4DLCD-144

Datasheet

Revision 1.3

Contents

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)	

Part Number Details

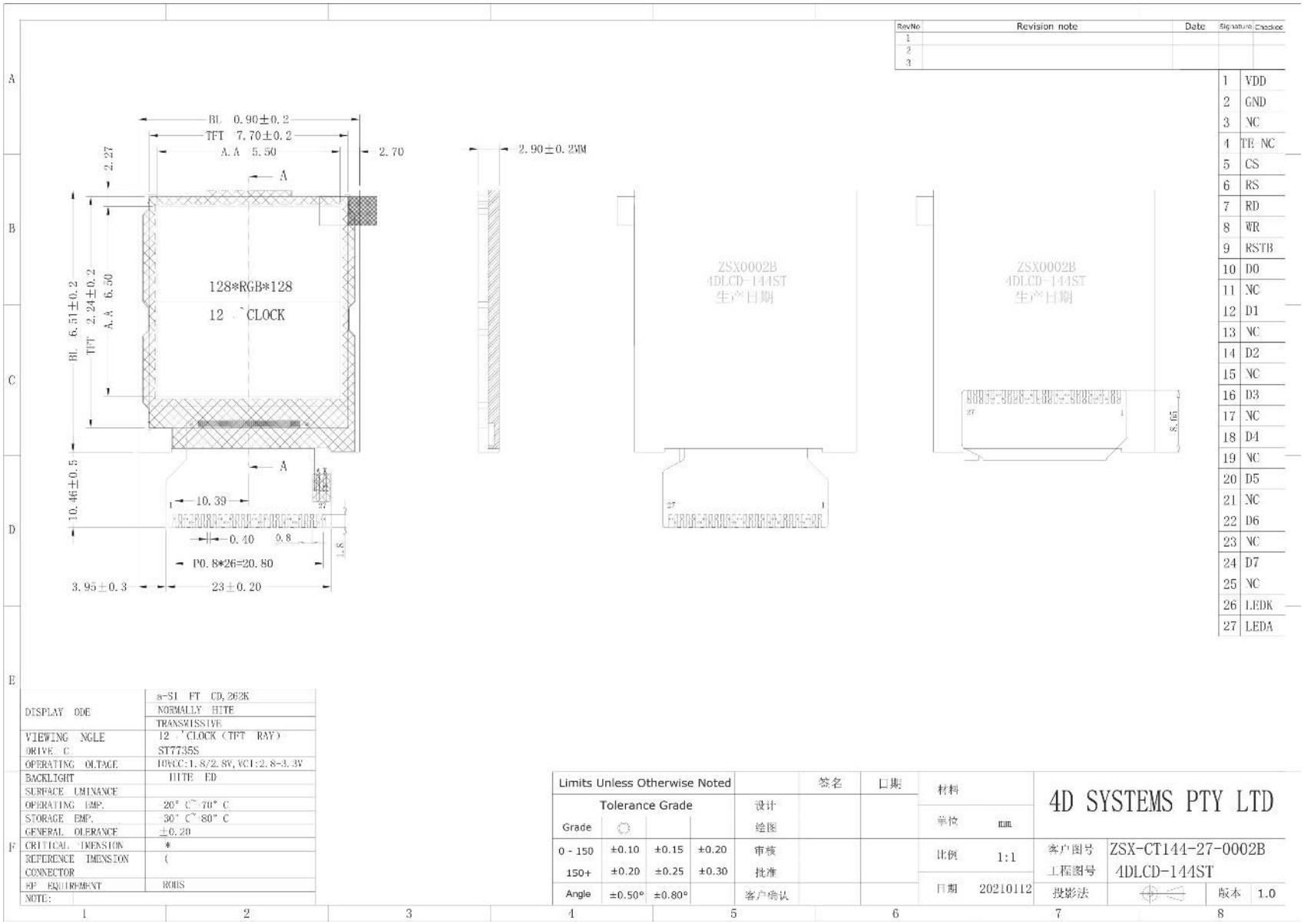
4DLCD - 4DLCD LCD Display

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

Note

1. RoHS compliant
2. LCD weight tolerance: ± 5%.

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

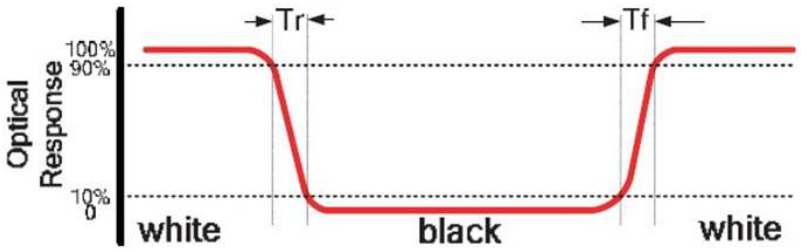
Note

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

6. Electro-Optical Characteristics

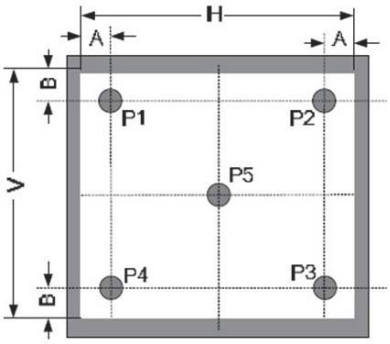
Electro-Optical Characteristics

ITEM		SYM	CONDITION	MIN	TYP	MAX	UNIT	REMARK
Response Time		Tr+Tf	θ=0	-	25	-	ms	see figure
Contrast Ratio		Cr	°	-	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	x		0.558	0.608	0.628		see figure
		y		0.296	0.316	0.336		
	Green	x	θ=0°	0.285	0.305	0.325		
		y	Ø=0°	0.536	0.556	0.576		
	Blue	x	Ta=25	0.115	0.135	0.155		
		y		0.117	0.137	0.157		
	White	x		0.285	0.305	0.325		
		y		0.314	0.334	0.354		
Transmittance		T		-	6	-	%	

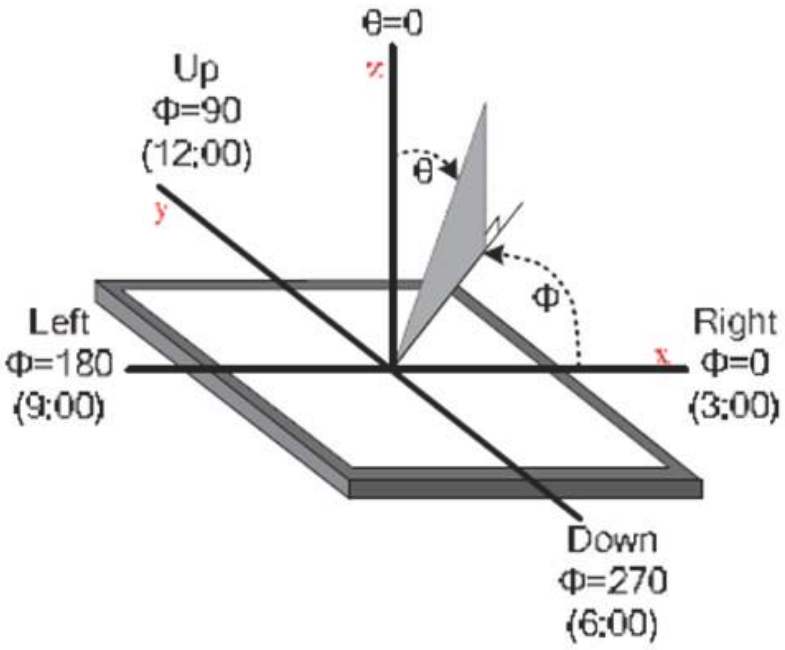


The definition of response time

A : 5 mm
B : 5 mm
H,V : Active Area
Light spot size ∅=5mm, 500mm distance from the LCD surface to detector lens
measurement instrument is TOPCON's luminance meter BM-5



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.

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

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

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

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.

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	

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, ST7735R, 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	0x3a	
PWCTR6	0xFC	unique to ST7735	FRMCTR1	0xB1	
VCOM4L	0xFF	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		VMCTR1	0xC5	
RAMWR	0x2C		GAMCTRP1	0xE0	
RAMRD	0x2E		GAMCTRN1	0xE1	
PTLAR	0x30		F0new	0xF0	
MADCTL	0x36		F6new	0xF6	

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
```

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	0x11	COLMOD	0x3a	PWCTR5	0xC4
PTLON	0x12	FRMCTR1	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, Data1, ... 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
```

8.3. ILI9163C Driver IC Version

Sold approximately 2013 to late 2019

	Value		Value
SWRESET	0x01	FRMCTR1	0xB1
SLPOUT	0x11	SDDC	0xB7
GAMMASET	0x26	PWCTR1	0xC0
DISPOFF	0x28	PWCTR2	0xC1
DISPON	0x29	VMCTR1	0xC5
CASET	0x2A	VOC	0xC7
RASET	0x2B	GAMCTRP1	0xE0
RAMWR	0x2C	GAMCTRN1	0xE1
RAMRD	0x2E	UNDOC	0xEC
MADCTL	0x36	GRSEL	0xF2
IPF	0x3A		

Init Code: (Command, Data1, ... 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,
0x00,
GAMCTRN1, 0x00, 0x16, 0x18, 0x13, 0x18, 0x13, 0x2B, 0x38, 0x3F, 0x06, 0x18, 0x21, 0x3D, 0x3E,
0x3F,
DISPON
```

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	0x12	FRMCTR1	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, Data1, ... 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
```

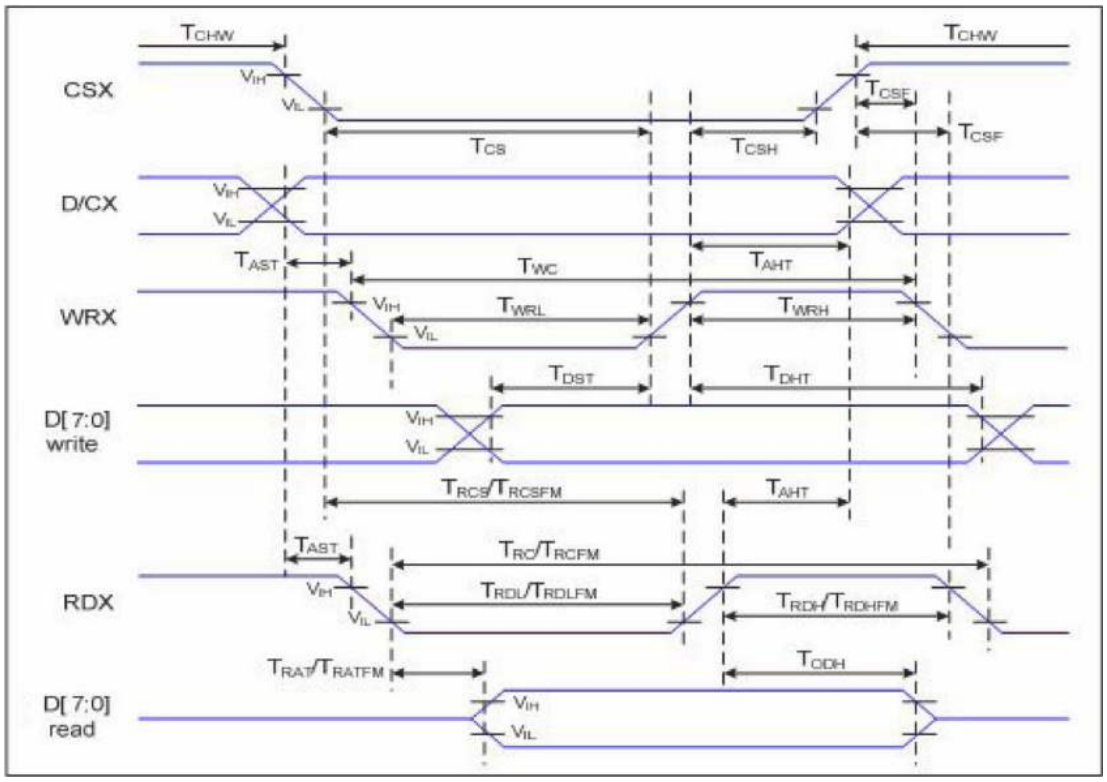
8.5. Reading Driver IC

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
    if (ID1 == 0x5C && ID2 == 0x88 && ID3 == 0x35)      // "ST7735"
        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 (COM0); print("Unknown Driver IC, ID bytes:- ");
        to (COM0); print([HEX2]ID1, " " , [HEX2]ID2, " " , [HEX2]ID3, "\n") ;
    else
        print("Driver IC is\n", [STR] msg) ;
        to (COM0); print("Driver IC is ", [STR] msg, "\n") ;
    endif

    repeat forever

endfunc
```

9. LCD Timing Details

9.1. Timing Chart



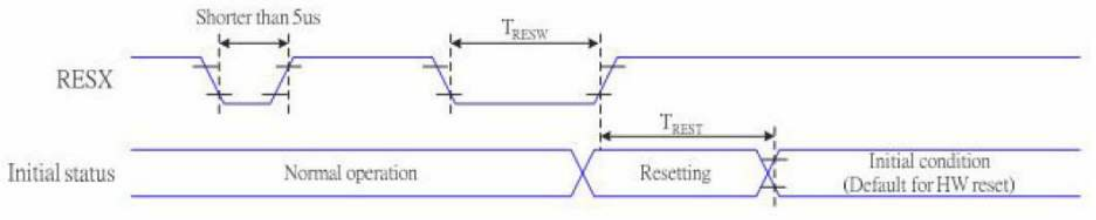
SIGNAL	SYMBOL	PARAMETER	MIN	MAX	UNIT	DESCRIPTION
DCX	tast	Address setup time	10	-	ns	-
	taht	Address hold time (Write/Read)	10	-	ns	-
CSX	tchw	CSX “H” pulse width	0	-	ns	-
	tcs	Chip Select setup time	15	-	ns	-
	trcs	Chip Select setup time (Read ID)	45	-	ns	-
	trcsfm	Chip Select setup time (Read FM)	350	-	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	-

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	

Note

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

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

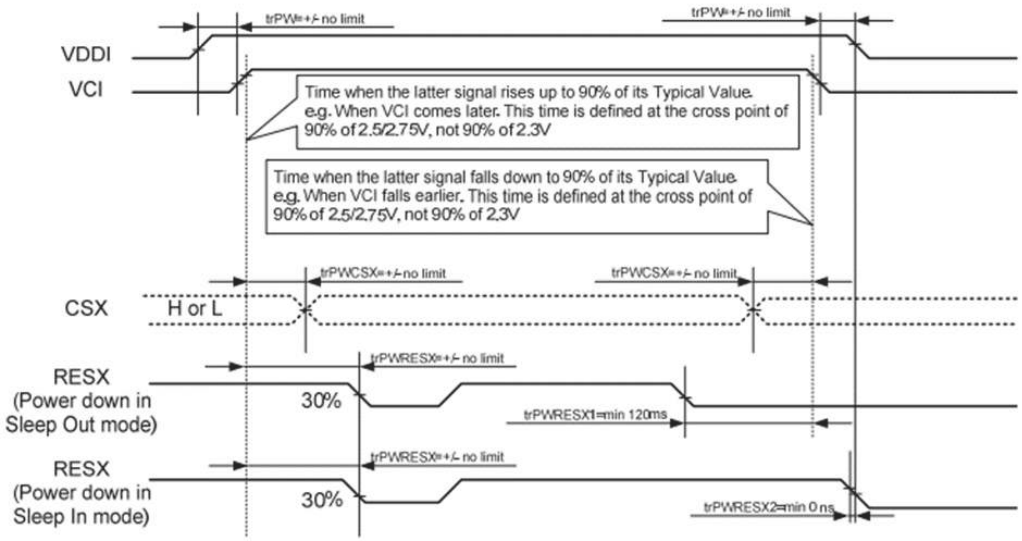
Note

- 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

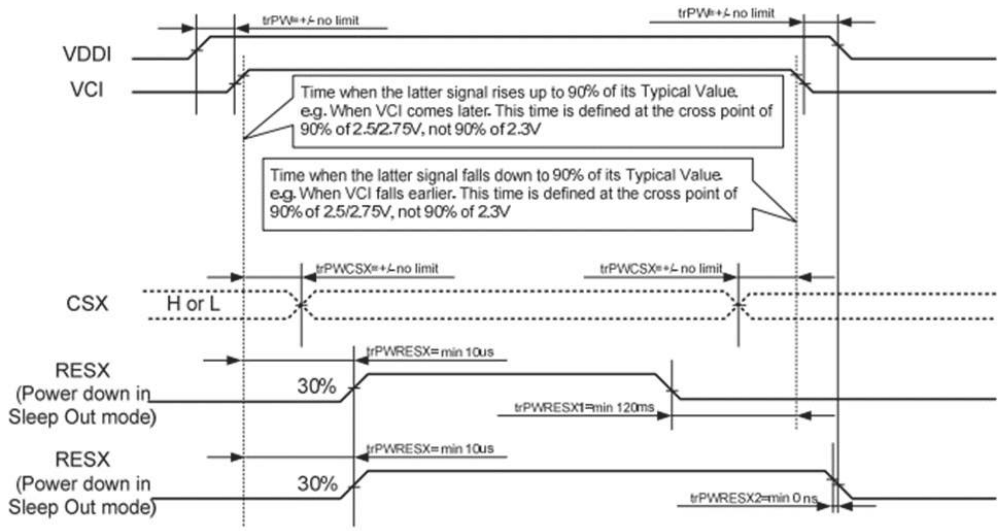
9.3. Power On Sequence

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.

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	
6	Temperature Cycle	-20˚C<-->25˚C<-->70˚C 30min 5min 30min 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	

Note

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.

- 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.
    - 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.

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℃ and 35℃, 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

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