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4DLCD-144ST

1.44" TFT Liquid Crystal Display

DATASHEET

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Revision History

REVISION	DATE	COMMENT	REMARKS
1.0 (01)	29/01/2010	Initial Version	Initial Version, Revision 01
1.1 (02)	20/05/2012	Driver IC Change	Revision 02
1.2	14/01/2021	Facelift of Datasheet, updated information	

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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 128 x 128 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 Inversion Direction	6:00	O'Clock
LCD (W × H × D)	30.9 × 36.51 × 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/m ²
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)	

Note 1: RoHS compliant

Note 2: LCD weight tolerance: ± 5%.

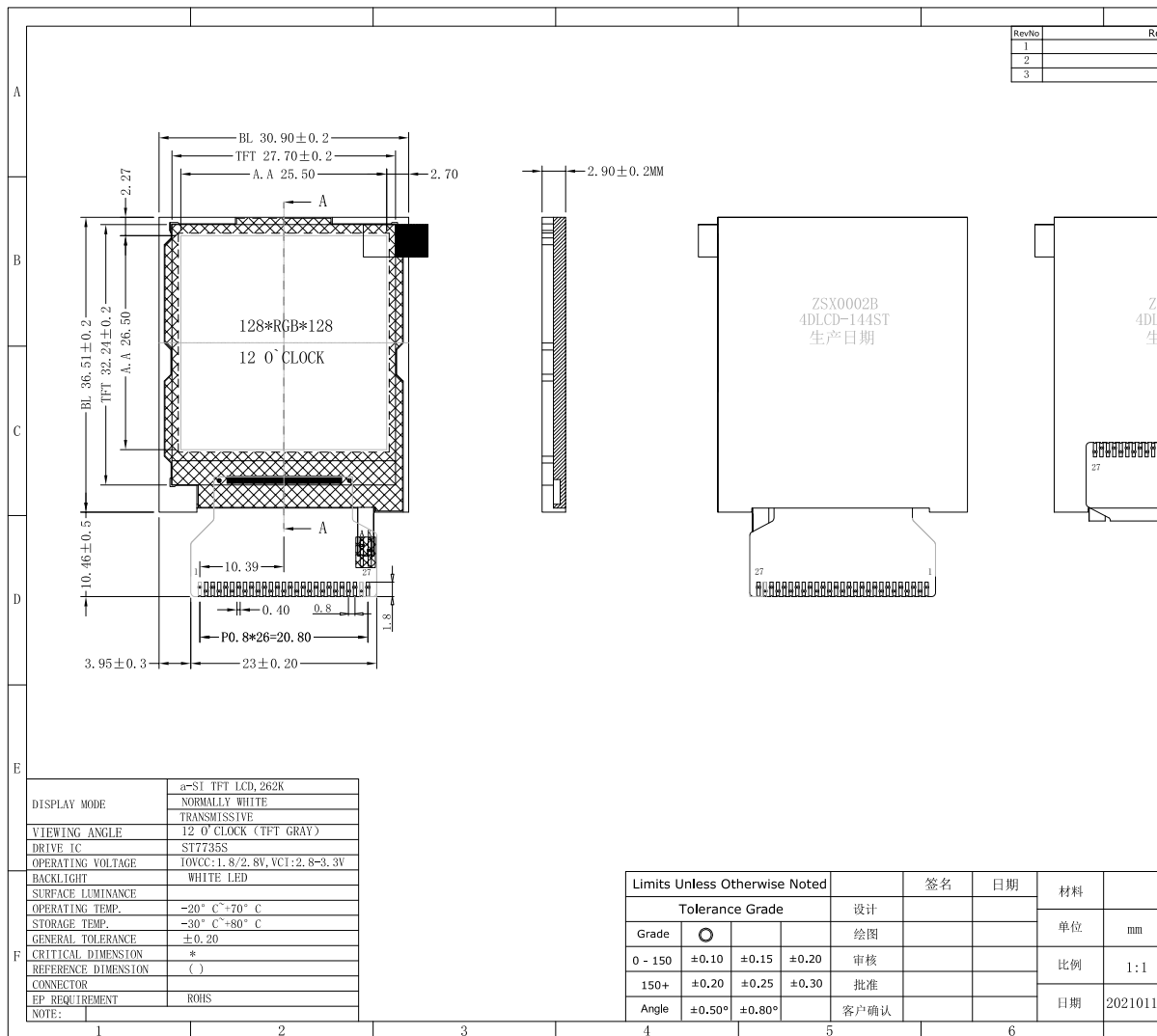
Part Number Details:

4DLCD 4DLCD LCD Display

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

4DLCD-144-2NT

2. TFT LCD Display Drawing



3. 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	T _{OP}	-20	70	°C
Storage Temperature	T _{ST}	-30	80	°C
Humidity	RH	10%	90% (Max 60°C)	RH

4. 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	V _{IH}	0.7VDD	-	VDD	V
Input Voltage 'L' Level	V _{IL}	0	-	0.2VDD	V

5. Backlight Characteristics

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Voltage for LED backlight	V _I	-	2.8	3.1	V
Current for LED backlight	I _I	-	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

ITEM	SYM	CONDITION	MIN	TYP	MAX	UNIT	REMARK
Response Time	Tr+Tf	$\theta=0$	-	25	-	ms	Figure 1 (4)
Contrast Ratio	Cr	$^{\circ}$	-	350	-	-	Figure 2 (1)
Luminance Uniformity	δ WHITE	$\phi=0$	75	80	-	%	Figure 2 (3)
Surface Luminance	Lv	20mA	-	120	-	cd/m ²	Figure 2 (2)
Viewing Angle Range	θ	$\phi = 90^{\circ}$	-	35	-	deg	Figure 3 (6)
		$\phi = 270^{\circ}$	-	15	-	deg	
		$\phi = 0^{\circ}$	-	45	-	deg	
		$\phi = 180^{\circ}$	-	45	-	deg	
CIE (x,y) Chromacity	Red	x	$\theta=0^{\circ}$ $\phi=0^{\circ}$ Ta=25	0.558	0.608	0.628	Figure 2 (5)
		y		0.296	0.316	0.336	
	Green	x		0.285	0.305	0.325	
		y		0.536	0.556	0.576	
	Blue	x		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	-	%	

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

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

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

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

Note 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 minimum luminance of 5 points luminance. For more information, see Figure 2.

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

Note 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 FIG 1. The test equipment is Autronic-Melchers ConoScope series.

Note 5: CIE (x, y) chromaticity, the x, y value is determined by measuring luminance at each test position 1 through 5, and then make average value.

Note 6: Viewing angle is the angle at which the contrast ratio is greater than 2. For 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 with respect to the z axis which is normal to the LCD surface. For more information, see Figure3.

Note 7: For viewing angle and response time testing, the testing data is based on Autronic-Melchers ConoScope series. Instruments for Contrast Ratio, Surface Luminance, Luminance Uniformity, CIE the test data is based on TOPCONs BM-5 photo detector.

Figure 1. The definition of response time

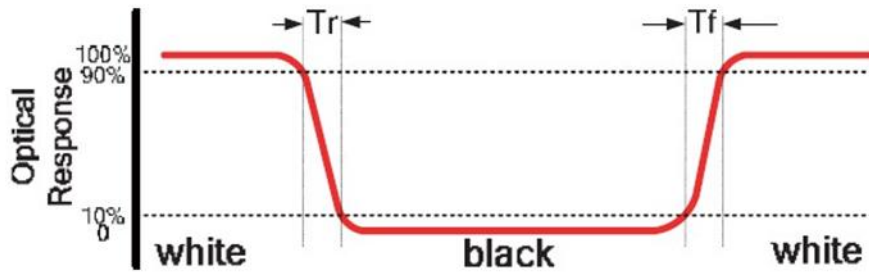


Figure 2. Measuring method for Contrast ratio, surface luminance, Luminance uniformity, CIE (x, y) chromaticity

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

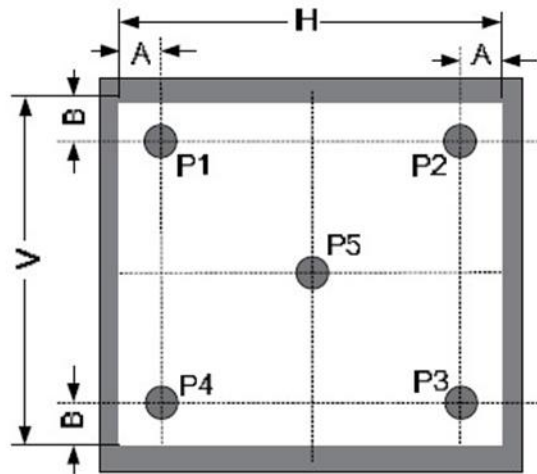
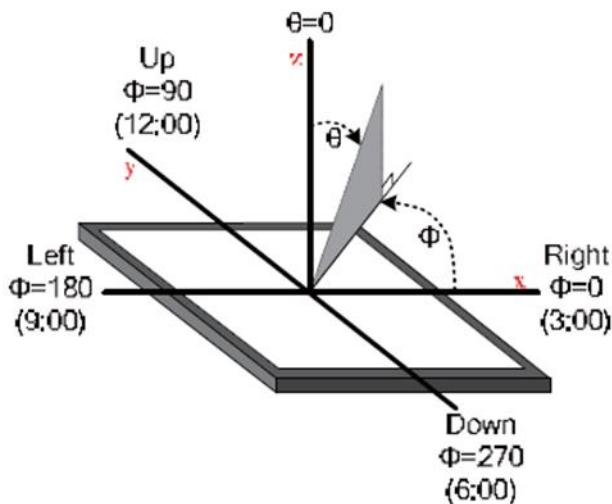


Figure 3. The definition of viewing angle



7. Interface Descriptions

7.1 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 Code

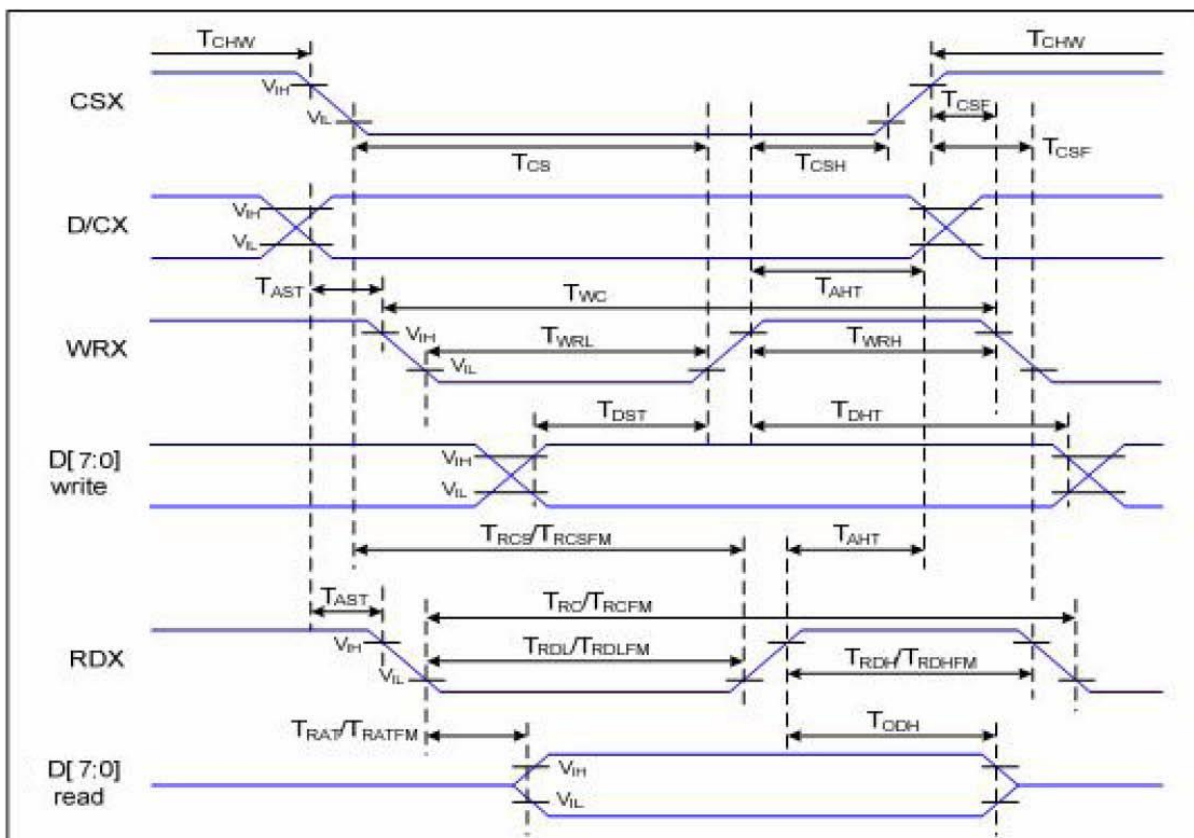
Please see separate document with initialisation codes

9. LCD Timing Details

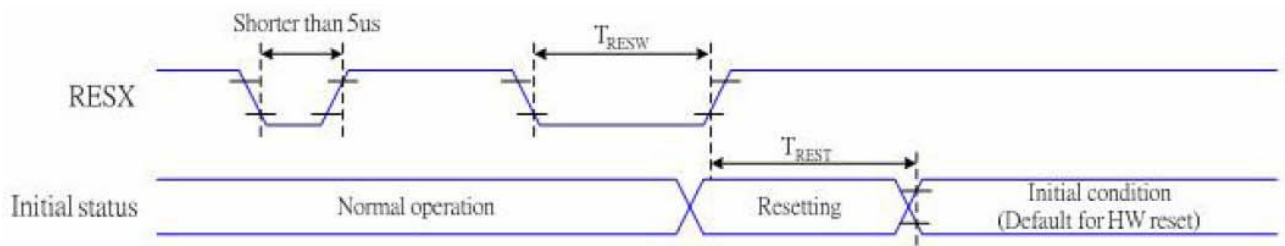
9.1 Timing Chart

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	-
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)



9.2 Reset Timing



SIGNAL	SYMBOL	PARAMETER	MIN	MAX	UNIT
RESET (RESX)	tresw	Reset pulse duration	10	-	us
	trest	Reset cancel	-	5	ms
			-	120	ms

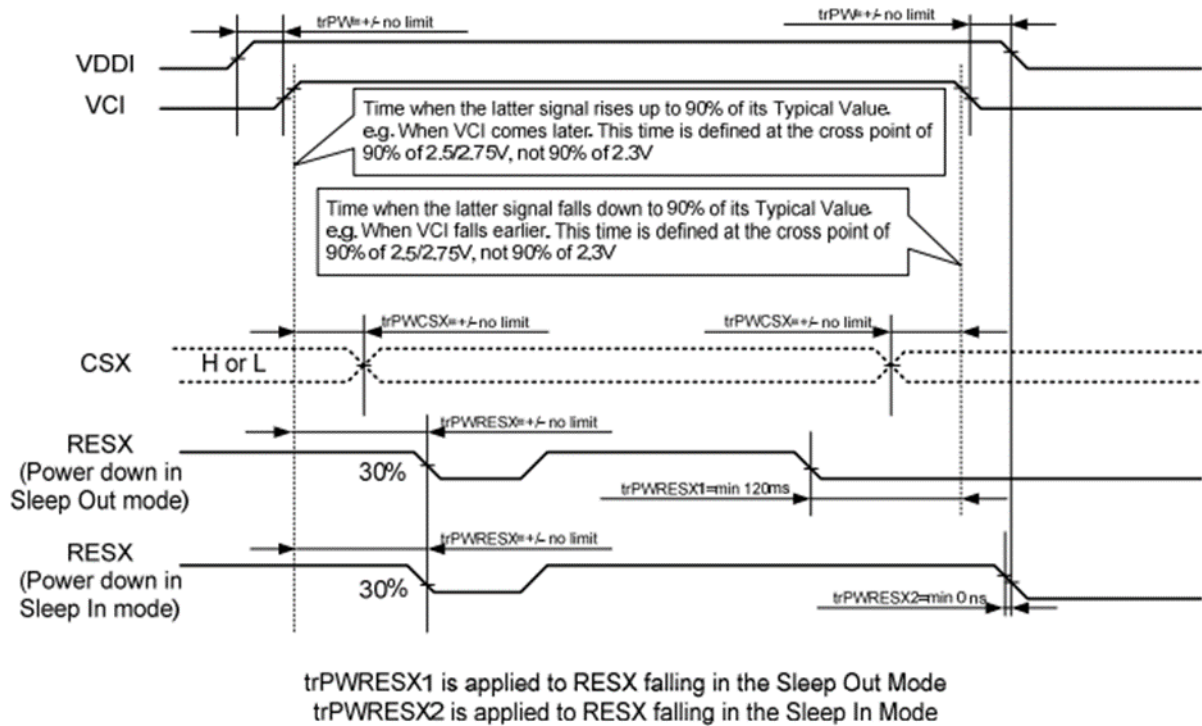
Notes:

- 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 rising edge of RESX.
- Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below

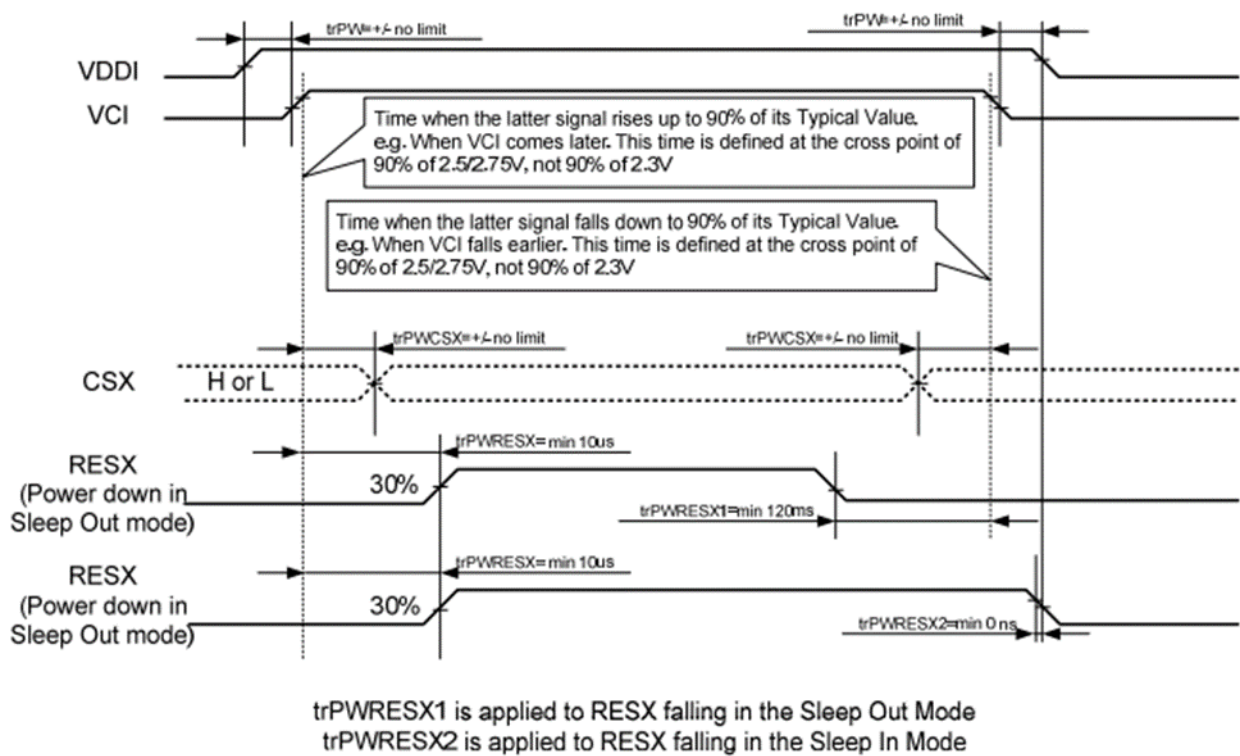
RESX Pulse	Action
Shorter than 5us	Reset rejected
Longer than 9us	Reset
Between 5us and 9us	Reset starts

9.3 Power On Sequence

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



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



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 damage 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

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 Handling Precautions

- The display panel is made of glass and 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 to 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 degraded 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 on the display area to avoid leaving marks on it. Condensation on the surface and contact with terminals due to cold temperature will damage, stain or contaminate the polarizer. After products are tested at low temperature 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 alcoholDo 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 of time 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 on 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 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 has 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. A relative humidity of 50%-60% is recommended. As much as possible, make the electric potential of your work clothes and that of the work bench 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 components to be attached.
 - Do not damage or modify the pattern writing on the printed circuit board.
 - Absolutely 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°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 temperature (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 temperature.
- 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 destruction caused by static electricity etc., please avoid holding the following sections when handling the modules'
 - Exposed area of the printed circuit board
 - Terminal electrode sections

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