


# SPECIFICATIONS FOR LCD MODULE

<b>CUSTOMER</b>	
<b>MODEL</b>	<b>SCT028002-V19</b>
<b>CUSTOMER APPROVED</b>	

<b>APPROVED BY</b>	<b>CHECKED BY</b>	<b>ORGANIZED BY</b>
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## RECORDS OF REVISIONS

Version	Content	Date
<b>A0</b>	<b>First Issue</b>	<b>2020-08-25</b>

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## 1. General Description

This Module SCT028002-V19 is TFT Liquid Crystal Display Module. This specification covers the delivery requirements for the liquid crystal display module delivered by quality to Customer.

### 1.1. Mechanical & Display Specifications

Item	Standard value	Unit
LCD Size	2.8	inch
Dot Matrix	240(RGB) × 320	pixel
Module Size	50.00 × 69.20 × 3.00(Include EVA)	mm
Active Area	43.20 × 57.60	mm
Dot Pitch	0.180 × 0.180	mm
Pixel Configuration	R.G.B. Stripe	-
Color depth	262K	-
Display Mode	Normally white, Transmissive	-
Technology Type	a-Si	-
Viewing Direction	6 o'clock	-
Gray Scale Inversion Direction	12 o'clock	-
Driver IC	ST7789V	-
Interface	16-bit MCU	-
LED Numbers	4 LEDs	-
Weight	TBD	g

## 1.2. Interface Pin

Pin No.	Symbol	Type	Description
1	GND	P	Ground
2	DB0	I/O	Data bus
3	DB1	I/O	Data bus
4	DB2	I/O	Data bus
5	DB3	I/O	Data bus
6	GND	P	Ground
7	VDD	P	Power supply
8	/CS	I	Chip Select signal
9	RS	I	Display data/command selection (D/C) pin in MCU interface. RS='1': display data or parameter. RS='0': register index / command.
10	/WR	I	Write signal
11	/RD	I	Read signal
12-16	NC	-	No connection
17	LEDA	P	LED driving anode
18	LEDK1	P	LED driving cathode
19	LEDK2	P	LED driving cathode
20	LEDK3	P	LED driving cathode
21	LEDK4	P	LED driving cathode
22	NC	-	No connection
23	DB4	I/O	Data bus
24	DB8	I/O	Data bus
25	DB9	I/O	Data bus
26	DB10	I/O	Data bus
27	DB11	I/O	Data bus
28	DB12	I/O	Data bus
29	DB13	I/O	Data bus
30	DB14	I/O	Data bus
31	DB15	I/O	Data bus
32	/RESET	I	Chip reset signal
33	VDD	P	Power supply
34	VDD	P	Power supply
35	GND	P	Ground
36	DB5	I/O	Data bus
37	DB6	I/O	Data bus
38	DB7	I/O	Data bus
39	GND	P	Ground
40	GND	P	Ground

Note1: TYPE definition: I----Input O---Output P----Power/Ground

## 2. Electrical Characteristics

### 2.1. Absolute Maximum Rating

Item	Symbol	Min.	Max.	Unit	Remark
Power Supply Voltage	VDD	-0.3	4.6	V	
Input Signal Voltage	V <sub>IN</sub>	-0.3	VDD	V	Note 1
Operating Temperature	T <sub>OPR</sub>	-20	+70	°C	Ambient
Storage Temperature	T <sub>STG</sub>	-30	+80	°C	Ambient

Note1: V<sub>IN</sub> represent IO

### 2.2. DC Electrical Characteristics

#### 2.2.1. Driving TFT LCD Panel

GND=0V, Ta=25°C

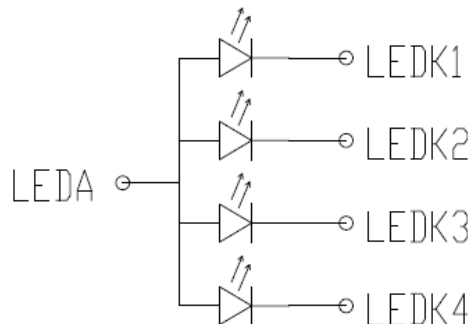
Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Operating Voltage	VDD	2.4	3.0	3.3	V	
Logic High level input voltage	V <sub>IH</sub>	0.7VDD	-	VDD	V	
Logic Low level input voltage	V <sub>IL</sub>	0	-	0.3VDD	V	
Logic High level output voltage	V <sub>OH</sub>	0.8VDD	-	VDD	V	I <sub>OH</sub> =-1.0mA
Logic Low level output voltage	V <sub>OL</sub>	0	-	0.2VDD	V	I <sub>OL</sub> =1.0mA
Power Consumption	I <sub>CC</sub>	-	TBD	-	mA	

#### 2.2.2. Driving Backlight

Ta=25°C

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Forward Current	I <sub>F</sub>	-	80	80	mA	Note1
Forward Current Voltage	V <sub>F</sub>	2.75	3.1	3.5	V	
Operating Life Time	-	10000			hrs	

Note 1: The figure below shows the connection of backlight LED.



Note 2: One LED: I<sub>F</sub> =20mA.

## 2.3. AC Electrical Characteristics

### 2.3.1. 8080 Series MCU Parallel Interface Characteristics: 16-bit Bus

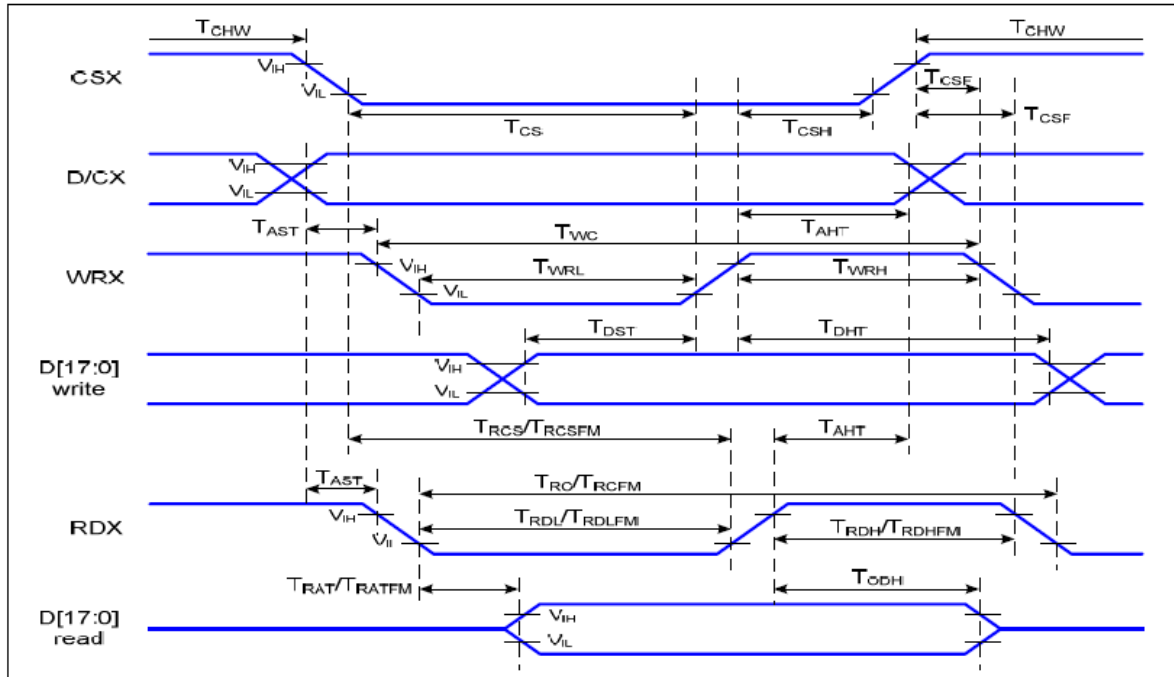


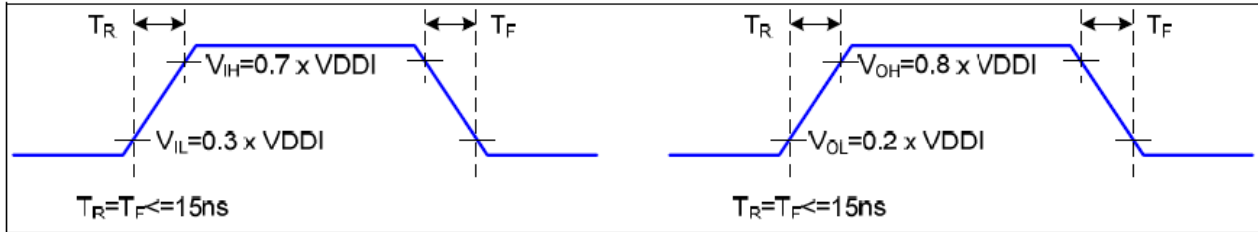
Figure 1 Parallel Interface Timing Characteristics (8080-Series MCU Interface)

$V_{DDI}=1.65$  to  $3.3V$ ,  $V_{DD}=2.4$  to  $3.3V$ ,  $AGND=DGND=0V$ ,  $T_a=-30$  to  $70\text{ }^{\circ}C$

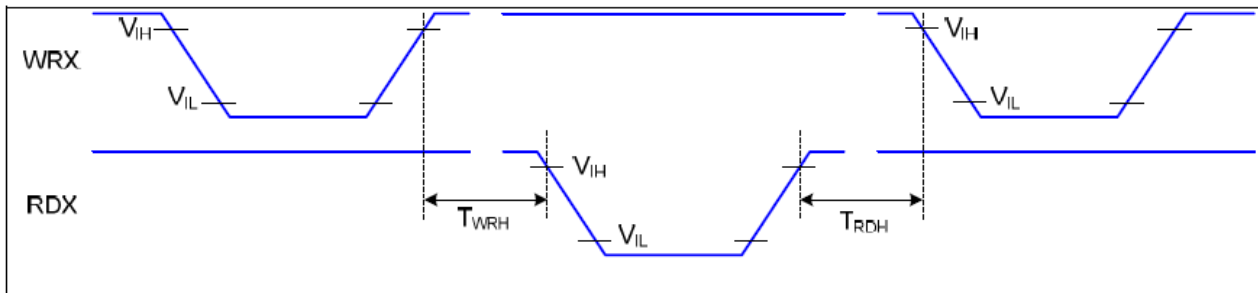
Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	$T_{AST}$	Address setup time	0		ns	-
	$T_{AHT}$	Address hold time (Write/Read)	10		ns	
CSX	$T_{CHW}$	Chip select "H" pulse width	0		ns	-
	$T_{CS}$	Chip select setup time (Write)	15		ns	
	$T_{RCS}$	Chip select setup time (Read ID)	45		ns	
	$T_{RCSFM}$	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

**Table 4 8080 Parallel Interface Characteristics**



**Figure 2 Rising and Falling Timing for I/O Signal**



**Figure 3 Write-to-Read and Read-to-Write Timing**

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



### 2.3.2. Reset Timing

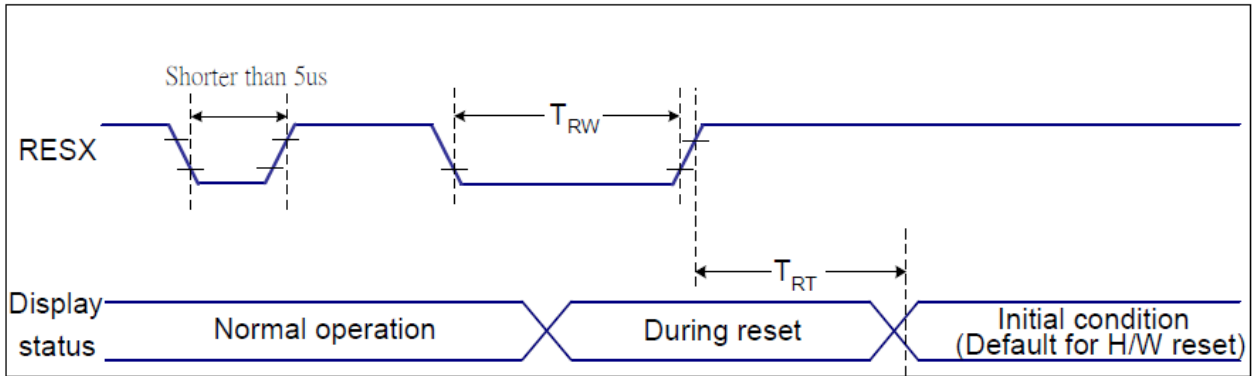


Figure 7 Reset Timing

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

Related Pins	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	

Table 9 Reset Timing

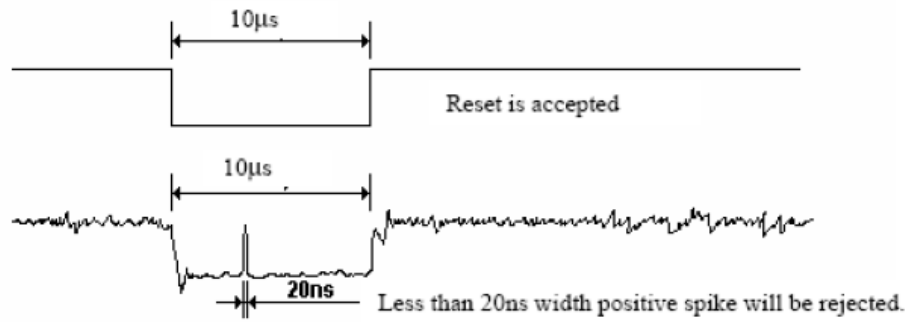
Notes:

1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time ( $t_{RT}$ ) within 5 ms after a rising edge of RESX.
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 9us	Reset
Between 5us and 9us	Reset starts

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.

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



5. When Reset applied during Sleep In Mode.

6. When Reset applied during Sleep Out Mode.

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

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### 3. Optical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark		
Viewing angle	$\theta_T$	$CR \geq 10$	-	50	-	degree	Note5		
	$\theta_B$		-	20	-				
	$\theta_L$		-	45	-				
	$\theta_R$		-	45	-				
Contrast Ratio	CR	$\theta=0^\circ$ optimal	400	500	-	-	Note3		
Response Time	$T_R$	$T_a=25^\circ C$	-	4	8	ms	Note2		
	$T_F$		-	12	24				
Color Chromaticity	White	$\theta=0^\circ$	-0.05	+0.05	-	-	Note6		
								x	0.301
	y							0.337	
	Red							x	0.653
								y	0.332
	Green							x	0.314
								y	0.575
	Blue							x	0.137
y		0.133							
Uniformity	U	$\theta=0^\circ$	70	80	-	%	Note7		
Luminance	L	$I_F=Typ.$	200	250	-	$cd/m^2$	Note8		

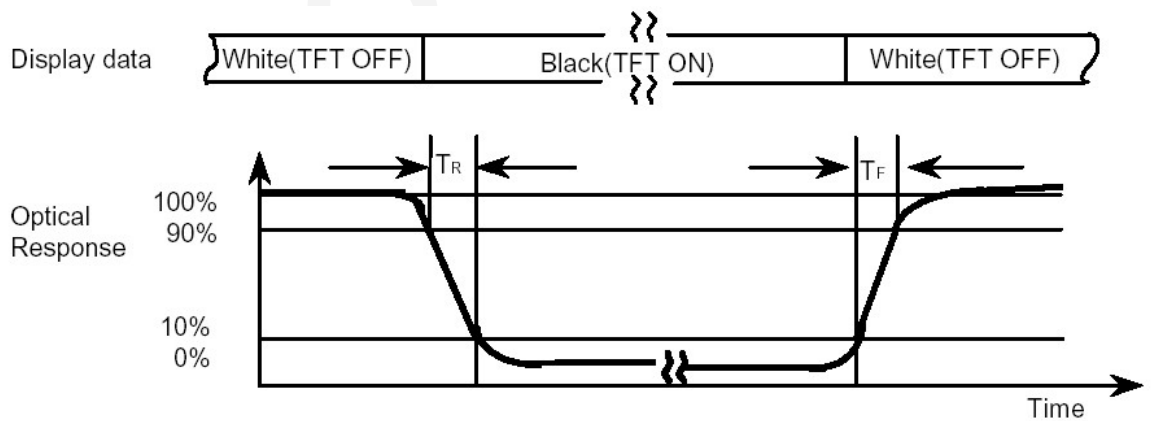
Note:

#### 1. Test equipment setup

After stabilizing and leaving the panel alone at a given temperature for 30 minutes, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7 with a viewing angle of  $1^\circ$  at a distance of 50cm and normal direction.

#### 2. Definition of response time: $T_R$ and $T_F$

The figure below is the output signal of the photo detector.

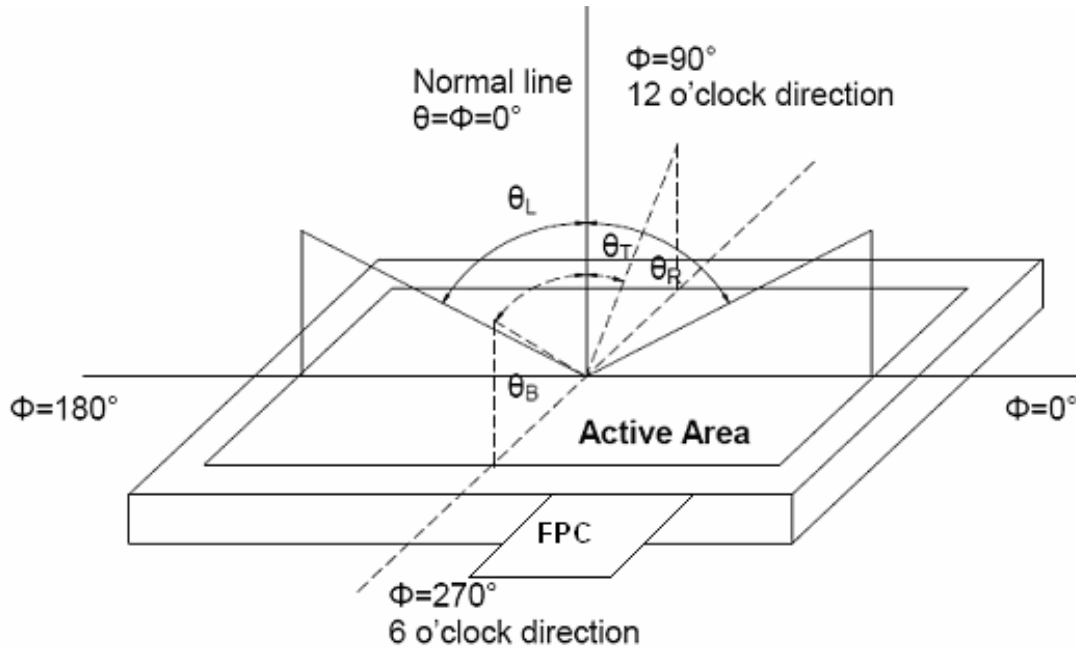


#### 3. Definition of contrast ratio

$$CR = \frac{\text{Luminance with all pixel white}}{\text{Luminance with all pixel black}}$$

4. The 100% transmission is defined as the transmission of LCD panel when all the input terminals of module are electrically opened.

5. Definition of viewing angle:



6. Definition of color chromaticity (CIE1931)

Color coordinates measured at center point of LCD.

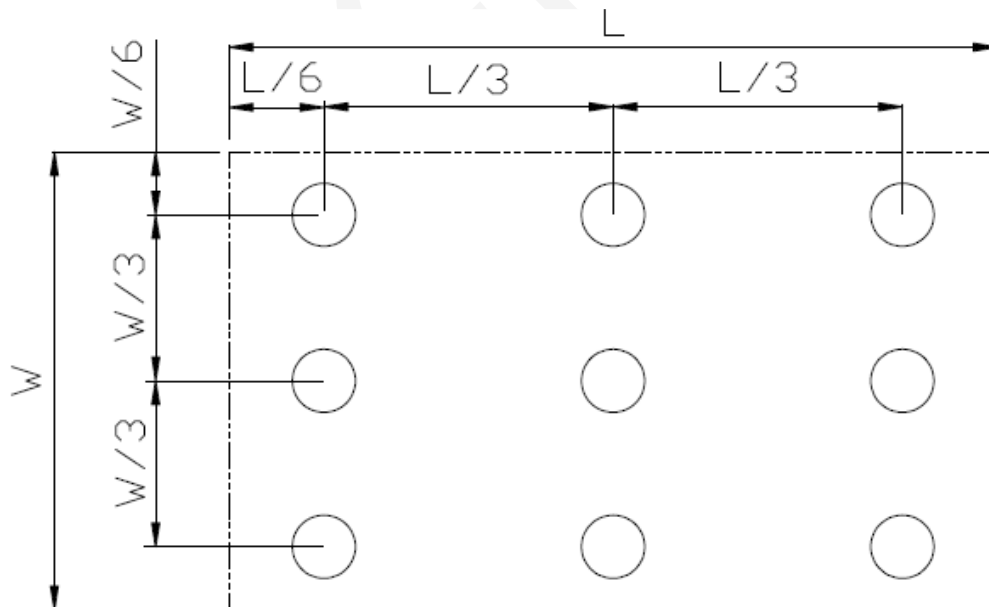
7. Definition of Luminance Uniformity

Active area is divided into 9 measuring areas (Refer Fig.). Every measuring point is placed at the center of each measuring area.

$$\text{Luminance Uniformity}(U) = L_{\text{MIN}} / L_{\text{MAX}}$$

L-----Active area length

W----- Active area width



$L_{\text{MAX}}$ : The measured maximum luminance of all measurement position.

$L_{\text{MIN}}$ : The measured minimum luminance of all measurement position.

8. Definition of Luminance:

Measure the luminance of white state at center point.

## 4. Reliability

### 4.1. Reliability Condition

No.	Item	Condition	Remark
1	High temperature Operating	70°C, 240hrs	Finish product (With polarizer)
2	Low temperature Operating	-20°C, 240hrs	Finish product (With polarizer)
3	High temperature Storage	80°C, 240hrs	Finish product (With polarizer)
4	Low temperature Storage	-30°C, 240hrs	Finish product (With polarizer)
5	High temperature & Humidity Storage	80°C, 90%RH, 240hrs	Finish product (With polarizer)
6	Thermal Shock Storage (No operation)	-30°C, 30min. <=> 80°C, 30min. 100 Cycles	Finish product (With polarizer)
7	ESD Test	Voltage: +8KV R:330Ω, C:150pF Air discharge, 10 times	Finish product (With polarizer)
8	Vibration Test	0.015G*G/Hz from 5-200HZ, -6dB/Octave from 200-500HZ 2 hours for each direction of X. Y. Z. (6 hours for total)	Finish product (With polarizer)
9	Drop Test	Packed, 60cm free fall 1 corner, 3 edges, 6 surfaces	Finish product (With polarizer)

\*One single product test for only one item.

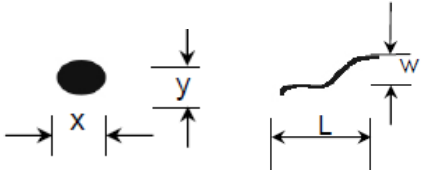
\* Judgment after test: keep in room temperature for more than 2 hours.

- Current consumption < 2 times of initial value
- Contrast > 1/2 initial value
- Function: work normally

## 4.2. Inspection plan

Class	Item	Judgment	Class
Packing & Indicate	1.Outside and inside package	"Model no.", "lot no." and " quantity" should indicate on the package.	Minor
	2.Model mixed and quantity	Other model mixed ..... rejected. Quantity short or over ..... rejected.	Critical
	3.Product indication	"Model no." should indicate on the product	Major
Assembly	4.Dimension,LCD glass scratch and scribe defect	According to specification or drawing	Major
Appearance	5.Viewing area	Polarizer edge or LCD's sealing line is visible in the viewing area ..... rejected	Minor
	6.Blemish,black spot, white spot in the LCD and LCD glass cracks	According to standard of visual inspection (inside viewing area)	Minor
	7.Blemish,black spot White spot and scratch on the polarizer	According to standard of visual inspection (inside viewing area)	Minor
	8.Bubble in polarizer	According to standard of visual inspection (inside viewing area)	Minor
	9.LCD's rainbow color	Strong deviation color (or Newton ring) of LCD ..... rejected. Or according to limited sample (if needed, and inside viewing area)	Minor
	10.FPC	Burned area or wrong part number is on FPC. The symbol, character, and mark of FPC are unidentifiable. The stripped solder mask, $A > 1.0\text{mm}$ . $0.3\text{mm} < \text{stripped solder mask or visible circuit}$ , $A < 1.0\text{mm}$ ,and the number is $\geq 4$ pieces. Particle between circuits in solder mask. Circuit is peeled off or cracked. Any circuit risen or exposed. $0.2\text{mm} < \text{Area of solder ball}$ , $A$ is $\leq 0.4\text{mm}$ ,the number of solder ball is $\geq 3$ pieces. The magnitude of solder ball, $A$ is $> 0.4\text{mm}$ .	Minor
Electrical	11.Electrical and optical characteristics (contrast, VOP, chromaticity etc.)	According to standard of visual inspection (inside viewing area)	Critical
	12.Missing pattern	Missing dot, line, character ..... rejected	Critical
	13.Short circuit, wrong pattern display	Non display, wrong pattern display, current consumption out of specification ..... rejected	Critical
	14.Pin hole, pattern deformity	According to standard of visual inspection	Minor
	15.Black spot, white spot, black line, white line, slant line, background uneven, color uneven	Strong deviation color ..... rejected Or according to limited sample full off screen (all black) ..... disregards	Minor
	16.Stick image (retention image)	Fixed test picture within two hours ..... rejected	Minor

### 4.3. Standard of visual inspection

Class	Item	Judgment															
Minor	Blemish, black spot, white spot in the LCD.	(A) Round type Unit: mm															
	Blemish, black spot, white spot and scratch on the polarizer.	<table border="1"> <thead> <tr> <th>Diameter (mm)</th> <th>Acceptable Quantity</th> </tr> </thead> <tbody> <tr> <td><math>0.25 &lt; A</math></td> <td>0</td> </tr> </tbody> </table> <p>Note: <math>A = (x + y)/2</math> (mm)</p>	Diameter (mm)	Acceptable Quantity	$0.25 < A$	0											
Diameter (mm)	Acceptable Quantity																
$0.25 < A$	0																
	 <p>Round type                      Line type</p>	(B) Line type Unit: mm															
		<table border="1"> <thead> <tr> <th>Length</th> <th>Width</th> <th>Acceptable Quantity</th> </tr> </thead> <tbody> <tr> <td>-</td> <td><math>W \leq 0.03</math></td> <td>Acceptable</td> </tr> <tr> <td><math>L &lt; 5</math></td> <td><math>0.03 &lt; W \leq 0.07</math></td> <td>3</td> </tr> <tr> <td><math>L &lt; 5</math></td> <td><math>0.03 &lt; W \leq 0.07</math></td> <td>1</td> </tr> <tr> <td>-</td> <td><math>0.07 &lt; W</math></td> <td>Follow round type</td> </tr> </tbody> </table>	Length	Width	Acceptable Quantity	-	$W \leq 0.03$	Acceptable	$L < 5$	$0.03 < W \leq 0.07$	3	$L < 5$	$0.03 < W \leq 0.07$	1	-	$0.07 < W$	Follow round type
Length	Width	Acceptable Quantity															
-	$W \leq 0.03$	Acceptable															
$L < 5$	$0.03 < W \leq 0.07$	3															
$L < 5$	$0.03 < W \leq 0.07$	1															
-	$0.07 < W$	Follow round type															
Minor	Bubble in polarizer	Unit: mm															
		<table border="1"> <thead> <tr> <th>Diameter (mm)</th> <th>Acceptable Quantity</th> </tr> </thead> <tbody> <tr> <td><math>A &lt; 0.3</math></td> <td>Acceptable</td> </tr> <tr> <td><math>0.3 &lt; A &lt; 0.5</math></td> <td>1</td> </tr> <tr> <td><math>0.5 &lt; A</math></td> <td>0</td> </tr> </tbody> </table>	Diameter (mm)	Acceptable Quantity	$A < 0.3$	Acceptable	$0.3 < A < 0.5$	1	$0.5 < A$	0							
Diameter (mm)	Acceptable Quantity																
$A < 0.3$	Acceptable																
$0.3 < A < 0.5$	1																
$0.5 < A$	0																
Minor	Pin hole, Pattern deformity	Unit: mm															
		<table border="1"> <thead> <tr> <th>Diameter (mm)</th> <th>Acceptable Quantity</th> </tr> </thead> <tbody> <tr> <td><math>0.4 &lt; A</math></td> <td>0</td> </tr> </tbody> </table>	Diameter (mm)	Acceptable Quantity	$0.4 < A$	0											
Diameter (mm)	Acceptable Quantity																
$0.4 < A$	0																

## 5. Precautions

### 5.1. Handling Precautions

- (1) Protect the panel from static, it may cause damage to the CMOS Gate Array IC.
- (2) Use fingerstalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (3) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.
- (4) The desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane. Don't use Ketone type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.
- (5) Pins of I/F connector shall not be touched directly with bare hands.
- (6) Refrain from strong mechanical shock and / or any force to the panel. In addition to damage, this may cause improper operation or damage to the panel.
- (7) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a B pencil lead.
- (8) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining and discoloration may occur.
- (9) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.

### 5.2. Storage Precautions

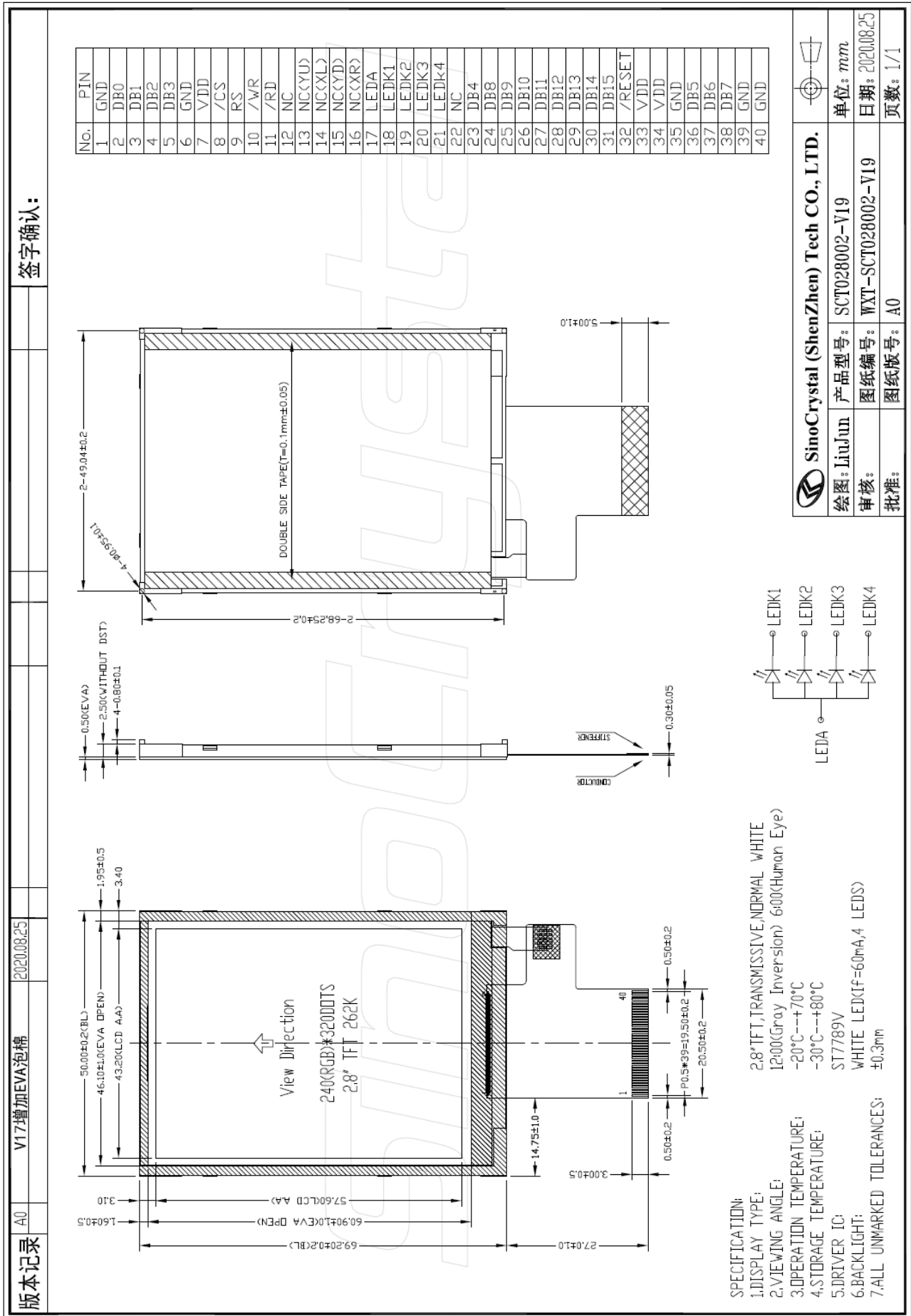
- (1) Do not leave the panel in high temperature, and high humidity for a long time. It is highly recommended to store the panel with temperature from 0 to 35°C and relative humidity of less than 70%.
- (2) The panel shall be stored in a dark place. It is prohibited to apply sunlight or fluorescent light during the store.

### 5.3. Operation Precautions

- (1) The LCD shall be operated within the limits specified. Operation at values outside of these limits may shorten life, and/or harm display images.
- (2) Do not exceed the absolute maximum rating value. (the supply voltage variation, Input voltage variation in part contents and environmental temperature and so on). Otherwise the panel may be damaged.
- (3) If the panel displays the same pattern continuously for a long period of time, it can be the situation when the image "Sticks" to the screen.



## 6. Outline Dimension



## **7. Packing Information**

### **7.1. Packing Quantity**

TBD.

### **7.2. Flowing chart**

TBD.

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