

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	1 / 21

### Thin-Film-Transistor LCD Module Model:XTPQ20NN09-01

Acceptance

Approved and Checked by

Approved by	Checked by		Made by



## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	3 / 21

### 1. General Description and Features

XTPQ20NN09-01 is a TM (Transmissive) type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT-LCD module, a driver circuit and a back-light unit. The resolution of a 2.0" contains 240RGBx320dots and can display up to 262K colors. The following table described the features of XTPQ20NN09-01.

#### LCD Module

Item	Specification	Unit
Screen Size	2.0inches	Diagona
Display Resolution	240RGB(H)x320(V)	Dot
Active Area	30.24 (H) x 40.32(V)	mm
Outline Dimension	35.9 (W) x 51.66(H) x 2.75 (D)	mm
Display Mode	Normally white/Transmissive	--
Pixel Arrangement	RGB-Vertical Stripe	--
Display Color	262K	--
Gray scale inversion Direction	12 o'clock	
Viewing Direction	6 o'clock	--
Drive IC	ST7789V	--

Product Specification				
	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	4 / 21

## 2.Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module Size	Horizontal (H)	--	35.9	--	mm	--
	Vertical (V)	--	51.66	--	mm	(1)
	Thickness (T)	--	2.75	--	mm	(2)
Weight		--	N/A	--	g	--

Note (1) Not include FPC.

Refer to the Outline Dimension for further information.

(2) Back-light unit are included.

## 3.Electrical Specifications

### 3.1 Absolute Max. Ratings

#### 3.1.1 Absolute Ratings of Environment

If the operating condition exceeds the following absolute maximum ratings, the TFT LCD module may be damaged permanently.

(Ta=25±2°C, V<sub>SS</sub>=GND=0)

Item	Symbol	Min.	Max.	Unit	Note
Operating temperature	T <sub>OPR</sub>	-20	70	°C	(1)
Storage temperature	T <sub>STG</sub>	-30	80	°C	(1,2,3)

Note (1) 95 % RH Max. ( 40 °C ≥ Ta ). Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C)  
No condensation.

Note (2) In case of below 0°, the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC's character

Note (3) Only operation is guaranteed at operating temperature. Contrast, response time, another display quality are evaluated at +25°C.

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	5 / 21

### 3.2 Electrical Absolute Rating

#### 3.2.1 TFT-LCD Module

(Voltage Referenced to VSS)

Item	Symbol	Value		Unit	Condition
		Min.	Max.		
Digital Power Supply Voltage	VDD	VSS-0.3	5.0	V	--

#### 3.2.2 Back-Light Unit

(Ta=25±2°C)

Item	Symbol	Min.	Max.	Unit	Note
current	I <sub>f</sub>	--	30	mA	(1)
voltage	V <sub>R</sub>	--	5.0	V	(1)

Note (1) Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded. Functional operation should be restricted to the conditions described under normal operating conditions.

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	6 / 21

### 4 Electrical Characteristics

#### 4.1 Backlight Unit

The back-light system is an edge-lighting type with 5 white LEDs (Light Emitting Diode).

(Ta=25±2°C)

Item	Symbol	Value			Unit	Condition
		Min.	Typ.	Max.		
LED Voltage	V <sub>F</sub>	5.9	6.2	6.5	V	If=100mA
LED Current	I <sub>F</sub>	-	100	-	mA	
Power Consumption	P <sub>BL</sub>	-	-	-	mW	
Brightness through TFT	L <sub>v</sub>	---	1000	----	nit	If=100mA
Uniformity(TFT Surface)		≥80%				

Note (1)  $P_{BL} = V_F \times I_F$

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	7 / 21

### 5 Input Terminal Pin Assignment

PIN.NO	SYMBOL	I/O/P	FUNCTI	MEMARK
1	C/D	I	<ul style="list-style-type: none"> <li>-Write enable in MCU parallel interface.</li> <li>- Display data/command selection pin in 4-line serial interface.</li> <li>- Second Data lane in 2 data lane serial interface.</li> <li>-If not used, please fix this pin at VDDI or DGND.</li> </ul>	
2	CS	I	<ul style="list-style-type: none"> <li>-Chip selection pin</li> <li>Low enable.</li> <li>High disable.</li> </ul>	
3	SCK	I	<ul style="list-style-type: none"> <li>-This pin is used to be serial interface clock.</li> </ul>	
4	MISO	O	<ul style="list-style-type: none"> <li>-SPI interface output pin.</li> <li>-The data is output on the falling edge of the SCL signal.</li> <li>-If not used, let this pin open.</li> </ul>	
5	MOSI	I/O	<ul style="list-style-type: none"> <li>-When IM3: High, SPI interface input pin.</li> <li>-The data is latched on the rising edge of the SCL signal.</li> </ul>	
6	RESET	I	<ul style="list-style-type: none"> <li>-This signal will reset the device and it must be applied to properly initialize the chip.</li> <li>-Signal is active low.</li> </ul>	
7-22	D0-D15	I/O	<ul style="list-style-type: none"> <li>-DB[17:0] are used as MCU parallel interface data bus.</li> <li>8-bit I/F: when IM3:0, DB[7:0] are used; when IM3:1, DB[17:10] are used.</li> <li>9-bit I/F: when IM3:0, DB[8:0] are used; when IM3:1, DB[17:9] are used.</li> <li>16-bit I/F: when IM3:0, DB[15:0] are used; when IM3:1, DB[17:10] and DB[8:1] are used.</li> <li>18-bit I/F: DB[17:0] are used.</li> <li>-DB[17:0] are used as RGB interface data bus.</li> <li>6-bit RGB I/F: DB[5:0] are used.</li> <li>16-bit RGB I/F: DB[17:13], DB[11:1] are used.</li> <li>18-bit RGB I/F: DB[17:0] are used.</li> <li>-If not used, please fix this pin at VDDI or DGND.</li> </ul>	
23	DCLK	I	<ul style="list-style-type: none"> <li>-Dot clock signal for RGB interface operation.</li> <li>-If not used, please fix this pin at VDDI or DGND.</li> </ul>	
24	DE	O	<ul style="list-style-type: none"> <li>-Tearing effect signal is used to synchronize MCU to frame memory</li> </ul>	

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	8 / 21

			writing. -If not used, please let this pin open	
<b>25</b>	<b>VS</b>	<b>I</b>	-Vertical (Frame) synchronizing input signal for RGB interface operation. -If not used, please fix to the VDDI or DGND.	
<b>26</b>	<b>HS</b>	<b>I</b>	-Horizontal (Line) synchronizing input signal for RGB interface operation. - If not used, please fix to VDDI or DGND.	
<b>27</b>	<b>GND</b>	<b>P</b>	<b>POWER GROUND</b>	
<b>28</b>	<b>IOVCC</b>	<b>I</b>	Power Supply for I/O System.	
<b>29</b>	<b>VCI</b>	<b>I</b>	Power Supply for Analog, Digital System and Booster Circuit.	
<b>30</b>	<b>GND</b>	<b>P</b>	<b>POWER GROUND</b>	
<b>31</b>	<b>LED +</b>	<b>P</b>	<b>POWER FOR BACKLIHT(ANODE)</b>	
<b>32</b>	<b>LED -</b>	<b>P</b>	<b>POWER FOR BACKLIHT(CATHODE)</b>	

## 6 LCD Optical Characteristics

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	9 / 21

Item	Symbol	Condition	Min	Typ	Max	Unit	Remark
View Angles	$\theta T$	$CR \cong 10$	60	70	-	Degree	Note 2
	$\theta B$		50	60	-		
	$\theta L$		6	70	-		
	$\theta R$		60	70	-		
Contrast Ratio	CR	$\theta=0^\circ$	400	600	-	-	Note1 Note3
Response Time	$T_{ON}$	25°C	-	20	30	ms	Note1
	$T_{OFF}$		-	-	-		Note4
Chromaticity	White	x		0.299		-	Note5 Note1
		y		0.355			
	Red	x		0.640			
		y		0.321			
	Green	x		0.293			
		y		0.579			
	Blue	x		0.134			
		y		0.142			
NTSC	-	-	-	60	-	%	Note 5
Transmittance	T	-	4.2	4.7	-	%	Note 1

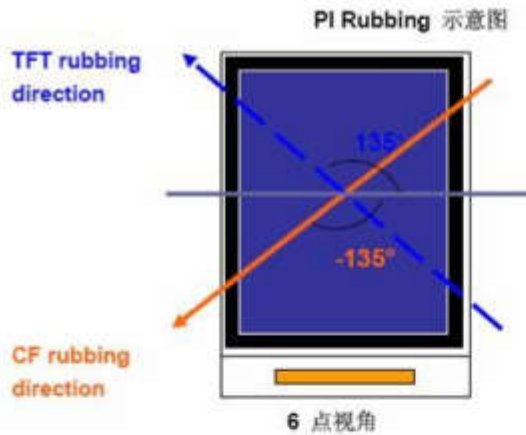
### Test Conditions:

1. The ambient temperature is 25°C.
2. The test systems refer to Note 1 and Note 2.

### 6.2 Rubbing Direction

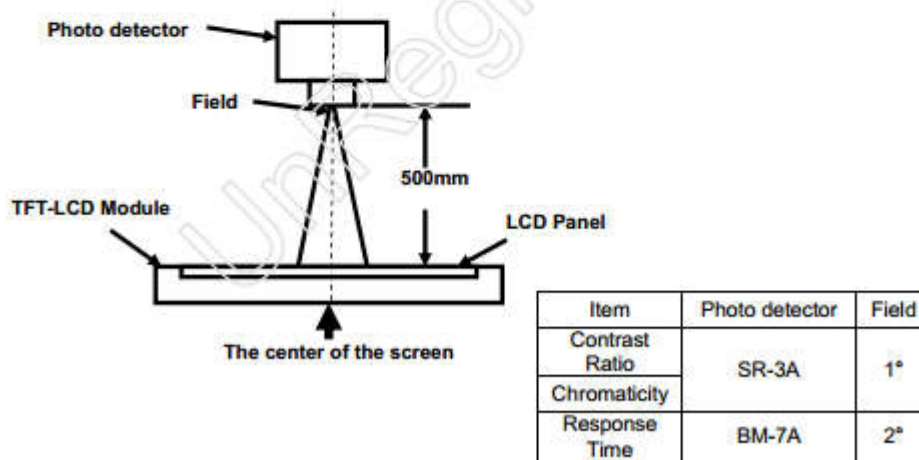
# Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	10 / 21



**Note 1:** Definition of optical measurement system.

The optical characteristics should be measured in dark room. After 5 minutes operation, the optical properties are measured at the center point of the LCD screen. All input terminals LCD panel must be ground when measuring the center area of the panel.



**Note 2:** Definition of viewing angle range and measurement system.

viewing angle is measured at the center point of the LCD by CONOSCOPE(ergo-80).



## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	12 / 21

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is on the "White" state}}{\text{Luminance measured when LCD is on the "Black" state}}$$

**Note 3: Definition of contrast ratio**

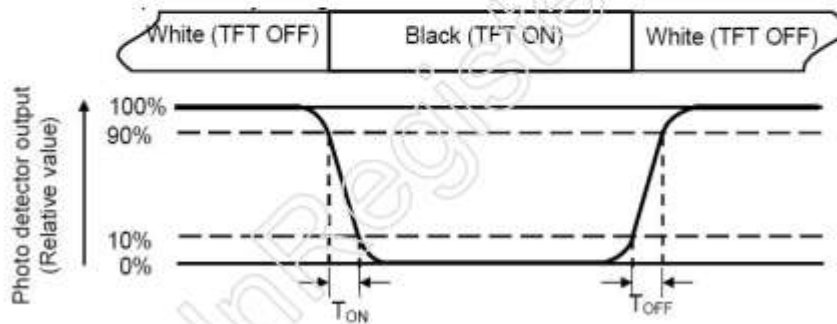
"White state": The state is that the LCD should driven by Vwhite.

"Black state": The state is that the LCD should driven by Vblack.

Vwhite: To be determined    Vblack: To be determined.

**Note 4: Definition of Response time**

The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time (TON) is the time between photo detector output intensity changed from 90% to 10%. And fall time (TOFF) is the time between photo detector output intensity changed from 10% to 90%.



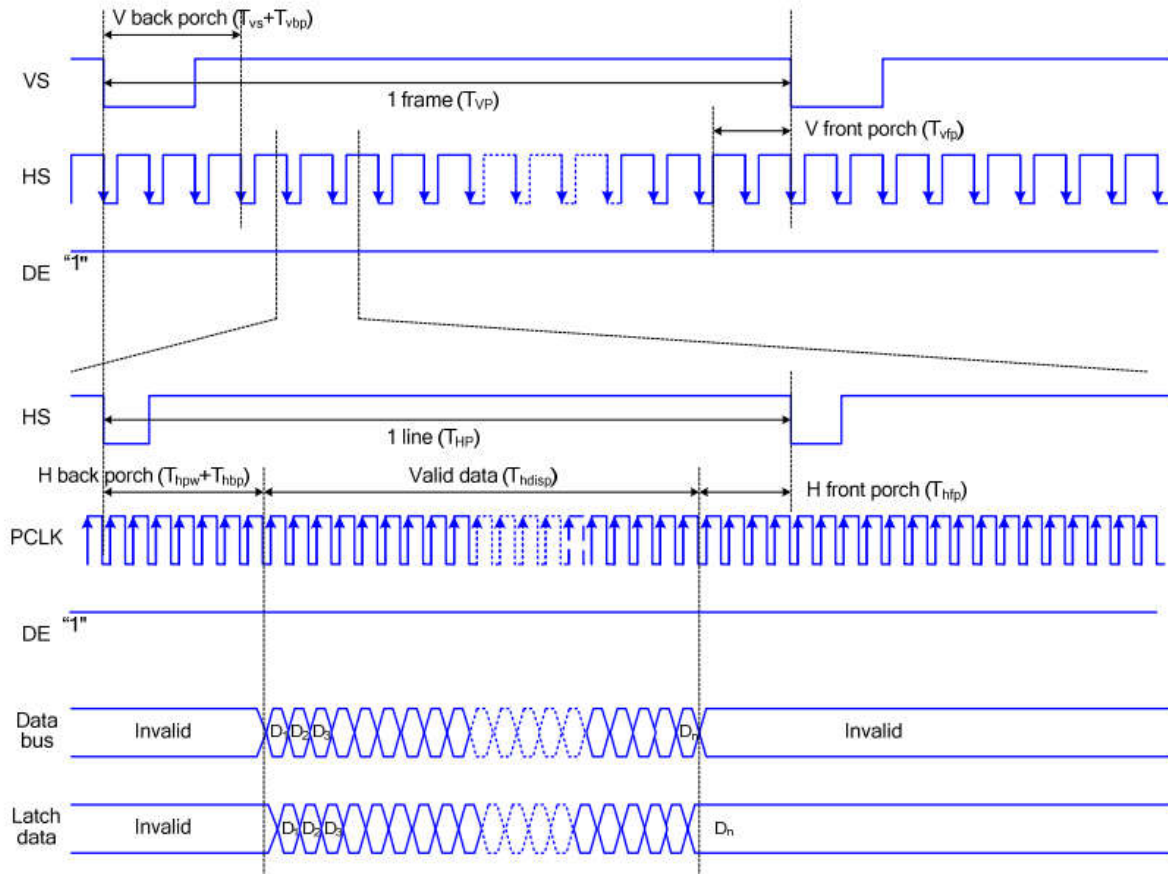
**Note 5: Definition of color chromaticity (CIE1931)**

Color coordinates measured at center point of LCD.

# Product Specification

Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
	A	2017,05,16	13 / 21

## 7 Interface Timing



**Figure 26 Timing chart of RGB interface HV mod**

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	14 / 21

### 8 Reliability Condition for LCD

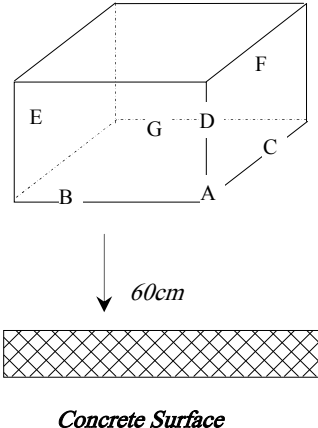
No change on display and in operation under the following test condition.

Condition: Unless otherwise specified, tests will be conducted under the following condition.

Temperature: 20±5°C                      Humidity: 65±5%RH

Tests will be not conducted under functioning state.

No.	Parameter	Condition	Notes
1	High Temperature Operating	70°C±2°C, 240hrs (Operation state)	--
2	Low Temperature Operating	-20°C±2°C, 240hrs (Operation state)	--
3	High Temperature Storage	80°C±2°C, 240hrs	--
4	Low Temperature Storage	-30°C±2°C, 240hrs	--
5	High Temperature and High Humidity Operation Test	60°C±2°C, 90%, 240hrs	--
6	Vibration Test	Total fixed amplitude: 1.5mm Vibration Frequency: 10±5Hz One cycle 60 seconds to 3 direction of X, Y, Z each 15 minutes.	--

7.	Drop Test	<p>To be measured after dropping from 60cm high on the concrete surface in packing state.</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p><i>Dropping method corner dropping</i></p> <p><i>A corner: once</i></p> <p><i>Edge dropping</i></p> <p><i>B, C, D edge: once</i></p> <p><i>Face dropping</i></p> <p><i>E, F, G face: once</i></p> </div> </div>	--
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- Notes:
1. No dew condensation to be observed.
  2. The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.

<b>Product Specification</b>				
	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	15 / 21

3. Vibration test will be conducted to the product itself without putting I in a container.

## **9 Dimensional outlines**

# Product Specification

Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
	A	2017,05,16	16 / 21

PN1	NAME
1	C/D
2	CS
3	SGK
4	MISO
5	MOSI
6	RESET
7	DD0(RGB)
8	D1(RGB)
9	D2(RGB)
10	D3(RGB)
11	D4(RGB)
12	D5(G2)
13	D6(G2)
14	D7(G4)
15	D8(G5)
16	D9(G6)
17	D10(G7)
18	D11(B3)
19	D12(B4)
20	D13(B5)
21	D14(B6)
22	D15(B7)
23	DCLK
24	DE
25	V5
26	HS
27	GND
28	IDVCC
29	VCL
30	GND
31	LED-ANODE
32	LED-CATHODE

**NOTES:**

1. Display Type: o-Si TFT;
2. Backlight: 5-chips LED, series;
3. Gray Scale Inversion Direction: 12H;
4. Driver IC: ST7789V
5. General Tolerance: ±0.3;
6. REQUIREMENTS ON ENVIRONMENTAL PROTECTION: RoHS

(BL CIRCUIT DIAGRAM)  
If=100mA Vf=6.2V  
1000 nits(Typ)

LED A ○ LEDK ○

FPC弯折示意图  
FPC弯折出货

日期	版本	修改内容	

DATE	20170411	REV	A	
UNIT : mm	Product :	XTPQ20NN09-01		OUTLINE Dwg.
SCALE : 1/1	DRAWN :	OSCAR	CHECKED :	PAGE : 1/1
SHEET : 1/1				

## 10 Incoming Inspection Standards

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	17 / 21

### 11.1 VISUAL & FUNCTION INSPECTION STANDARD

#### 11.1.1 Inspection conditions

Inspection performed under the following conditions is recommended.

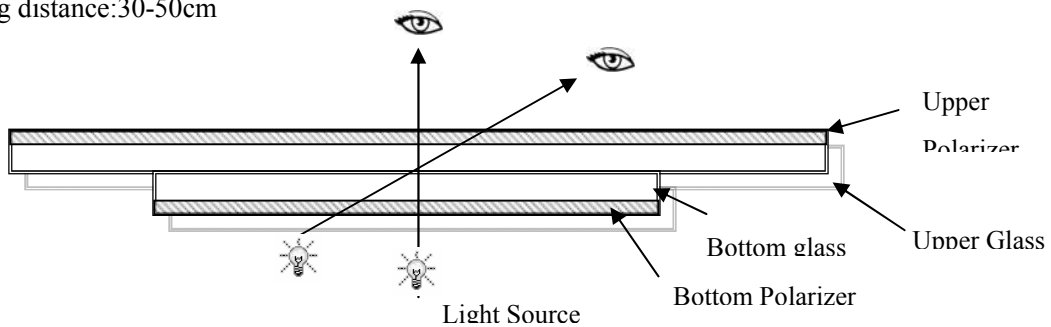
Temperature : 25±5°C

Humidity : 65%±10%RH

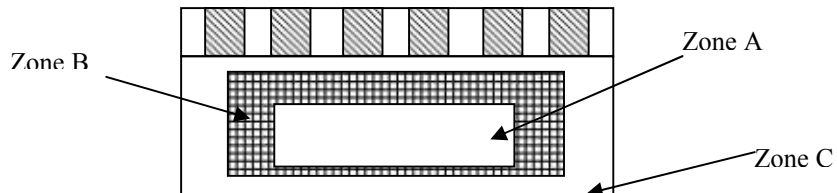
Viewing Angle : Normal viewing Angle.

Illumination: Single fluorescent lamp (300 to 700Lux)

Viewing distance:30-50cm



#### 11.1.2 Definition



Zone A : Effective Viewing Area(Character or Digit can be seen)

Zone B : Viewing Area except Zone A

Zone C : Outside (Zone A+Zone B) which can not be seen after assembly by customer .)

Note:

As a general rule ,visual defects in Zone C can be ignored when it doesn't effect product function or appearance after assembly by customer.

#### 11.1.3 Sampling Plan

According to GB/T 2828-2003 ; , normal inspection, Class II

AQL:

Major defect	Minor defect
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## Product Specification

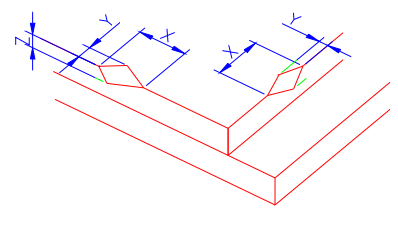
	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	18 / 21

0.65	1.5
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LCD: Liquid Crystal Display , TP: Touch Panel , LCM: Liquid Crystal Module

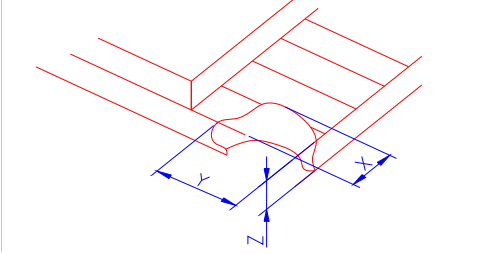
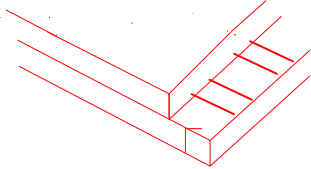
No	Items to be inspected	Criteria	Classification of defects
1	Functional defects	1) No display, Open or miss line 2) Display abnormally, Short 3) Backlight no lighting, abnormal lighting. 4) TP no function	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing is not allowed	
4	Color tone	Color unevenness, refer to limited sample	Minor
5	Soldering appearance	Good soldering , Peeling off is not allowed.	
6	LCD/Polarizer/TP	Black/White spot/line, scratch, crack, etc.	

### 11.1.4 Criteria (Visual)

Number	Items	Criteria(mm)						
1.0 LCD Crack/Broken	(1) The edge of LCD broken							
NOTE: X: Length Y: Width		<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="width: 33%; text-align: center;">X</td> <td style="width: 33%; text-align: center;">Y</td> <td style="width: 33%; text-align: center;">Z</td> </tr> <tr> <td style="text-align: center;"><math>\leq 3.0\text{mm}</math></td> <td style="text-align: center;">&lt;Inner border line of the seal</td> <td style="text-align: center;"><math>\leq T</math></td> </tr> </table>	X	Y	Z	$\leq 3.0\text{mm}$	<Inner border line of the seal	$\leq T$
X	Y	Z						
$\leq 3.0\text{mm}$	<Inner border line of the seal	$\leq T$						

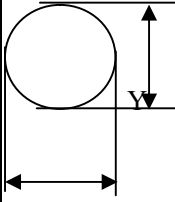
## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	19 / 21

<p>Z: Height L: Length of ITO, T: Height of LCD</p>	<p>(2)LCD corner broken</p>	 <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th style="padding: 5px;">X</th> <th style="padding: 5px;">Y</th> <th style="padding: 5px;">Z</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;"><math>\leq 3.0\text{mm}</math></td> <td style="padding: 5px;"><math>\leq L</math></td> <td style="padding: 5px;"><math>\leq T</math></td> </tr> </tbody> </table>	X	Y	Z	$\leq 3.0\text{mm}$	$\leq L$	$\leq T$
X	Y	Z						
$\leq 3.0\text{mm}$	$\leq L$	$\leq T$						
	<p>(3) LCD crack</p>	 <p style="text-align: center;">Crack Not allowed</p>						

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	20 / 21

Number	Items	Criteria (mm)																																																																				
2.0	Spot defect  $\Phi = (X+Y)/2$	① light dot (LCD/TP/Polarizer black/white spot, light dot, pinhole, dent, stain) <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 30%;">Zone</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>Size (mm)</th> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.10</math></td> <td colspan="3" style="text-align: center;">Ignore</td> </tr> <tr> <td><math>0.10 &lt; \Phi \leq 0.15</math></td> <td colspan="3" style="text-align: center;">3( distance <math>\geq 10\text{mm}</math>)</td> </tr> <tr> <td><math>0.15 &lt; \Phi \leq 0.2</math></td> <td colspan="3" style="text-align: center;">1</td> </tr> <tr> <td><math>0.2 &lt; \Phi</math></td> <td colspan="3" style="text-align: center;">0</td> </tr> </tbody> </table> ② Dim spot (LCD/TP/Polarizer dim dot, light leakage, dark spot) <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 30%;">Zone</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>Size (mm)</th> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.1</math></td> <td colspan="3" style="text-align: center;">Ignore</td> </tr> <tr> <td><math>0.1 &lt; \Phi \leq 0.2</math></td> <td colspan="3" style="text-align: center;">2( distance <math>\geq 10\text{mm}</math>)</td> </tr> <tr> <td><math>0.2 &lt; \Phi \leq 0.3</math></td> <td colspan="3" style="text-align: center;">1</td> </tr> <tr> <td><math>\Phi &gt; 0.3</math></td> <td colspan="3" style="text-align: center;">0</td> </tr> </tbody> </table> ③ Polarizer accidented spot <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 30%;">Zone</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>Size (mm)</th> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.2</math></td> <td colspan="3" style="text-align: center;">Ignore</td> </tr> <tr> <td><math>0.2 &lt; \Phi \leq 0.5</math></td> <td colspan="3" style="text-align: center;">2( distance <math>\geq 10\text{mm}</math>)</td> </tr> <tr> <td><math>\Phi &gt; 0.5</math></td> <td colspan="3" style="text-align: center;">0</td> </tr> </tbody> </table>	Zone	Acceptable Qty			Size (mm)	A	B	C	$\Phi \leq 0.10$	Ignore			$0.10 < \Phi \leq 0.15$	3( distance $\geq 10\text{mm}$ )			$0.15 < \Phi \leq 0.2$	1			$0.2 < \Phi$	0			Zone	Acceptable Qty			Size (mm)	A	B	C	$\Phi \leq 0.1$	Ignore			$0.1 < \Phi \leq 0.2$	2( distance $\geq 10\text{mm}$ )			$0.2 < \Phi \leq 0.3$	1			$\Phi > 0.3$	0			Zone	Acceptable Qty			Size (mm)	A	B	C	$\Phi \leq 0.2$	Ignore			$0.2 < \Phi \leq 0.5$	2( distance $\geq 10\text{mm}$ )			$\Phi > 0.5$	0		
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$0.10 < \Phi \leq 0.15$	3( distance $\geq 10\text{mm}$ )																																																																					
$0.15 < \Phi \leq 0.2$	1																																																																					
$0.2 < \Phi$	0																																																																					
Zone	Acceptable Qty																																																																					
Size (mm)	A	B	C																																																																			
$\Phi \leq 0.1$	Ignore																																																																					
$0.1 < \Phi \leq 0.2$	2( distance $\geq 10\text{mm}$ )																																																																					
$0.2 < \Phi \leq 0.3$	1																																																																					
$\Phi > 0.3$	0																																																																					
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Size (mm)	A	B	C																																																																			
$\Phi \leq 0.2$	Ignore																																																																					
$0.2 < \Phi \leq 0.5$	2( distance $\geq 10\text{mm}$ )																																																																					
$\Phi > 0.5$	0																																																																					

## Product Specification

	Model: XTPQ20NN09-01	Rev. No.	Issued Date.	Page.
		A	2017,05,16	21 / 21

	Line defect (LCD/TP /Polarizer black/white line, scratch, stain)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Width(mm)</th> <th rowspan="2">Length(mm)</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.03</math></td> <td>Ignore</td> <td colspan="2">Ignore</td> <td rowspan="3">Ignore</td> </tr> <tr> <td><math>0.03 &lt; W \leq 0.05</math></td> <td><math>L \leq 3.0</math></td> <td colspan="2"><math>N \leq 2</math></td> </tr> <tr> <td><math>0.05 &lt; W \leq 0.08</math></td> <td><math>L \leq 2.0</math></td> <td colspan="2"><math>N \leq 2</math></td> </tr> <tr> <td><math>0.08 &lt; W</math></td> <td colspan="4">Define as spot defect</td> </tr> </tbody> </table>	Width(mm)	Length(mm)	Acceptable Qty			A	B	C	$\Phi \leq 0.03$	Ignore	Ignore		Ignore	$0.03 < W \leq 0.05$	$L \leq 3.0$	$N \leq 2$		$0.05 < W \leq 0.08$	$L \leq 2.0$	$N \leq 2$		$0.08 < W$	Define as spot defect			
Width(mm)	Length(mm)	Acceptable Qty																										
		A	B	C																								
$\Phi \leq 0.03$	Ignore	Ignore		Ignore																								
$0.03 < W \leq 0.05$	$L \leq 3.0$	$N \leq 2$																										
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$0.08 < W$	Define as spot defect																											
3.0	Polarizer Bubble	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Zone Size (mm)</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.2</math></td> <td colspan="2">Ignore</td> <td rowspan="4">Ignore</td> </tr> <tr> <td><math>0.2 &lt; \Phi &lt; 0.4</math></td> <td colspan="2">2(distance <math>\geq 10</math>mm)</td> </tr> <tr> <td><math>0.4 &lt; \Phi \leq 0.6</math></td> <td colspan="2">1</td> </tr> <tr> <td><math>0.6 &lt; \Phi</math></td> <td colspan="2">0</td> </tr> </tbody> </table>	Zone Size (mm)	Acceptable Qty			A	B	C	$\Phi \leq 0.2$	Ignore		Ignore	$0.2 < \Phi < 0.4$	2(distance $\geq 10$ mm)		$0.4 < \Phi \leq 0.6$	1		$0.6 < \Phi$	0							
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4.0	SMT	According to IPC-A-610C class II standard . Function defect and missing part are major defect ,the others are minor defect.																										