晶采光電科技股份有限公司
AMPIRE CO., LTD.

Specifications for LCD module

Customer	
Customer part no.	
Ampire part no.	**AM-240320LITZQW-FCH**
Approved by	
Date	

■ **Preliminary Specification**
☐ **Formal Specification**

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Kokai	Lawlite	Mantle

This Specification is subject to change without notice.

RECORD OF REVISION

Revision Date	Page	Contents	Editor
2022/10/17	--	New Release	Mantle

1 Features

1.1 Introduction

This display module is a color active matrix thin film transistor (TFT) liquid crystal display that uses amorphous silicon TFT as a switching device. This TFT LCD panel has a 2.4 inch diagonally measured active display area with QVGA resolution (240 horizontal by 320 vertical pixels array). The LCD adopts one backlight with High brightness white LED.

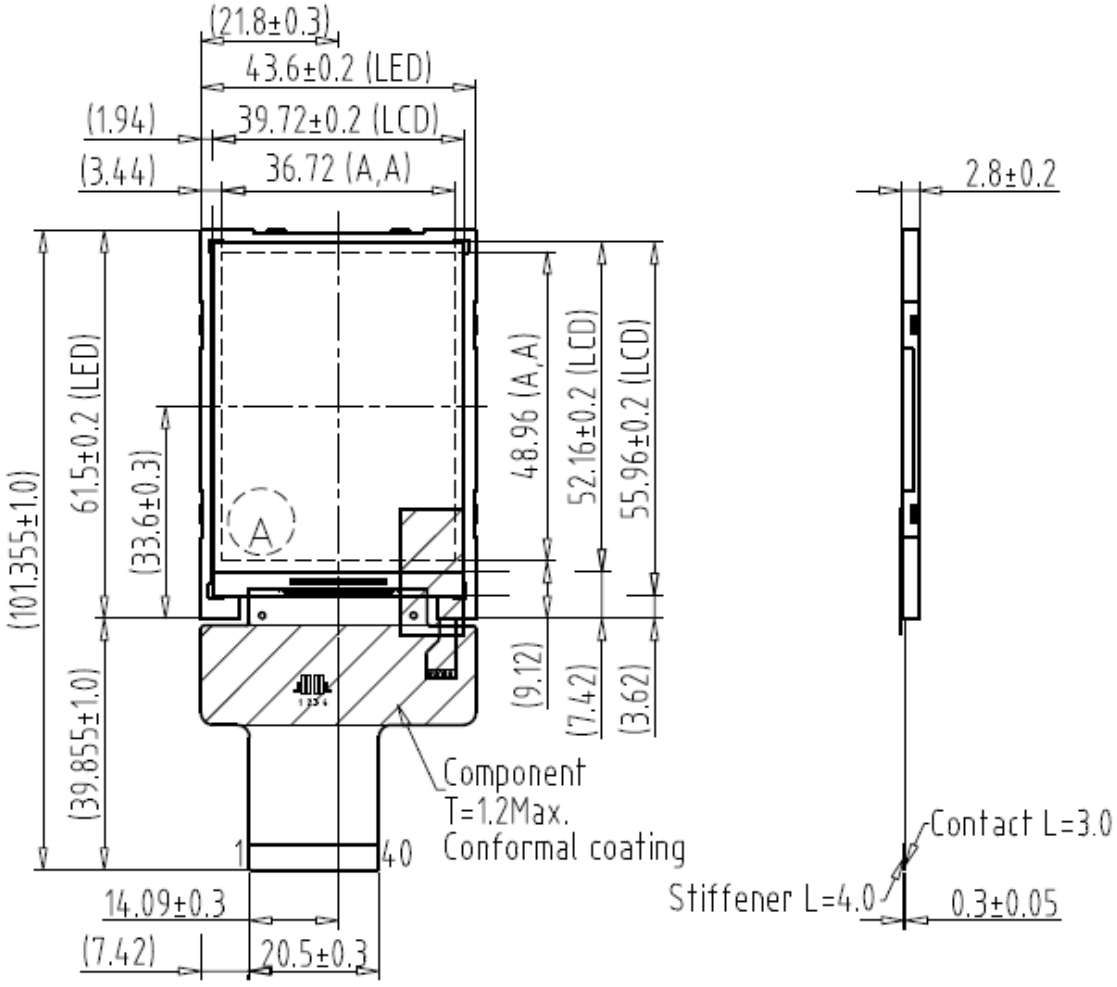
1.2 Feature

(1) 2.4” configuration
(2) 262K color by 6 bit R.G.B. signal input.
(3) RoHS
(4) MCU interface : SPI
(5) MPU interface: 18bits and 6bits, parallel interface.(default)
(6) Interface can Select by H/W Jumper

IM3	IM2	IM1	IM0	Interface	Read back selection
0	1	0	1	3-line serial interface	Via the read instruction (8-bit, 24-bit and 32-bit read parameter)

2. Mechanical specifications

Item	Specifications	Unit
Display resolution(dot)	240(W) x 320(H)	dots
Active area	36.72 (W) x 48.96(H)	mm
Pixel Pitch	0.153(H) x 0.153(V)	mm
Pixel Arrangement	R.G.B -stripe	-
Overall dimension	43.6 (W) x 101.355(H) x 2.8(D)	mm
Display Mode	Normally Black	--
Display Type	Transmissive	--



3. Absolute maximum ratings and environment

3.1 Absolute maximum ratings

Ta=25°C GND=0V

Item	Symbol	Min.	Max.	Unit	Remarks
Power voltage	V_{CC}	-0.3	+3.3	V	
Input voltage	V_{IN}	-0.5	V_{CC}	V	Note(1)
Backlight voltage	V_{AK}		T.B.D	V	

Note 1: Input voltage at ant terminal.

3.2 Environment

Item	Specifications	Remarks
Storage temperature	Max. +80°C Min. -30 °C	Note 1: Non-condensing
Operating temperature	Max. +70 °C Min. -20 °C	Note 1: Non-condensing

Note 1: Ta≦+40 °C・・・・Max.85%RH

Ta＞+40°C・・・・The maximum humidity should not exceed the humidity with 40°C 85%RH.

4. Electrical specifications

4.1 Electrical characteristics of LCM

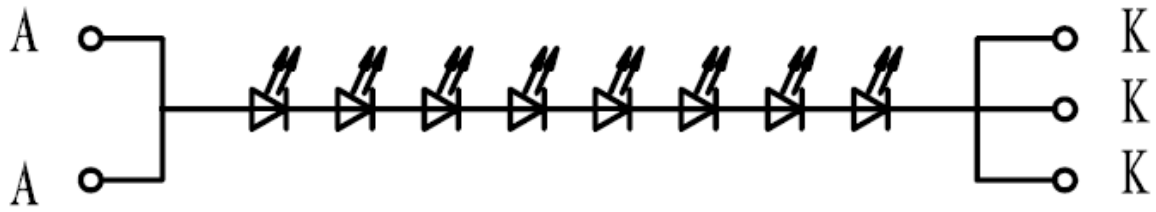
Item	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Operating voltage	V_{CC}		2.4	2.75	3.3	V
High-level input voltage	V_{IH}		$0.8V_{CC}$		V_{CC}	V
Low-level input voltage	V_{IL}		0		$0.2V_{CC}$	V

4.2 LED back light specification

It has LED backlight only without LED Driver.

Item	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Forward voltage	V_f	I_f =20mA	--	24	--	V
Reverse Current(Per LED)	I_r		-	-		uA
Forward current	I_f		-	20		mA
Uniformity	Avg			80		%
LED lifetime		Ta=25°C	-	T.B.D	-	Hr
Luminous color	White					
Chip connection	8 chip serial connection					

Bare LED measure position:



5. Optical characteristics

Item		Symbol	Conditions	Min	Typ	Max	Unit	Note
Contrast Ratio		CR	Viewing normal angle $\Theta_x = \Theta_y = 0$	600	800	-	-	
Response Time		T_R		-	16	21-	ms	(4)
		T_F		-	19	24	ms	(4)
Viewing Angle	Top	Θ_T	CR≧10	-	80	-	deg	(2)
	Bottom	Θ_B		-	80	-		
	Left	Θ_L		-	80	-		
	Right	Θ_R		-	80	-		
Module Chromaticity	Red	X_R	Viewing normal angle $\Theta_x = \Theta_y = 0$	0.627	0.647	0.667	-	-
		Y_R		0.297	0.317	0.337		
	Green	X_G		0.255	0.275	0.295		
		Y_G		0.562	0.582	0.602		
	Blue	X_B		0.120	0.140	0.160		
		Y_B		0.068	0.088	0.108		
	White	X_W		0.290	0.310	0.330		
		Y_W		0.316	0.336	0.359		
Brightness		-	LCD center	800	1000	-	Cd/㎡	(1)

Note (1) Measurement Setup:

The LCD module should be stabilized at given temperature(25℃) for 15 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting backlight for 15 minutes in a windless room.

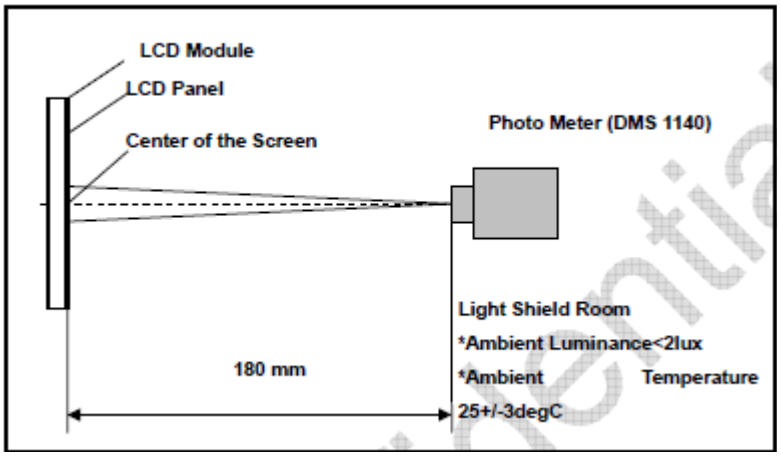


Figure 2 Measurement Setup

Note (2) Definition of Viewing Angle

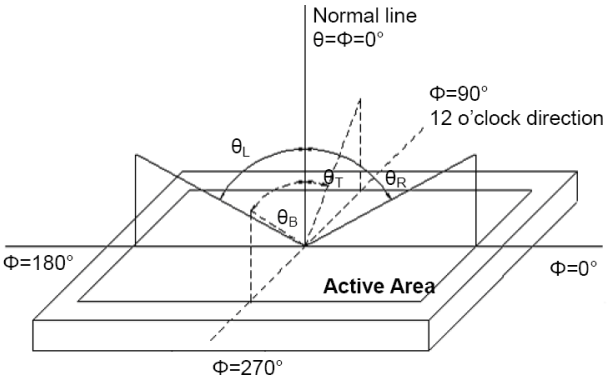


Figure 3 Definition of Viewing Angle

Note (3) Definition Of Contrast Ratio (CR)

The contrast ratio can be calculated by the following expression

Contrast Ratio (CR) = L63 / L0

L63: Luminance of gray level 63, L0: Luminance of gray level 0

Note (4) Definition Of Response Time

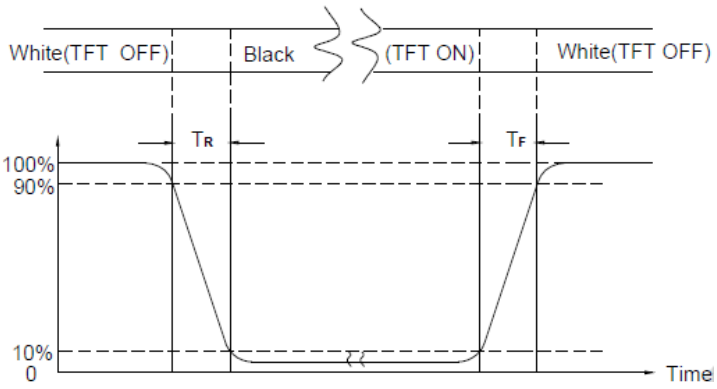


Figure 4 Definition of Response Time

6. Interface specifications

6.1 TFT LCD Panel FPC Descriptions

<table>
<tr><th>Pin No.</th><th>Terminal</th><th>Functions</th></tr>
<tr><td>1</td><td>LED A</td><td>LED anode.</td></tr>
<tr><td>2</td><td>LED K</td><td>LED cathode.</td></tr>
<tr><td>3~8</td><td>NC</td><td>No connection.</td></tr>
<tr><td>9</td><td>GND</td><td>Power ground.</td></tr>
<tr><td>10</td><td>DB0</td><td rowspan="18"><table><tr><th>Mode</th><th>DB Pin in use</th></tr><tr><td>Serial Mode/Digital RGB Interface Mode</td><td>SDI, SDO/ PD [17:0]
B[5:0]=PD[5:0]
G[5:0]=PD[11:6]
R[5:0]=PD[17:12]</td></tr></table></td></tr>
<tr><td>11</td><td>DB1</td></tr>
<tr><td>12</td><td>DB2</td></tr>
<tr><td>13</td><td>DB3</td></tr>
<tr><td>14</td><td>DB4</td></tr>
<tr><td>15</td><td>DB5</td></tr>
<tr><td>16</td><td>DB6</td></tr>
<tr><td>17</td><td>DB7</td></tr>
<tr><td>18</td><td>DB8</td></tr>
<tr><td>19</td><td>DB9</td></tr>
<tr><td>20</td><td>DB10</td></tr>
<tr><td>21</td><td>DB11</td></tr>
<tr><td>22</td><td>DB12</td></tr>
<tr><td>23</td><td>DB13</td></tr>
<tr><td>24</td><td>DB14</td></tr>
<tr><td>25</td><td>DB15</td></tr>
<tr><td>26</td><td>DB16</td></tr>
<tr><td>27</td><td>DB17</td></tr>
<tr><td>28</td><td>SDI</td><td>-Connect to IC ST7789V SDA
-IM3: High, SPI interface input pin.
-The data is latched on the rising edge of the SCL signal.
-If not used, please fix this pin at VCC or GND.</td></tr>
<tr><td>29</td><td>WR/SCL</td><td>-Connect to IC ST7789V DCX
-Display data/command selection pin in parallel interface.
-This pin is used to be serial interface clock.
DCX=’1’: display data or parameter.
DCX=’0’: command data.
-If not used, please fix this pin at VCC or GND.</td></tr>
<tr><td>30</td><td>/RD</td><td>-Connect to IC ST7789V RDX
-Read enable in 8080 MCU parallel interface.
-If not used, please fix this pin at VCC or GND.</td></tr>
<tr><td>31</td><td>/RESET</td><td>-Connect to IC ST7789V RESX
-This signal will reset the device and it must be applied to properly initialize the chip.
-Signal is active low.</td></tr>
<tr><td>32</td><td>DE</td><td>-Connect to IC ST7789V ENABLE
-Data enable signal for RGB interface operation.
-If not used, please fix this pin at VCC or GND.</td></tr>
<tr><td>33</td><td>GND</td><td>Power ground.</td></tr>
</table>

34	DCLK	-Dot clock signal for RGB interface operation. ***-If not used, please fix this pin at VCC or GND.***
35	GND	Power ground.
36	HSYNC	-Horizontal (Line) synchronizing input signal for RGB interface operation. ***-If not used, please fix this pin at VCC or GND.***
37	VSYNC	-Vertical (Frame) synchronizing input signal for RGB interface operation. ***-If not used, please fix this pin at VCC or GND.***
38	/CS	-**Connect to IC ST7789V CSX** -Chip selection pin **Low enable.** **High disable.**
39	RS	**-Connect to IC ST7789V WRX** - Write enable in MCU parallel interface. - Display data/command selection pin in 4-line serial interface. - Second Data lane in 2 data lane serial interface. ***-If not used, please fix this pin at VCC or GND.***
40	VCC	A supply voltage to the analog circuit. Connect to an external power supply of 2.4 ~ 3.3V.

Mating Connector : 6701-E40N-00R or equivalent.

6.2 System Function Command Table

(Please refer to **ST7789V** data sheet)

7. Application

7.1 Power ON/OFF Sequence

VDDI and VDD can be applied in any order.
VDD and VDDI can be power down in any order.
During power off, if LCD is in the Sleep Out mode, VDD and VDDI must be powered down minimum 120msec
after RESX has been released.
During power off, if LCD is in the Sleep In mode, VDDI or VDD can be powered down minimum 0msec after
RESX has been released.
CSX can be applied at any timing or can be permanently grounded. RESX has priority over CSX.

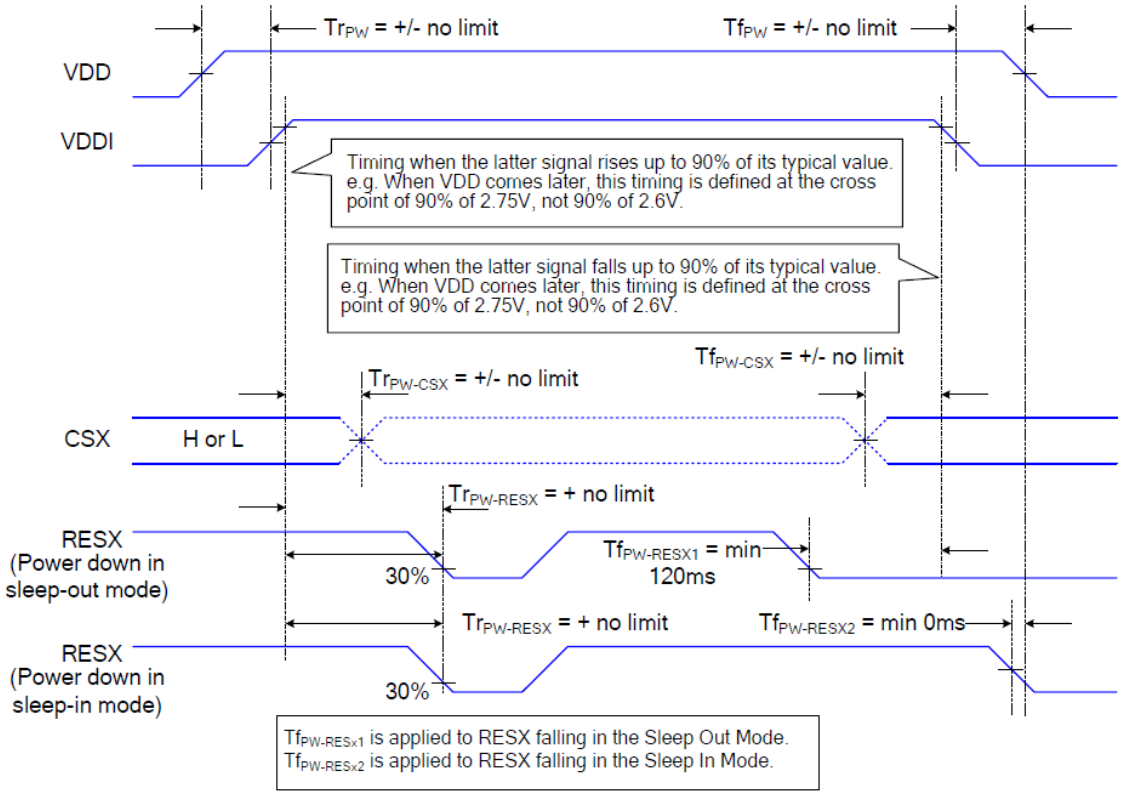
Note 1: There will be no damage to the display module if the power sequences are not met.

Note 2: There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.

Note 3: There will be no abnormal visible effects on the display between end of Power On Sequence and before receiving Sleep Out
command. Also between receiving Sleep In command and Power Off Sequence.

Note 4: If RESX line is not held stable by host during Power On Sequence as defined in the sequence below, then it will be necessary to
apply a Hardware Reset (RESX) after Host Power On Sequence is complete to ensure correct operation. Otherwise function is not
guaranteed.

The power on/off sequence is illustrated below



7.1.1 Uncontrolled Power Off

The uncontrolled power-off means a situation which removed a battery without the controlled power off sequence. It will neither damage the module or the host interface.

If uncontrolled power-off happened, the display will go blank and there will not any visible effect on the display (blank display) and remains blank until “Power On Sequence” powers it up.

7.2 Power Level Definition

6 level modes are defined they are in order of Maximum Power consumption to Minimum Power Consumption

1. Normal Mode On (full display), Idle Mode Off, Sleep Out.
   In this mode, the display is able to show maximum 262,144 colors.

2. Partial Mode On, Idle Mode Off, Sleep Out.
   In this mode part of the display is used with maximum 262,144 colors.

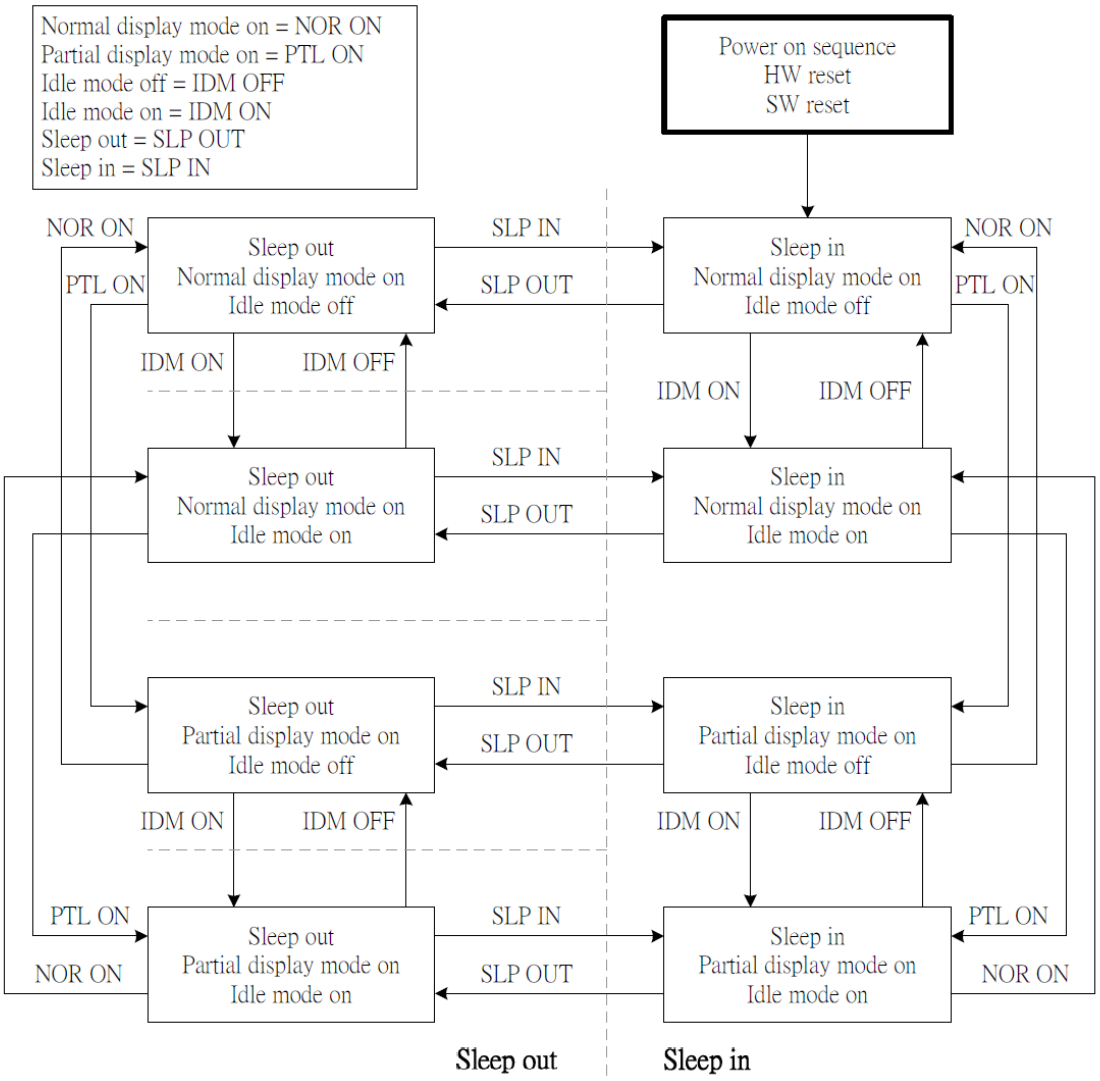
3. Normal Mode On (full display), Idle Mode On, Sleep Out.
   In this mode, the full display area is used but with 8 colors.

4. Partial Mode On, Idle Mode On, Sleep Out.
   In this mode, part of the display is used but with 8 colors.

5. Sleep In Mode
   In this mode, the DC: DC converter, internal oscillator and panel driver circuit are stopped. Only the MCU interface and memory works with VDDI power supply. Contents of the memory are safe.

Note: Transition between modes 1-5 is controllable by MCU commands. Mode 6 is entered only when both Power supplies are removed.

7.3 Power Flow Chart

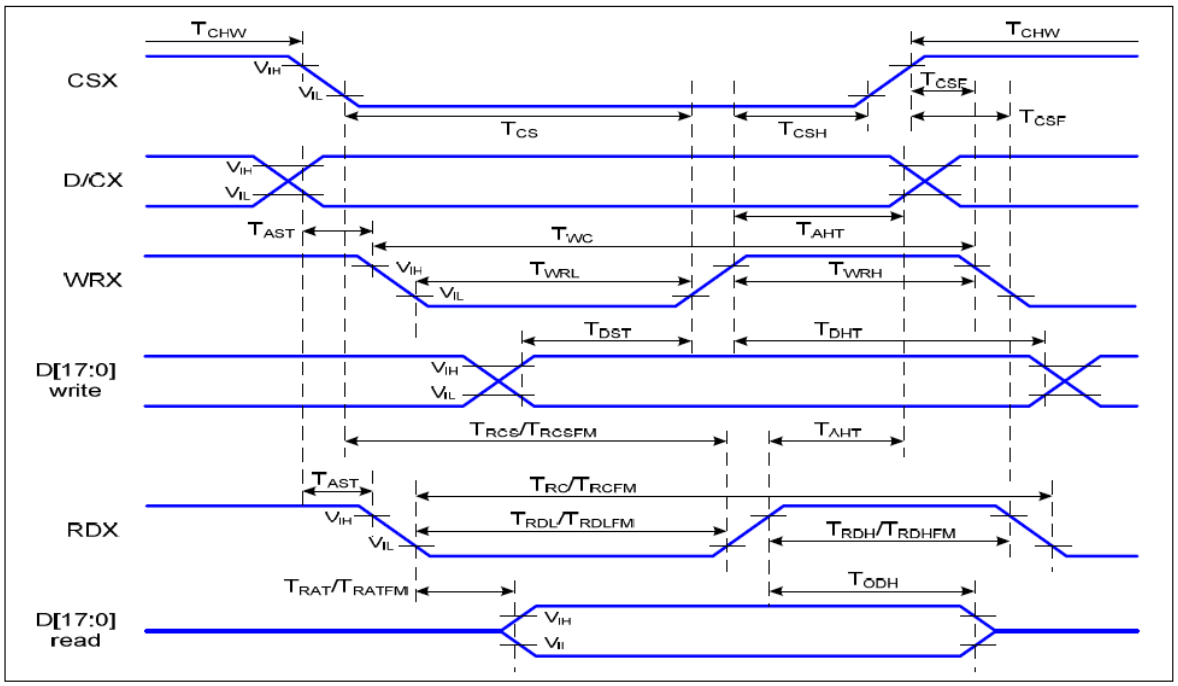


8. Electrical Characteristics

8.1 AC Characteristics (8080 Series MCU Parallel Interface Characteristics: 18/16/9/8-bit Bus)

VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta= -30 to 70 ℃

Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T_{AST}	Address setup time	0		ns	-
	T_{AHT}	Address hold time (Write/Read)	10		ns	
CSX	T_{CHW}	Chip select "H" pulse width	0		ns	-
	T_{CS}	Chip select setup time (Write)	15		ns	
	T_{RCS}	Chip select setup time (Read ID)	45		ns	
	T_{RCSFM}	Chip select setup time (Read FM)	355		ns	
	T_{CSF}	Chip select wait time (Write/Read)	10		ns	
	T_{CSH}	Chip select hold time	10		ns	
WRX	T_{WC}	Write cycle	66		ns	
	T_{WRH}	Control pulse "H" duration	15		ns	
	T_{WRL}	Control pulse "L" duration	15		ns	
RDX (ID)	T_{RC}	Read cycle (ID)	160		ns	When read ID data
	T_{RDH}	Control pulse "H" duration (ID)	90		ns	
	T_{RDL}	Control pulse "L" duration (ID)	45		ns	
RDX (FM)	T_{RCFM}	Read cycle (FM)	450		ns	When read from frame memory
	T_{RDHFM}	Control pulse "H" duration (FM)	90		ns	
	T_{RDLFM}	Control pulse "L" duration (FM)	355		ns	
D[17:0]	T_{DST}	Data setup time	10		ns	For CL=30pF
	T_{DHT}	Data hold time	10		ns	
	T_{RAT}	Read access time (ID)		40	ns	
	T_{RATFM}	Read access time (FM)		340	ns	
	T_{ODH}	Output disable time	20	80	ns	



Parallel Interface Timing Characteristics (8080-Series MCU Interface)

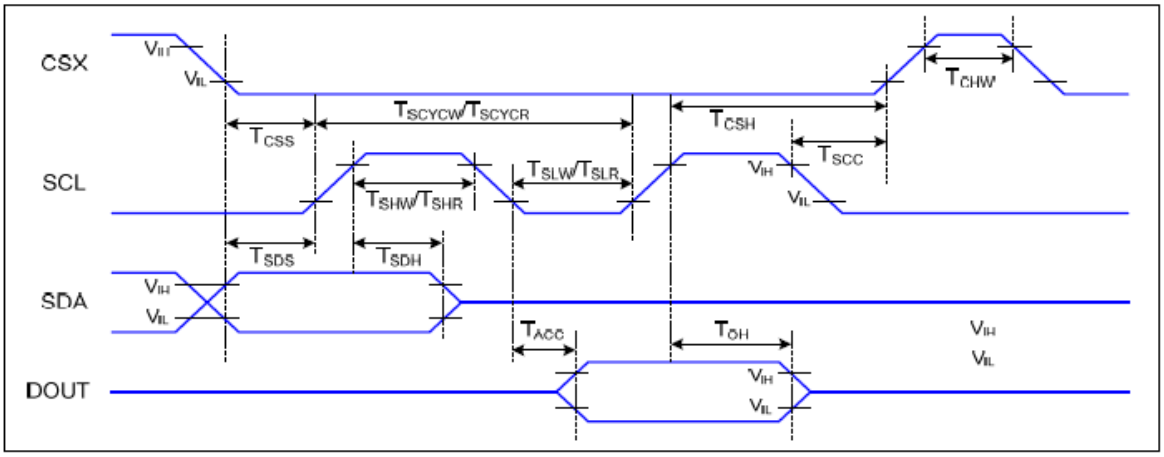
8.2 AC Characteristics (SPI Interface Timing Characteristics)

VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=-30 to 70 ℃

Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select "H" pulse width	40		ns	
SCL	T_{SCYCW}	Serial clock cycle (Write)	66		ns	
	T_{SHW}	SCL "H" pulse width (Write)	15		ns	
	T_{SLW}	SCL "L" pulse width (Write)	15		ns	
	T_{SCYCR}	Serial clock cycle (Read)	150		ns	
	T_{SHR}	SCL "H" pulse width (Read)	60		ns	
	T_{SLR}	SCL "L" pulse width (Read)	60		ns	
SDA (DIN)	T_{SDS}	Data setup time	10		ns	
	T_{SDH}	Data hold time	10		ns	
DOUT	T_{ACC}	Access time	10	50	ns	For maximum CL=30pF
	T_{OH}	Output disable time	15	50	ns	For minimum CL=8pF

3-line serial Interface Characteristics

Note : The rising time and falling time (Tr, Tf) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.


CSX
SCL
SDA
DOUT
VIH
VIL
TCSS
TSCYCW/TSCYCR
TCSH
TCHW
TSCC
TSHW/TSHR
TSLW/TSLR
TSDS
TSDH
TACC
TOH

8.3 3-Line Serial Interface

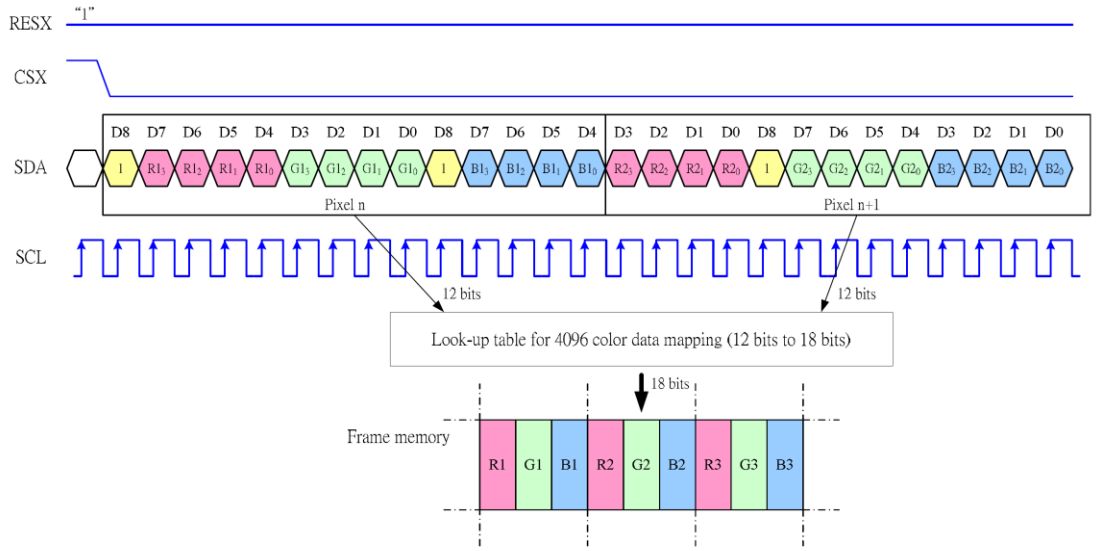
Different display data formats are available for three colors depth supported by the LCM listed below.

4k colors, RGB 4-4-4-bit input

65k colors, RGB 5-6-5-bit input

262k colors, RGB 6-6-6-bit input

Write data for 12-bit/pixel (RGB-4-4-4 bit input), 4K-Colors, 3Ah=”03h”

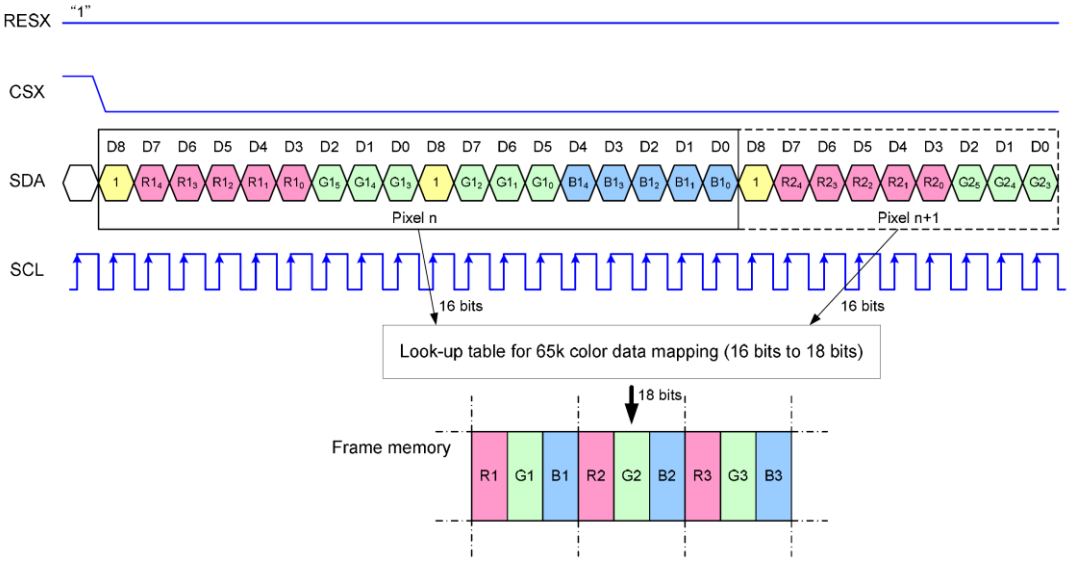


Note 1: Pixel data with the 16-bit color depth information

Note 2: The most significant bits are: Rx4, Gx5 and Bx4

Note 3: The least significant bits are: Rx0, Gx0 and Bx0

Write data for 16-bit/pixel (RGB 5-6-5-bit input), 65K-Colors, 3Ah=”05h”

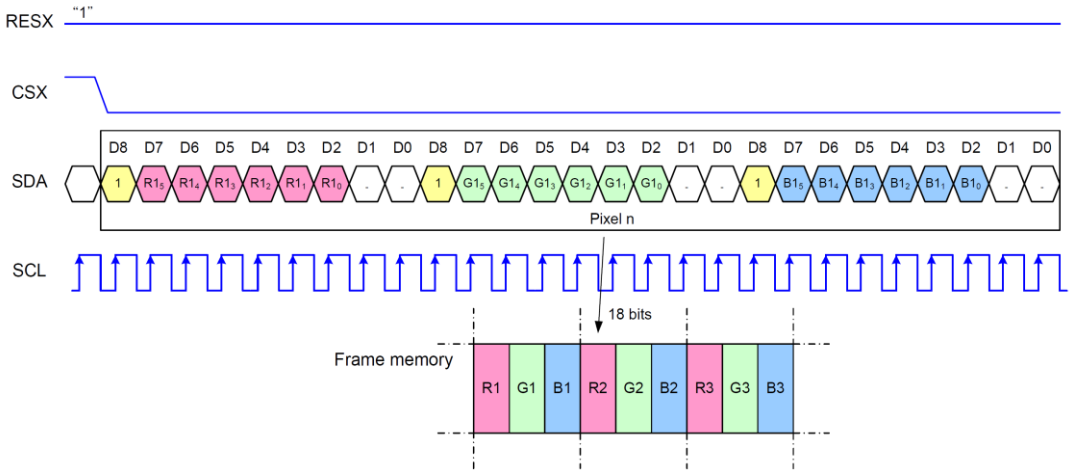


Note 1: Pixel data with the 16-bit color depth information

Note 2: The most significant bits are: Rx4, Gx5 and Bx4

Note 3: The least significant bits are: Rx0, Gx0 and Bx0

Write data for 18-bit/pixel (RGB-6-6-6-bit input), 262K-Colors, 3Ah=”06h”



Note 1: Pixel data with the 18-bit color depth information

Note 2: The most significant bits are: Rx5, Gx5 and Bx5

Note 3: The least significant bits are: Rx0, Gx0 and Bx0

8.4 RGB Interface

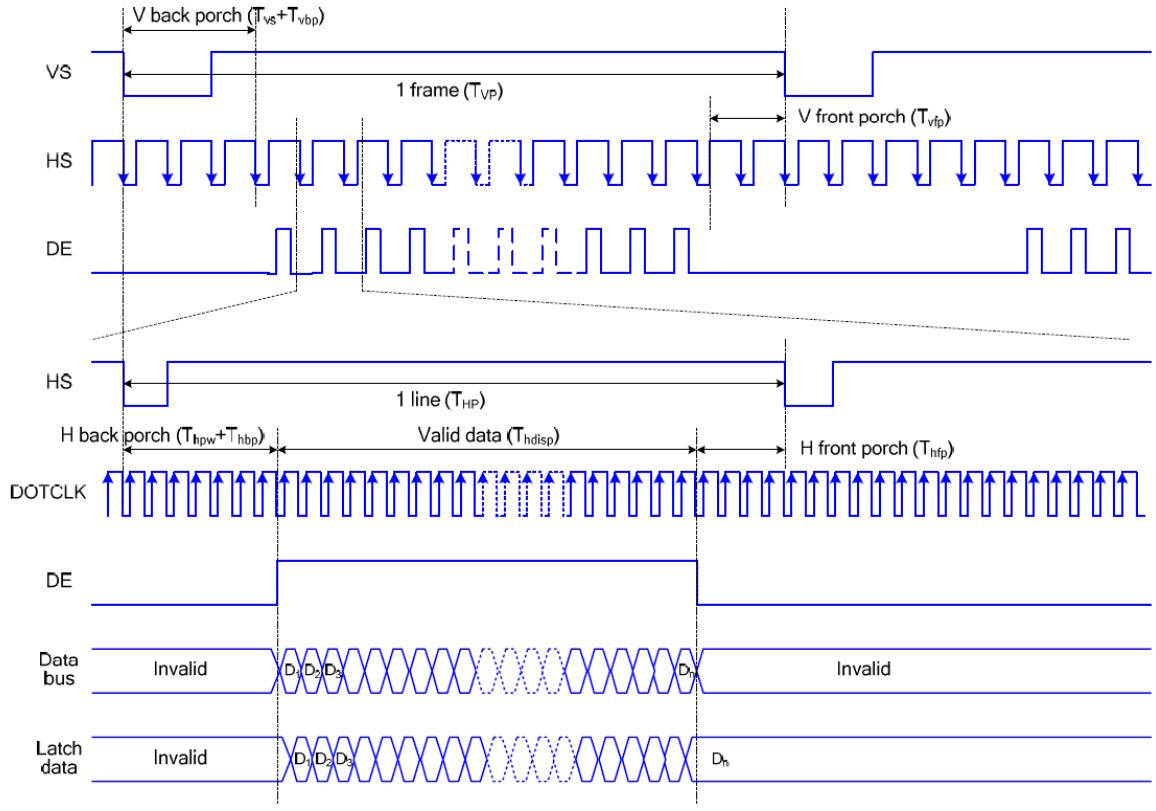
8.4.1 RGB Interface Mode Selection

ST7789V supports two kinds of RGB interface, DE mode and HV mode. Each mode also can select with ram and without ram. The table shown below uses command B1h to select RGB interface mode.

RCM[1:0]	WO	RGB Mode	Data Path
10	0	DE mode	Ram
	1		Shift register (without Ram)
11	0	HV mode	Ram
	1		Shift register (without Ram)

8.4.1 RGB Interface Timing

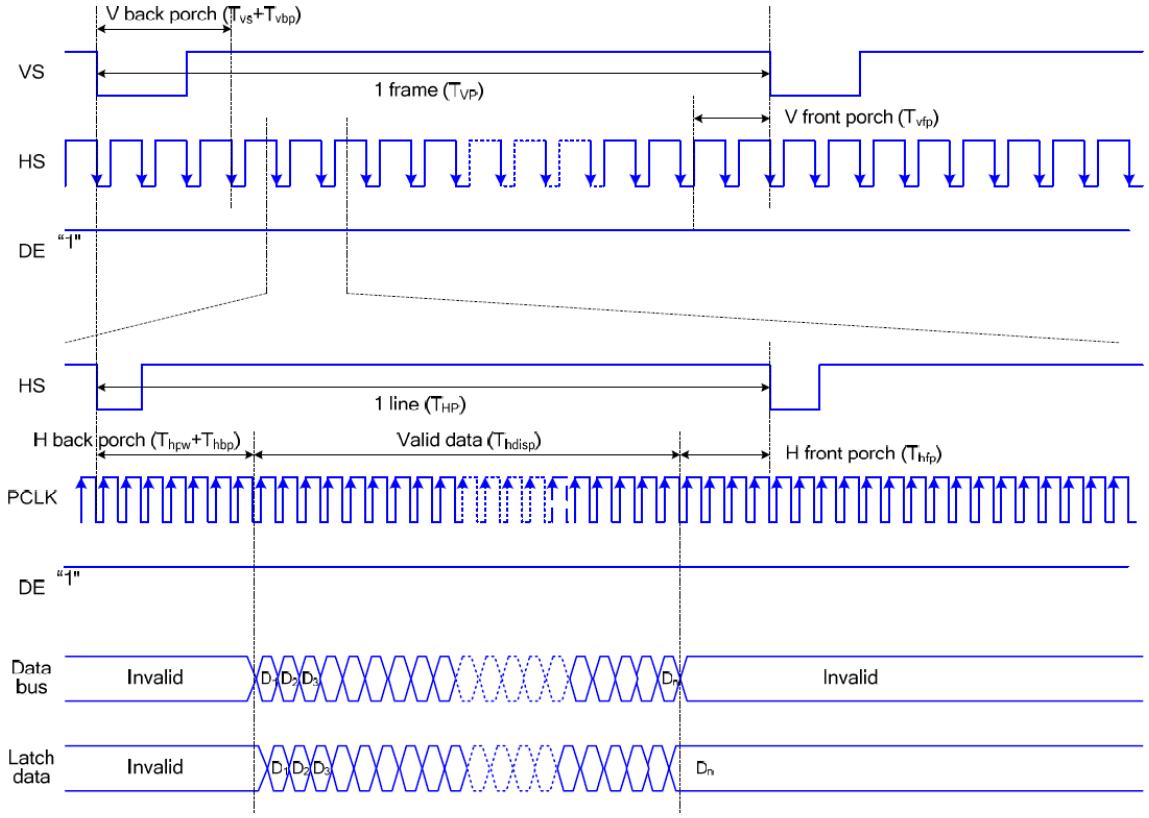
The timing chart of RGB interface DE mode is shown as follows.



Note: The setting of front porch and back porch in host must match that in IC as this mode.

Timing Chart of Signals in RGB Interface DE Mode

The timing chart of RGB interface HV mode is shown as follows.



Timing chart of RGB interface HV mod

9. RELIABILITY

Test Item	Test Conditions	Note
High Temperature Operation	70±3°C , t=240 hrs	
Low Temperature Operation	-20±3°C , t=240 hrs	
High Temperature Storage	80±3°C , t=240 hrs	1,2
Low Temperature Storage	-30±3°C , t=240 hrs	1,2
Thermal Shock Test	-20°C ~ 25°C ~ 70°C 30 m in. 5 min. 30 min. (1 cycle) Total 5 cycle	1,2
Humidity Test	60 °C, Humidity 90%, 96 hrs	1,2
Vibration Test (Packing)	Sweep frequency : 10 ~ 55 ~ 10 Hz/1min Amplitude : 0.75mm Test direction : X.Y.Z/3 axis Duration : 30min/each axis	2

Note (1) Condensation of water is not permitted on the module.

Note (2) The module should be inspected after 1 hour storage in normal conditions (15-35°C, 45-65%RH).

Note (3) The module shouldn't be tested more than one condition, and all the test conditions are independent.

Note (4) All the reliability tests should be done without protective film on the module.

Definitions of life end point:

- Current drain should be smaller than the specific value.
- Function of the module should be maintained.
- Appearance and display quality should not have degraded noticeably.
- Contrast ratio should be greater than 50% of the initial value.

10.USE PRECAUTIONS

10.1 Handling precautions

(1) The polarizing plate may break easily so be careful when handling it. Do not touch, press or rub it with a hard-material tool like tweezers.

(2) Do not touch the polarizing plate surface with bare hands so as not to make it dirty. If the surface or other related part of the polarizing plate is dirty, you could soak a soft cotton cloth or chamois leather into benzine and wipe off with it. Do not use chemical liquids such as acetone, toluene, and isopropyl alcohol. Failure to do so may bring chemical reaction phenomena and deteriorations.

(3) Remove any spit or water immediately. If it is left for hours, the suffered part may deform or decolorize.

(4) If the LCD elements breaks or any LC stuff leaks, you cannot suck or lick it. Besides, you need to wash thoroughly with the soap and water immediately if LC stuff stuck with your skin or clothing.

10.2 Installing precautions

(1) The PCB has many ICs that may be damaged easily by static electricity. To prevent breaking by static electricity from the human body or clothing, you need to earth the human body properly using the high resistance and discharge static electricity during the operation. However, the resistance value should be approx. in this case. 1MΩ and the resistance should be placed near the human body rather than the ground surface. When the indoor space is dry, static electricity may occur easily so carefully. We recommend the indoor space should be kept with humidity of 60% or more. When a soldering iron or other similar tool is used for assembly, you have to be sure to earth it.

(2) When you are installing the module and ICs, you cannot bend or twist them. If you fail to do so, it may crack LC elements and cause circuit failures.

(3) To protect LC elements, the polarizing plate, especially we use a transparent protective plate (e.g., acrylic plate, glass etc.) for the product case.

(4) Do not use adhesive materials like a both-side adhesive tape which

uses to make LCD surface (polarizing plate) and product case stick together. If you fail to do so, it may cause the polarizing plate to peel off.

10.3 Storage precautions

(1) Avoid the high temperature and humidity area. Keep the temperature between 0°C to 35°C and the humidity below 60%.
(2) Choose the dark spaces where the product won't be exposed to direct sunlight or fluorescent light.
(3) Store the products as they put in the boxes which are provided from us or in the same conditions as we recommend.

10.4 Operating precautions

(1) Do not boost the applied drive voltage abnormally. If you fail to do so, it may break the ICs. When you are applying power voltage, you need to check the electrical features beforehand and carefully. You need to always turn off the power to the LC module controller before removing or inserting the LC module input connector. The LC module internal circuit may break if the input connector is removed or inserted as the power is turned on.
(2) The display response may be late if the operating temperature is below the normal standard. Besides, it may be out of order if it is above the normal standard. However, this is not a failure, and it will be restored as it is within the normal standard.
(3) The LCD contrast varies depending on the visual angle, ambient temperature, power voltage etc. You can obtain the optimum contrast by adjusting the LC drive voltage.
(4) When you are carrying out the test, you cannot take a module out of the low-temperature space suddenly. If you fail to do so, it will cause a module condensing and leading to malfunctions.
(5) You need to be certain that each signal noise level is within the standard (L level: 0.2VCC or less and H level: 0.8VCC or more) even if the module has functioned properly. If it is beyond the standard, the module may often malfunction. In addition, you need to always connect the module during noise level measurements.
(6) The CMOS ICs are incorporated in the module. However, the pull-up and pull-down functions are not adopted for the input so you

need to avoid putting the input signal open while the power is ON.

(7) The characteristic of the semiconductor elements changes when semiconductor elements exposed to light emissions. Therefore, ICs on the LCD may malfunction if they receive light emissions. To prevent these malfunctions, we need to design and assemble ICs so that they are shielded from light emissions.

(8) Crosstalk occurs due to characteristics of the LCD. In general, crosstalk occurs when the regularized display maintain. Moreover, crosstalk is affected by the LC drive voltage. We need to design the contents of the display and consider crosstalk issue.

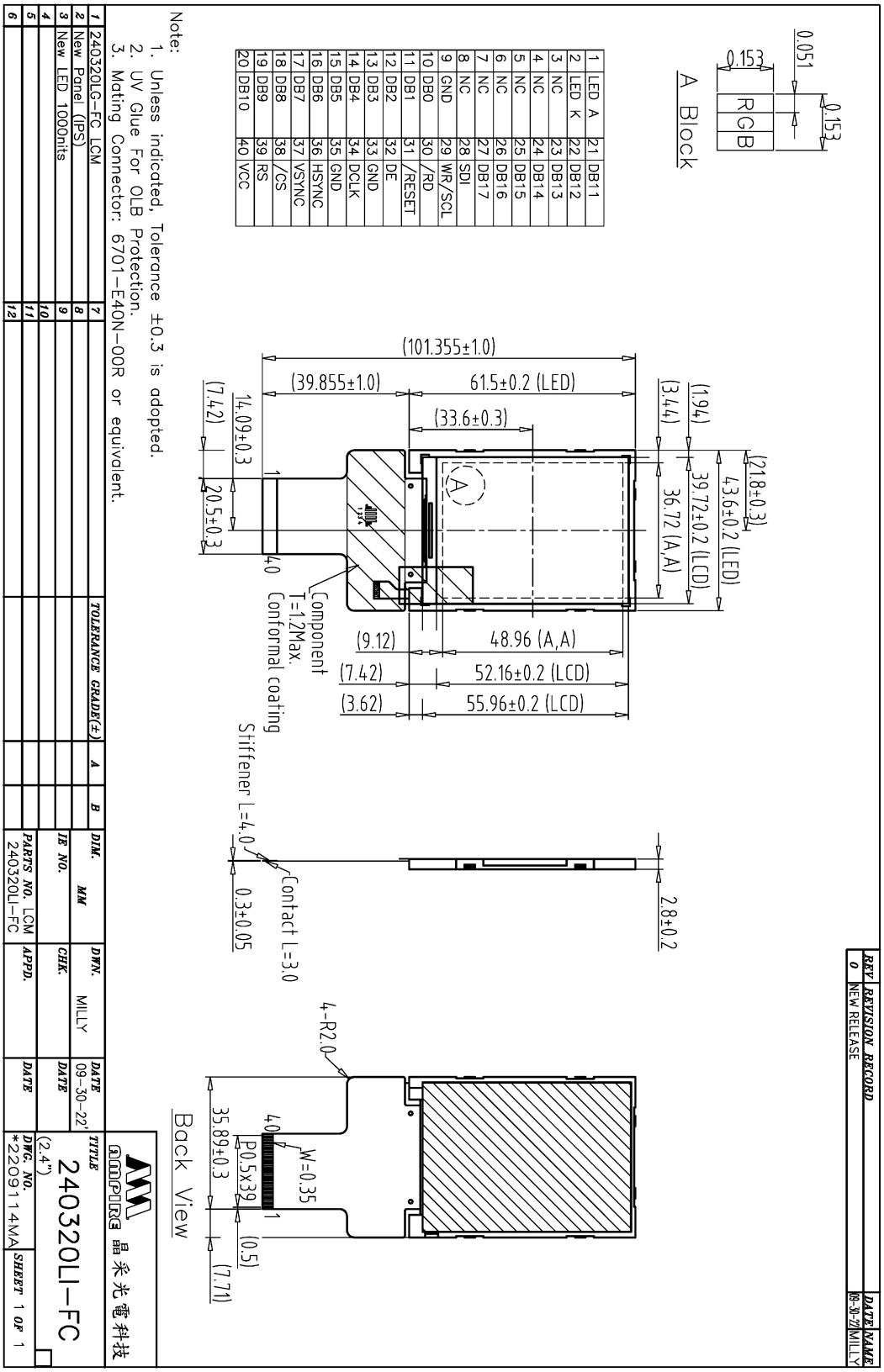
10.5 Other

(1) Do not disassemble or take the LC module into pieces. The LC modules once disassembled or taken into pieces are not the guarantee articles.

(2) Do not keep the LCD at the same display pattern continually. The residual image will happen and it will damage the LCD. Please use screen saver.

(3) AMIPRE will provide one year warrantee for all products, and three months warrantee for all repairing products.

11. MECHANICAL DRAWING



1	LED A
2	LED K
3	NC
4	NC
5	NC
6	NC
7	NC
8	NC
9	GND
10	DB0
11	DB1
12	DB2
13	DB3
14	DB4
15	DB5
16	DB6
17	DB7
18	DB8
19	DB9
20	DB10
21	DB11
22	DB12
23	DB13
24	DB14
25	DB15
26	DB16
27	DB17
28	SDI
29	WR/SCL
30	/RD
31	/RESET
32	DE
33	GND
34	DCLK
35	GND
36	HSYNC
37	VSYNC
38	/CS
39	RS
40	VCC

REV.	REVISION RECORD	DATE	NAME
0	NEW RELEASE	09-30-22	MILLY

1	240320LG-FC LCM	7		TOLERANCE GRADE(±)	A	B	DIM.	MM	DWN. MILLY	DATE 09-30-22'
2	New Panel (IPS)	8					IB NO.		CHK.	DATE
3	New LED 1000nits	9					PARTS NO. LCM 240320LI-FC		APPD.	DATE
4		10								
5		11								
6		12								

AMPIRE 晶采光電科技

TITLE: 240320LI-FC (2.4")

DWG. NO. *22091114-MA

SHEET 1 OF 1