

## LCD Module Specification

Module P/N: AML0231320240-01

Version: 1.0

Description : 2.31 inch TFT 320\*240 Pixels  
LED backlight  
with

### GH

DESIGNED BY	
CHECKED BY	
APPROVED BY	

### Customer

INSPECTION RESULT	
TESTED BY	
APPROVED BY	

Revision History

Date	Rev.	Page	Description
2023-05-31	1.0	All	First issue

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1. General Features

Item	Spec	Remark
Display Mode	Normally White	
Viewing Direction	12 O'CLOCK	
Input Signals	SPI 4 Line	
Outside Dimensions	51mm(W) x45.8mm(H) x2.3mm(D)	
Active Area	46.75mm(W)×35.06mm(H)	
Number of Pixels	320×RGB×240Pixels	
Dot Pitch	0.1461mm×0.1461mm	
Pixel Arrangement	RGB Vertical stripes	
Drive IC	ILI9342C	

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2. Absolute Maximum Ratings

The following are maximum values which, if exceeded may cause operation or damage to the unit.

Item	Symbol	Unit	Value
Supply voltage	VCI	V	-0.3 ~ +4.8
Supply voltage (Logic)	IOVCC	V	-0.3 ~ +4.6
Supply voltage (Digital)	VCORE	V	-0.3 ~ +2.4
Driver supply voltage	VGH-VGL	V	-0.3 ~ +32.0
Logic input voltage range	VIN	V	-0.3 ~ IOVCC + 0.3
Logic output voltage range	VO	V	-0.3 ~ IOVCC + 0.3

*Note: If the absolute maximum rating of even is one of the above parameters is exceeded even momentarily, the quality of the product may be degraded. Absolute maximum ratings, therefore, specify the values exceeding which the product may be physically damaged. Be sure to use the product within the range of the absolute maximum ratings.*

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### 3.Electrical Specification

#### 3.1 Driving TFT LCD Panel

Item		Sym.	Min	Typ.	Max	Unit	Note
Power for Circuit Driving		IOVCC	1.65	1.8	3.3	V	
		VCI	2.65	2.8	3.3	V	
Logic Input Voltage	Low Voltage	V <sub>IL</sub>	0	-	0.3IOVCC	V	
	High Voltage	V <sub>IH</sub>	0.7IOVCC	-	IOVCC	V	
Logic Output Voltage	Low Voltage	V <sub>OL</sub>	0	-	0.2IOVCC	V	
	High Voltage	V <sub>OH</sub>	0.8IOVCC	-	IOVCC	V	

#### 3.2 Driving Backlight

Item	Sym.	Min	Typ.	Max	Unit	Note
Backlight driving voltage	V <sub>F</sub>	11.2	12	13.2	V	
Backlight driving current	I <sub>F</sub>	-	20	-	mA	
Backlight Power Consumption	W <sub>BL</sub>	-	-	-	mW	
Life Time	-	-	10,000	-		Note 3

Note 1: (Unless specified, the ambient temperature Ta=25℃)

Note 2: The recommended operating conditions refer to a range in which operation of this product is guaranteed. Should this range is exceeded, the operation cannot be guaranteed even if the values may be without the absolute maximum ratings.

Note 3: If LED is driven by high current, high ambient temperature & humidity condition. The life time of LED will be reduced. Operating life means brightness goes down to 50% initial brightness. Typical operating life time is estimated data.

## 4.Optical Specifications

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25 °C. The values specified are at an approximate distance 500mm from the LCD surface at a viewing angle of  $\Phi$  and  $\theta$  equal to 0°.

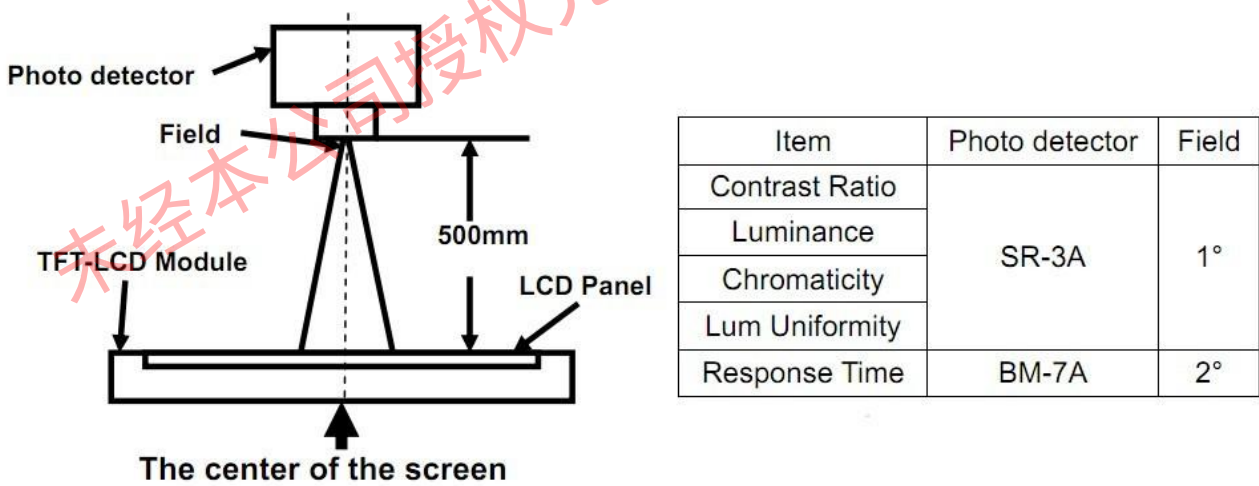
Item	Sym.	Values			Unit	Note
		Min.	Typ.	Max.		
1)Contrast Ratio	C/R	-	250	-		FIG.1
2)Module Luminance	L	400	500	-	cd/m <sup>2</sup>	FIG.1
3)Response time	Tr+Tf	-	16	30	ms	FIG.2
4)Viewing Angle	$\theta_T$	60	70	-	Degree	FIG.3
	$\theta_B$	50	60	-		
	$\theta_L$	60	70	-		
	$\theta_R$	60	70	-		
5)Chromaticity	Wx	-	TBD	-		
	Wy	-	TBD	-		
	Rx	-	TBD	-		
	Ry	-	TBD	-		
	Gx	-	TBD	-		
	Gy	-	TBD	-		
	Bx	-	TBD	-		
	By	-	TBD	-		
NTSC	50%					

◆ Measurement System

Notes:

- 1. Contrast Ratio(CR) is defined mathematically as :  
**Contrast Ratio =  $\frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$**
- 2. Surface luminance is the center point across the LCD surface 500mm from the surface with all pixels displaying white. For more information see FIG 1.
- 3. Response time is the time required for the display to transition from white to black (Rising Time, Tr) and from black to white (Falling Time, Tf). For additional information see FIG 2.
- 4. Viewing angle is the angle at which 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 FIG 3.

FIG. 1 Optical Characteristic Measurement Equipment and Method



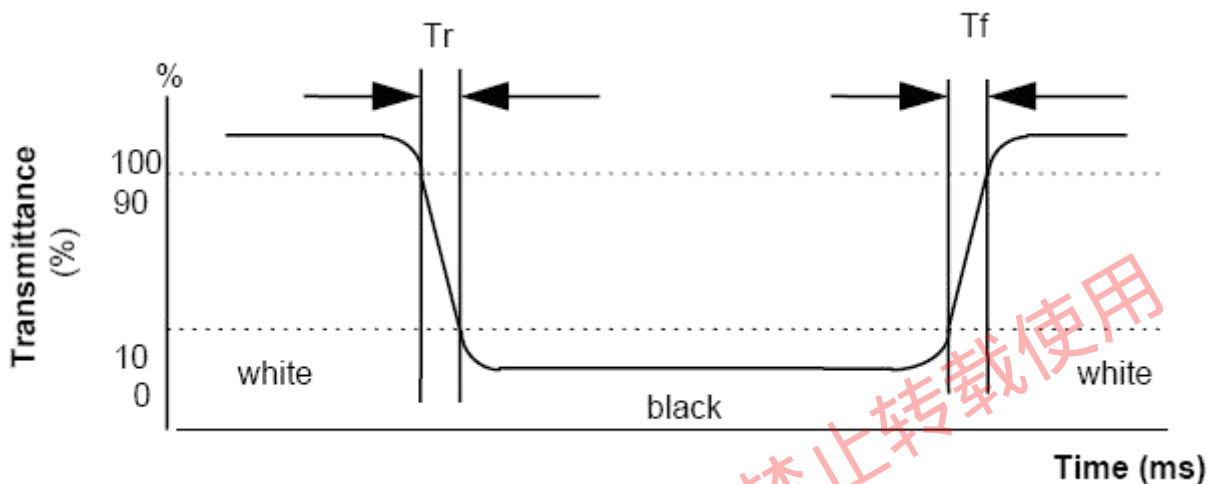


## FIG. 2 The definition of Response Time

The response time is defined as the following figure and shall be measured by switching the input signal for “black” and “white”.

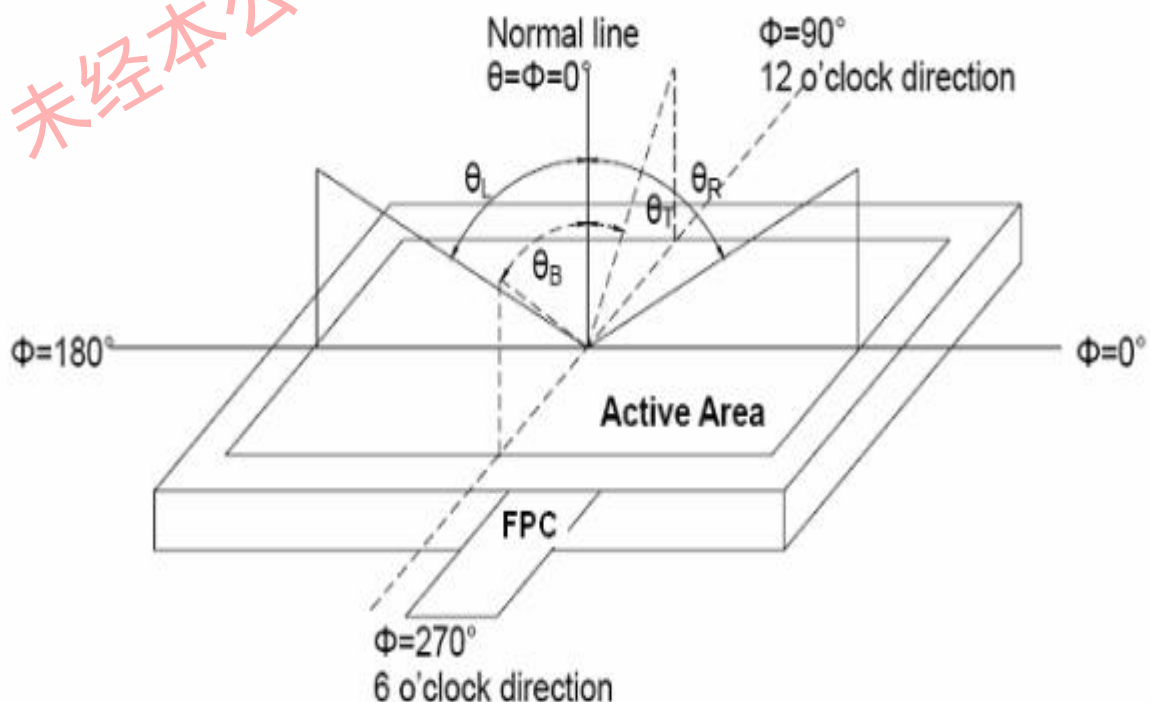
Response Time = Rising Time( $T_r$ ) + Falling Time( $T_f$ )

- Rising Time( $T_r$ ) : Full White 90% → Full White 10% Transmittance.
- Falling Time( $T_f$ ) : Full White 10% → Full White 90% Transmittance.

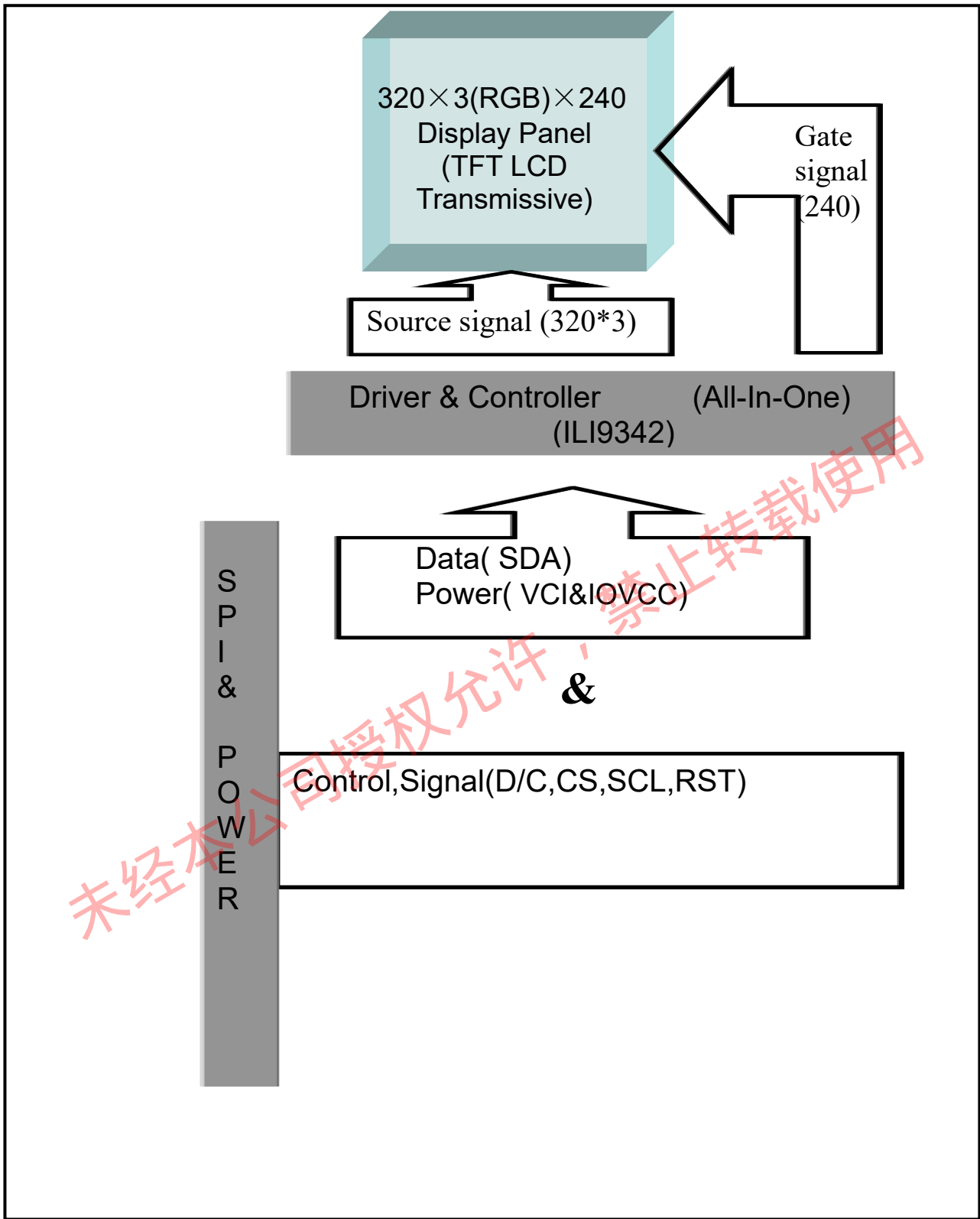


## FIG. 3 The definition of Viewing Angle

Use Fig. 1 (Test Procedure) under Measurement System to measure the contrast from the measuring direction specified by the conditions as the following figure.



5.Block Diagram

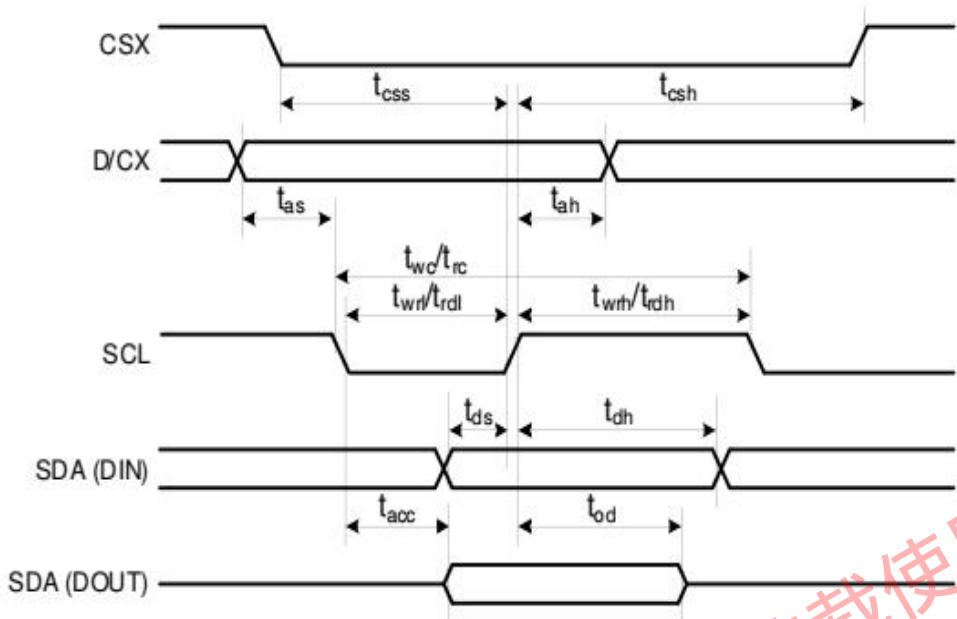


## 6.Pin Description

Item	Terminal	Functions
1	LEDA	B/L Power input PIN anode
2	LEDK	B/L Power input PIN negative
3	LEDK	B/L Power input PIN negative
4	LEDK	B/L Power input PIN negative
5	LEDK	B/L Power input PIN negative
6	GND	Power ground
7	RST	RESET PIN
8	NC	NC
9	GND	Power ground
10	D/C	Display data/command selection pin in 4-line serial interface.
11	SDA	Serial data input pin
12	IOVCC	Power supply
13	SCL	This pin is used to be serial interface clock.
14	CS	Chip select pin
15	GND	Power ground
16	NC	NC
17	NC	NC
18	VCI	Power supply
19	IOVCC	Power supply
20	GND	Power ground

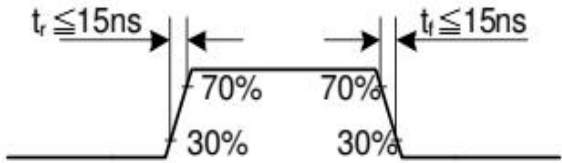
7.Timing Characteristics

7.1. 4-Line Interface Characteristics

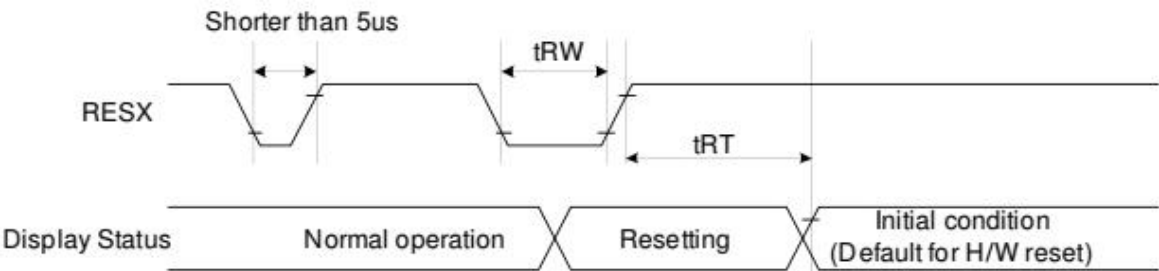


Signal	Symbol	Parameter	min	max	Unit	Description
CSX	$t_{css}$	Chip select time (Write)	15	-	ns	
	$t_{csh}$	Chip select hold time (Read)	15	-	ns	
SCL	$t_{wc}$	Serial clock cycle (Write)	66	-	ns	
	$t_{wrh}$	SCL "H" pulse width (Write)	15	-	ns	
	$t_{wrl}$	SCL "L" pulse width (Write)	15	-	ns	
	$t_{rc}$	Serial clock cycle (Read)	150	-	ns	
	$t_{rdh}$	SCL "H" pulse width (Read)	60	-	ns	
	$t_{rdl}$	SCL "L" pulse width (Read)	60	-	ns	
	$t_{dsh}$	SCL "L" pulse width (Read)	60	-	ns	
D/CX	$t_{as}$	D/CX setup time	10	-	ns	
	$t_{ah}$	D/CX hold time (Write / Read)	10	-	ns	
SDA (Input)	$t_{ds}$	Data setup time (Write)	10	-	ns	
	$t_{dh}$	Data hold time (Write)	10	-	ns	
SDA (Output)	$t_{acc}$	Access time (Read)	10	50	ns	For maximum CL=30pF
	$t_{od}$	Output disable time (Read)	15	50	ns	For minimum CL=8pF

Note:  $T_a = -40$  to  $85\text{ }^{\circ}\text{C}$ ,  $IOVCC=1.65\text{V}$  to  $3.3\text{V}$ ,  $VCI=2.3\text{V}$  to  $4.8\text{V}$ ,  $AGND=DGND=0\text{V}$



7.2 Reset Operation



Signal	Symbol	Parameter	Min	Max	Unit
RESX	tRW	Reset pulse duration	10		uS
	tRT	Reset cancel		5 (note 1,5)	mS
				120 (note 1,6,7)	mS

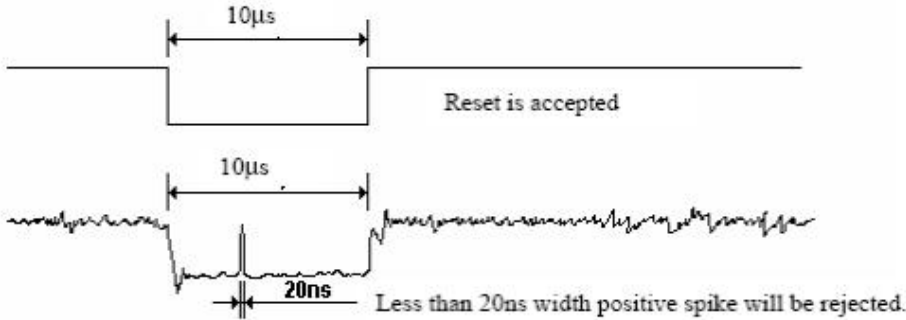
Note 1: The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NV memory to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5 ms after a rising edge of RESX.

Note 2: 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 10us	Reset
Between 5us and 10us	Reset starts

Note 3: During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In -mode.) And then return to Default condition for Hardware Reset.

Note 4: Spike Rejection also applies during a valid reset pulse as shown below:



Note 5: When Reset applied during Sleep In Mode.

Note 6: When Reset applied during Sleep Out Mode.

Note 7: It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

8	7	6	5	4	3	2	1	
							REV	DESCRIPTION:
							AO	First Design
							BY	DATE
							YK	2023-05-27

9.Reliability and Inspection Standard

No.	Test Item		Test Conditions	Remark
1	High Temperature	Storage	80℃, 48Hr	Note
		Operation	70℃, 48Hr	Note
2	Low Temperature	Storage	-30℃, 48Hr	Note
		Operation	-20℃, 48Hr	
3	High Temperature and High Humidity		40℃, 90%RH, 48Hr	Note

Note:

- 1) The test samples should be applied to only one test item.
- 2) Evaluation should be tested after storage at room temperature for two hours.

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## 10. PRECAUTIONS FOR USING LCD MODULES

### Handling Precautions

- (1) The display panel is made of glass and polarizer. As glass is fragile, it tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring. Do not subject it to a mechanical shock by dropping it or impact.
- (2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.
- (3) 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 degraded insulation between terminals (some cosmetics are determined to the polarizer).
- (4) 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 polarizers with anything harder than an HB pencil lead (glass, tweezers, etc.). Do not put or attach anything on the display area to avoid leaving marks on. Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizer. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.
- (5) 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 cloth with one of the following solvents
  - Isopropyl alcohol
  - Ethyl alcoholDo not scrub hard to avoid damaging the display surface.
- (6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.
  - Water
  - Ketone
  - Aromatic solventsWipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading. Avoid contacting oil and fats.
- (7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.
- (8) 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.
- (9) Do not attempt to disassemble or process the LCD module.
- (10) NC terminal should be open. Do not connect anything.
- (11) If the logic circuit power is off, do not apply the input signals.
- (12) Since 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.



- Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
- Do not drop, bend or twist LCM.

### Storage Precautions

When storing the LCD modules, the following precaution is necessary.

- (1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for the dessicant.
- (2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C.
- (3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped).

### Others

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 subject to a 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., exercise care to avoid holding the following sections when handling the modules.

- Exposed area of the printed circuit board.
- Terminal electrode sections.