Code: (Command, Datal, ... DataN)

```
SWRESET,
delay 10ms,
SLPOUT, //Sleep Out
delay 120ms,
FRMCTR1, 0x02, 0x35, 0x36, //Setup Frame Rate Control (In Normal Mode/ Full Colours)
FRMCTR2, 0x02, 0x35, 0x36, //Setup Frame Rate Control (In Idle Mode/ 8-Colors)
FRMCTR3, 0x02, 0x35, 0x36, 0x02, 0x35, 0x36, //Frame Rate Control (Partial Mode/ Full Colours)
INVCTR, 0x07,
DISSET5, 0xB4, 0xF0,
PWCTR1, 0xA2, 0x02, 0x84,
PWCTR2, 0xC5,
PWCTR3, 0x0A, 0x00,
PWCTR4, 0x8A, 0x2A,
PWCTR5, 0x8A, 0xEE,
VMCTR1, 0x06,
MADCTL, 0xC8,
GAMCTRP1, 0x12, 0x1C, 0x10, 0x18, 0x33, 0x2C, 0x25, 0x28, 0x28, 0x27, 0x2F, 0x3C, 0x00, 0x03,
0x03, 0x10,
GAMCTRN1, 0x12, 0x1C, 0x10, 0x18, 0x2D, 0x28, 0x23, 0x28, 0x28, 0x26, 0x2F, 0x3B, 0x00, 0x03,
0x03, 0x10,
F0new, 0X01,
F6new, 0X00,
COLMOD, 0X05,
CASET, 0x00, 0x02, 0x00, 0x81,
RASET, 0x00, 0x03, 0x00, 0x82,
DISPON,
delay 10ms,
RAMWR
```

4DLCD-144 ILI9163C Driver IC Version

8.3. ILI9163C Driver IC Version

Sold approximately 2013 to late 2019

| | Value | | Value |
|----------|-------|----------|-------|
| SWRESET | 0x01 | FRMCTR1 | 0xB1 |
| SLPOUT | Ox11 | SDDC | 0xB7 |
| GAMMASET | 0x26 | PWCTRI | 0xC0 |
| DISPOFF | 0x28 | PWCTR2 | 0xC1 |
| DISPON | 0x29 | VMCTR1 | 0xC5 |
| CASET | 0x2A | VOC | 0xC7 |
| RASET | 0x2B | GAMCTRPI | 0xE0 |
| RAMWR | 0x2C | GAMCTRN1 | 0xE1 |
| RAMRD | 0x2E | UNDOC | OxEC |
| MADCTL | 0x36 | GRSEL | 0xF2 |
| IPF | 0x3A | | |

Init Code: (Command, Datal, ... DataN)

```
SWRESET,
delay 10ms,
DISPON,
delay 100ms,
SLPOUT,
delay 20ms,
GAMMASET, 0x04,
FRMCTR1, 0x0B, 0x14,
PWCTR1, 0x10, 0x00,
PWCTR2, 0x03,
VMCTR1, 0x46, 0x40,
VOC, 0xBD,
UNDOC, 0x0C,
IPF, 0x05,
CASET, 0x00, 0x00, 0x00, 0x7F,
PASET, 0x00, 0x00, 0x00, 0x7F,
MADCTL, 0xC8,
SDDC, 0x00,
GRSEL, 0x01,
GAMCTRP1, 0x3F, 0x29, 0x27, 0x2C, 0x27, 0x0C, 0x54, 0xC7, 0x40, 0x19, 0x17, 0x1E, 0x02, 0x01,
GAMCTRN1, 0x00, 0x16, 0x18, 0x13, 0x18, 0x13, 0x2B, 0x38, 0x3F, 0x06, 0x18, 0x21, 0x3D, 0x3E,
0x3F,
DISPON
```

4DLCD-144 ST7735S Driver IC Version

8.4. ST7735S Driver IC Version

Sold approximately late 2019 to present

| | Value | | Value | | Value |
|---------|-------|---------|-------|----------|-------|
| SWRESET | 0x01 | RAMRD | 0x2E | PWCTR2 | 0xC1 |
| RDDID | 0x04 | PTLAR | 0x30 | PWCTR3 | 0xC2 |
| SLPIN | 0x10 | MADCTL | 0x36 | PWCTR4 | 0xC3 |
| SLPOUT | 0x11 | COLMOD | 0x3a | PWCTR5 | 0xC4 |
| PTLON | Ox12 | FRMCTRI | 0xB1 | VMCTR1 | 0xC5 |
| DISPOFF | 0x28 | FRMCTR2 | 0xB2 | GAMCTRP1 | 0xE0 |
| DISPON | 0x29 | FRMCTR3 | 0xB3 | GAMCTRN1 | 0xE1 |
| CASET | 0x2A | INVCTR | 0xB4 | F0new | 0xF0 |
| RASET | 0x2B | DISSET5 | 0xB6 | F6new | 0xF6 |
| RAMWR | 0x2C | PWCTR1 | 0xC0 | | |

Init Code: (Command, Datal, ... DataN)

```
SWRESET,
delay 10ms,
SLPOUT, //Sleep Out
delay 120ms,
FRMCTR1, 0x02, 0x35, 0x36, //Setup Frame Rate Control (In Normal Mode/ Full Colours)
FRMCTR2, 0x02, 0x35, 0x36, //Setup Frame Rate Control (In Idle Mode/ 8-Colors)
FRMCTR3, 0x02, 0x35, 0x36, 0x02, 0x35, 0x36, //Frame Rate Control (Partial Mode/ Full Colours)
INVCTR, 0x07,
DISSET5, 0xB4, 0xF0,
PWCTR1, 0xA2, 0x02, 0x84,
PWCTR2, 0xC5,
PWCTR3, 0x0A, 0x00,
PWCTR4, 0x8A, 0x2A,
PWCTR5, 0x8A, 0xEE,
VMCTR1, 0x06,
MADCTL, 0xC8,
GAMCTRP1, 0x12, 0x1C, 0x10, 0x18, 0x33, 0x2C, 0x25, 0x28, 0x28, 0x27, 0x2F, 0x3C, 0x00, 0x03,
0x03, 0x10,
GAMCTRN1, 0x12, 0x1C, 0x10, 0x18, 0x2D, 0x28, 0x23, 0x28, 0x28, 0x26, 0x2F, 0x3B, 0x00, 0x03,
0x03, 0x10,
F0new, 0X01,
F6new, 0X00,
COLMOD, 0X05,
CASET, 0x00, 0x02, 0x00, 0x81,
RASET, 0x00, 0x03, 0x00, 0x82,
DISPON,
delay 10ms,
RAMWR
```

4DLCD-144 Reading Driver IC

8.5. Reading Driver IC

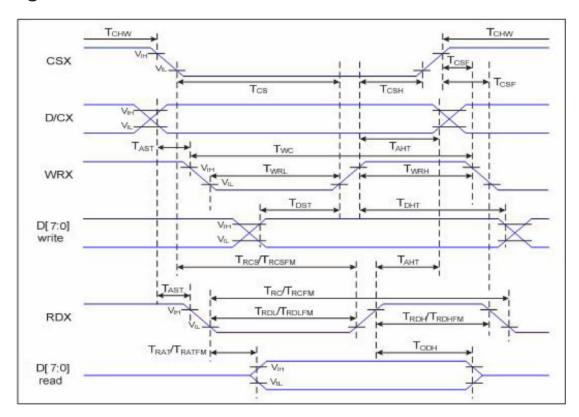
The following application (written in 4DGL for 4D Systems Processors) can be used to identify which driver IC is used. This program can be ported to another language if not using a 4D Processor. Essentially it reads 3 bytes from the display at a specified address, and those 3 bytes dictate which driver IC is being used.

```
#platform "GOLDELOX"
#inherit "4DGL_16bitColours.fnc"
#constant RDDID 0x04
func main()
   var ID1, ID2, ID3, msg;
    disp_WriteControl(RDDID);
    disp_ReadByte(); // dummy read
   ID1 := disp_ReadByte();
   ID2 := disp_ReadByte();
   ID3 := disp_ReadByte();
    gfx_MoveTo(0,0);
    gfx_Rectangle(0, 0, peekB(SYS_X_MAX), peekB(SYS_Y_MAX), BLUE);
    // decide which device
                                                      // "ST7735"
    if (ID1 == 0x5C && ID2 == 0x88 && ID3 == 0x35)
       msg := "ST7735" ;
    else if (ID1 == 0x5C && ID2 == 0x89 && ID3 == 0xF0) // "ST7735R"
       msg := "ST7735R" ;
    else if (ID1 == 0x7C && ID2 == 0x89 && ID3 == 0xF0) // "ST7735S"
       msg := "ST7735S" ;
    else if (ID1 == 0x54 && ID2 == 0x80 && ID3 == 0x66) // "ILI9163C"
       msg := "ILI9163C";
    else
       msg := 0;
    endif
    gfx_MoveTo(10, 10);
    if (msg == 0)
        print("Unknown Driver IC,\nID bytes:-\n");
        print([HEX2]ID1, " " , [HEX2]ID2, " " , [HEX2]ID3);
        to (COMO); print("Unknown Driver IC, ID bytes:- ");
        to (COM0); print([HEX2]ID1, " " , [HEX2]ID2, " " , [HEX2]ID3, "\n");
        print("Driver IC is\n", [STR] msg);
        to (COMO); print("Driver IC is ", [STR] msg, "\n");
    endif
    repeat forever
endfunc
```

4DLCD-144 LCD Timing Details

9. LCD Timing Details

9.1. Timing Chart



| SIGNAL | SYMBOL | PARAMETER | MIN | MAX | UNIT | DESCRIPTION |
|--------|--------|---------------------------------------|-----|-----|------|-------------|
| DCX | tast | Address setup time | 10 | - | ns | - |
| | taht | Address hold time (Write/Read) | 10 | - | ns | - |
| CSX | tchw | CSX "H" pulse width | 0 | - | ns | - |
| | tcs | Chip Select setup time | 15 | - | ns | - |
| | trcs | Chip Select setup time (Read ID) | 45 | - | ns | - |
| | trcsfm | Chip Select setup time (Read FM) | 350 | - | ns | - |
| | tcsf | Chip Select Wait time (Write/Read) | 10 | - | ns | - |
| | tcsh | Chip Select Hold time | 10 | - | ns | - |
| WRX | twc | Write cycle | 100 | - | ns | - |
| | twrh | Write Control Pulse H duration | 30 | - | ns | - |
| | twrl | Write Control Pulse L duration | 30 | - | ns | - |

4DLCD-144 Timing Chart

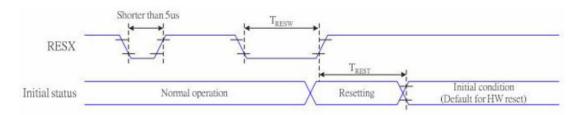
| SIGNAL | SYMBOL | PARAMETER | MIN | MAX | UNIT | DESCRIPTION |
|---------|--------|---------------------------------------|-----|-----|------|-----------------------------|
| RDX(FM) | trcfm | Read cycle (FM) | 450 | - | ns | |
| | trdhfm | Read Control Pulse H duration (FM) | 90 | - | ns | |
| | trdlfm | Read Control Pulse L duration (FM) | 355 | - | ns | |
| RDX(ID) | trc | Read cycle (ID) | 160 | - | ns | When read ID Data |
| | trdh | Read Control Pulse H duration | 90 | - | ns | |
| | trdl | Read Control Pulse L duration | 45 | - | ns | |
| D[7:0] | tdst | Write data setup time | 10 | - | ns | When read from frame memory |
| | tdht | Write data hold time | 10 | - | ns | |
| | trat | Read access time | - | 40 | ns | |
| | Tratfm | Read access time | - | 340 | ns | |
| | trod | Read output disable time | 20 | 80 | ns | |



Timing parameter (VDD=3.3V, GND=0V, Ta=25°C)

4DLCD-144 Reset Timing

9.2. Reset Timing



| SIGNAL | SYMBOL | PARAMETER | MIN | MAX | UNIT |
|--------------|-------------------|-------------------------|-----|-----|------|
| RESET (RESX) | T _{RESW} | Reset pulse duration | 10 | - | us |
| | T _{REST} | Reset cancel | - | 5 | ms |
| | | | - | 120 | ms |



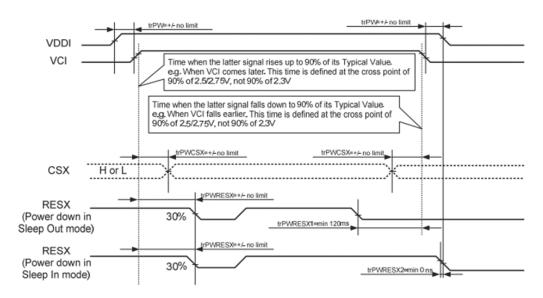
- The reset cancel includes the time required for loading ID bytes, VCOM setting and other settings from the EEPROM (or similar device) to register. This loading is done every time when there is HW reset cancel time (trest) within 5 ms after a siring edge of RESX.
- Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below

| RESX Pulse | Action |
|---------------------|----------------|
| Shorter than 5us | Reset rejected |
| Longer than 9us | Reset |
| Between 5us and 9us | Reset starts |

4DLCD-144 Power On Sequence

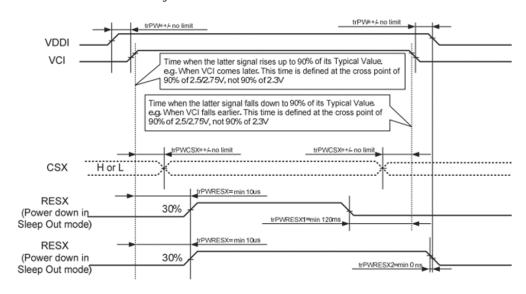
9.3. Power On Sequence

9.3.1. Case 1 - RES line is held High or Unstable by Host at Power ON



trPWRESX1 is applied to RESX falling in the Sleep Out Mode trPWRESX2 is applied to RESX falling in the Sleep In Mode

9.3.2. Case 2 - RES line is held Low by Host at Power ON



trPWRESX1 is applied to RESX falling in the Sleep Out Mode trPWRESX2 is applied to RESX falling in the Sleep In Mode

9.4. Power-off Sequence - Uncontrolled Power Off

Uncontrolled power off is a situation where power is removed unexpectedly, e.g. a battery powering a device is disconnected without using the controlled power off sequence. There will not be any da mage to the display module, nor will the display module cause any damage to the host. During an uncontrolled power off event, ST7735S causes the display to blank its content and there will not be any further abnormal visible effects on the display after 1 second of the power being removed. The display will remain blank until the Power On Sequence occurs.

4DLCD-144 Reliability Test

10. Reliability Test

| Reliability Test | | | | | |
|------------------|--|---|---|--|--|
| No. | SYMBOL | TEST CONDITION | REMARK | | |
| 1 | High Temperature Storage | 80°C±2°C 96H Restore 2H at 25°C Power off | After test cosmetic and electrical defects should not happen. | | |
| 2 | Low Temperature Storage | -30°C±2°C 96H Restore 2H at 25°C Power off | | | |
| 3 | High Temperature Operation | 70°C±2°C 96H Power on | | | |
| 4 | Low Temperature Operation | -20°C±2°C 96H Power on | | | |
| 5 | High Temperature & Humidity Operation | 60°C±2°C 90%RH 96H Power on | | | |
| | | -20°C<>25°C<>70°C 30min 5min 30min | | | |
| 6 | Temperature Cycle | After 10 cycles, restore 2H at 25°C Power off | | | |
| 7 | Vibration Test | 10Hz~150Hz, 100m/s ² , 120min | | | |
| 8 | Shock Test | Half-sinewave, 300m/s ² , 11ms | | | |



The Displays are of the highest rated 'Grade A', which allows for 0-4 defective pixels. A defective pixel could be solid Black (Dead), White, Red, Green or Blue.

11. Precautions for Using LCD Modules

11.1. Handing Precautions

- The display panel is made of glass and a polarizer. The glass is fragile. It tends to be chipped during handling, especially on the edges. Please avoid dropping or jarring. Please be careful not subject it to a mechanical shock by dropping it on impact.
- If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any of it in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.
- Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary. Do not touch the display with bare hands. This will stain the display area and degrade insulation between terminals (some cosmetics are determined by the polarizer).
- The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully. Do not touch, push or rub the exposed polarizer with anything harder than an HB pencil lead (e.g., glass, tweezers, etc.). Do not put or attach anything to the display area to avoid leaving marks on it. Condensation on the surface and contact with terminals due to cold temperatures will damage, stain or contaminate the polarizer. After products are tested at low temperatures they must be warmed up in a container before coming into contact with room-temperature air.
- If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten the cloth with one of the following solvents
 - · Isopropyl alcohol
 - Ethyl alcohol Do not scrub hard as it might damage the display surface.
- · Solvents other than those mentioned above may damage the polarizer. Especially the following.
 - Water
 - Ketone
 - Aromatic solvents Wipe off saliva or water drops immediately, contact with water over a long period may cause deformation or color fading. Avoid contact with oil and fat.
- Take necessary precautions to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or current flow in a high-humidity environment.
- Install the LCD Module by using the mounting holes. When mounting the LCD module, make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.
- Do not attempt to disassemble or process the LCD module.
- · NC terminal should be open. Do not connect anything to it.
- · If the logic circuit power is off, do not apply input signals.

4DLCD-144 Handing Precautions

• Control Electro-Static Discharge. Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC. To prevent the destruction of the elements by static electricity, ensure that an optimum work environment is maintained.

- Before removing the LCM from its packing case or incorporating it into a set, be sure that the module and your body have the same electric potential. Be sure to ground your body when handling the LCD modules.
- To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions. To reduce the generation of static electricity, please ensure that the air in the work environment is not too dry. Relative humidity of 50%-60% is recommended. As much as possible, make the electric potential of your work clothes and that of the workbench the ground potential.
- The LCD module is coated with a film to protect the display surface. Be careful when peeling off this protective film since static electricity may be generated.
- Since the LCM has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.
 - \cdot Do not alter, modify or change the shape of the tab on the metal frame.
 - Do not make extra holes on the printed circuit board, modify its shape or change the positions of the components to be attached.
 - · Do not damage or modify the pattern writing on the printed circuit board.
 - Do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
 - · Do not drop, bend or twist the LCM.

4DLCD-144 Storage Precautions

11.2. Storage Precautions

When storing the LCD modules, the following precautions are necessary.

· Store them in a sealed polyethylene bag. If properly sealed, there is no need for the desiccant.

- Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C, and keep the relative humidity between 40%RH and 60%RH.
- The polarizer surface should not come in contact with any other objects. (We advise you to store them in an anti-static electricity container in which they were shipped. Some Liquid crystals solidify under low temperatures (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subjected to low temperatures.
- If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.
- To minimize the performance degradation of the LCD modules resulting from the destruction caused by static electricity etc., please avoid holding the following sections when handling the modules'
 - · The exposed area of the printed circuit board
 - · Terminal electrode sections

4DLCD-144 Revision History

12. Revision History

| Document Revision | | | | |
|-------------------|------------|--|--|--|
| REVISION | DATE | COMMENT | | |
| 1.0 | 29/01/2010 | Initial Version | | |
| 1.1 | 20/05/2012 | Driver IC Change | | |
| 1.2 | 14/01/2021 | Facelift of Datasheet, updated information | | |
| 1.3 | 20/01/2023 | Modified datasheet for web-based documentation | | |