

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	1 / 18

Thin-Film-Transistor LCD Module
Model: XTPQ28TP02-01

Acceptance

Approved and Checked by

Approved by	Checked by		Made by

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	2 / 18

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Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	3 / 18

1.General Description and Features

XTPQ28TP02-01 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 circuits and a back-light unit. The resolution of a 2.8" contains 240RGBx320 dots and can display up to 262K colors. The following table described the features of XTPQ28TP02-01.

LCD Module

Item	Specification	Unit
Screen Size	2.8inches	Diagonal
Dot arrangement	240RGB(H)x320(V)	Dot
Vision Area	44.2(W) x 58.6(H)	mm
Outline Dimension	50(W) x 69.2(H) x6.46MAX (T)	mm
Display Mode	Normally white/Transmissive	--
Pixel Arrangement	RGB-Vertical Stripe	--
Display Color	262K	--
Viewing Direction	6 o'clock	--
Gray viewing Direction	12 o'clock	--
Drive IC	ILI9341V	--

2.Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module Size	Horizontal (H)	--	50	--	mm	--
	Vertical (V)	--	69.2	--	mm	(1)
	Thickness (T)	--	6.46	--	mm	(2)
Weight		--	N/A	--	g	--

Note (1) Not include FPC.

Refer to the Outline Dimension for further information.

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	4 / 18

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_{SS}=GND=0)

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T _{STG}	-30	80	°C	(1)
Operating temperature	T _{OPR}	-20	70	°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.

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	-0.3	4.6	V	--

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				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	5 / 18

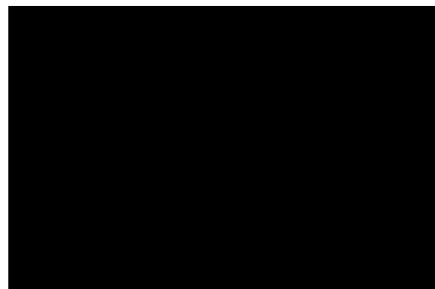
4 Electrical Characteristics

4.1 TFT-LCD Module (DC Characteristics)

Item	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Power Supply Digital Voltage	VDDI	1.65	3.0	3.3	V	
Power Supply Logic Voltage	VCI	2.5	3.0	3.3	V	
Input High Threshold Voltage	V _{IH}	0.7 VDD	-	VDD	V	
Input Low Threshold Voltage	V _{IL}	0	-	0.3 VDD	V	
Power Supply Current	I _{CC}	-	5	--	mA	(1)
Power Consumption	P _L	-	-	-	mW	(1)

Note (1) The specified power consumption is under the conditions at VDD=3.3V , F_V=60Hz, whereas a Power dissipation check pattern below is displayed.

Black Pattern / 0 Gray



Active Area

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	6 / 18

5 Input Terminal Pin Assignment

5.1 Pin Assignment (LCD)

Pin No.	Symbol	I/O /P	Description
1	NC		Not connection
2	NC		Not connection
3	NC		Not connection
4	NC		Not connection
5	IM2	I	Select the MCU interface mode
6	IM1		
7	IM0		
8	LEDON	0	Output pin for enabling LED driving. If not used, open this pad.
9	LEDPWM	0	Output pin for PWM (Pulse Width Modulation) signal of LED driving. If not used, open this pad.
10	SDA	I/O	When IM[3] : Low, Serial in/out signal. When IM[3] : High, Serial input signal. The data is applied on the rising edge of the SCL signal.
11	SD0	0	Serial output signal. The data is outputted on the falling edge of the SCL signal. If not used, open this pin
12	D17	I/O	18-bit parallel bi-directional data bus for MCU system and RGB interface mode
13	D16		
14	D15		
15	D14		
16	D13		
17	D12		
18	D11		
19	D10		
20	D9		
21	D8		
22	D7		

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	7 / 18

23	D6		
24	D5		
25	D4		
26	D3		
27	D2		
28	D1		
29	D0		
30	RESX	I	This signal will reset the device and must be applied to properly initialize the chip. Signal is active low.
31	RDX	I	8080- I /8080- II system (RDX): Serves as a read signal and MCU read data at the rising edge.
32	WRX	I	- 8080- I /8080- II system (WRX): Serves as a write signal and writes data at the rising edge. - 4-line system (D/CX): Serves as command or parameter select.
33	DCX	I	This pin is used to select "Data or Command" in the parallel interface or 4-wire 8-bit serial data interface. When DCX = '1', data is selected. When DCX = '0', command is selected. This pin is used serial interface clock in 3-wire 9-bit / 4-wire 8-bit serial data interface.
34	CSX	I	Chip select input pin ("Low" enable). This pin can be permanently fixed "Low" in MPU interface mode only.
35	GND	P	Power Ground
36	VCI	I	High voltage power supply for analog circuits blocks
37	VDDI	I	Low voltage power supply for interface logic circuits .
38	LEDA	I	Power supply for backlight
39	LEDK1	I	Ground supply for backlight
40	LEDK2	I	Ground supply for backlight

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	8 / 18

6 Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (1).

Measuring equipment: BM-5A, BM-7,

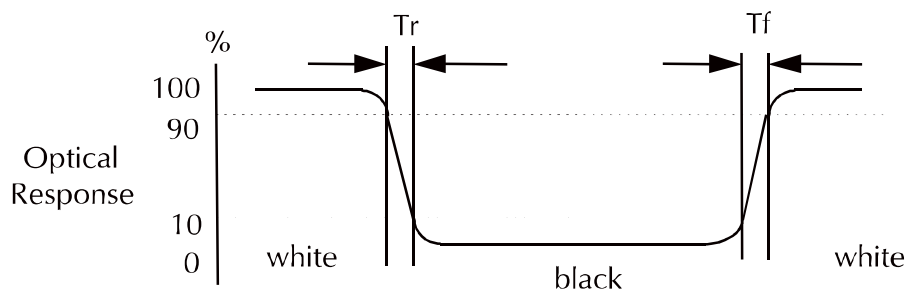
Item	Symbol	Condition	Min	Type	Max	Unit	Note
Brightness	B		195	220	--	cd/m ²	
Response time	T _r +T _f	$\theta=0^\circ$ T=25°C	--	12	24	ms	.
Contrast ratio	CR		400	500	--	--	
Color Gamut	NTSC %	--	--	60	--	%	
Luminance Uniformity	ΔL		--	80	--	%	
Color Chromaticity (CIE 1931)	White	W _x	0.283	0.303	0.323	--	BM-7A
		W _y	0.305	0.325	0.345		
Viewing Angle	Hor.	θ_R	35	45	--	Degree	
		θ_L	35	45	--		
	Ver.	θ_U	40	50	--		
		θ_D	10	20	--		

a. Test equipment setup

After stabilizing and leaving the panel alone shall be warmed up for the stable operation of LCM, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7(fast) with a viewing angle of 2° at a distance of 50cm and normal direction.

b. Definition of response time: Tr and Tf

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



Product Specification

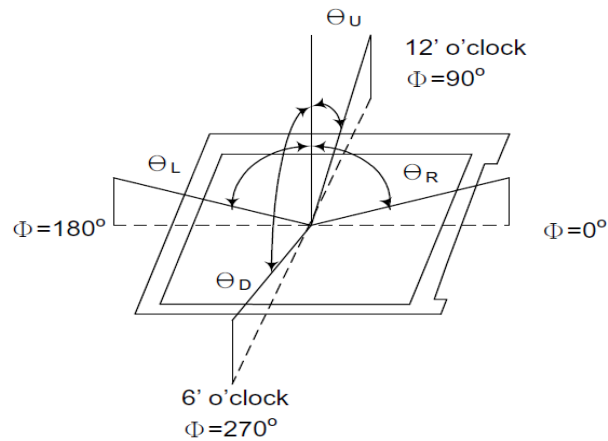
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	9 / 18

c. Definition of contrast ratio:

$$\text{Contrast Ratio (CR)} = \frac{\text{Brightness measured when LCD is at "white state"}}{\text{Brightness measured when LCD is at "black state"}}$$

d. Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

e. View Angle



f. Definition of White Uniformity

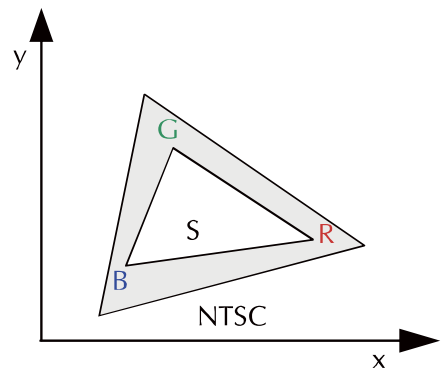
$$\text{White Uniformity} = \frac{\text{Min. luminance of white among 9-points}}{\text{Max. luminance of white among 9-points}} \times 100\%$$

g. The definition of Color Gamut -Color Chromaticity CIE 1931

Color coordinate of white & red, green, blue at center point.

$$\text{Color Gamut : NTSC(\%)} = \left(\frac{\text{RGB Triangle Area}}{\text{NTSC Triangle Area}} \right) \times 100$$

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	10 / 18

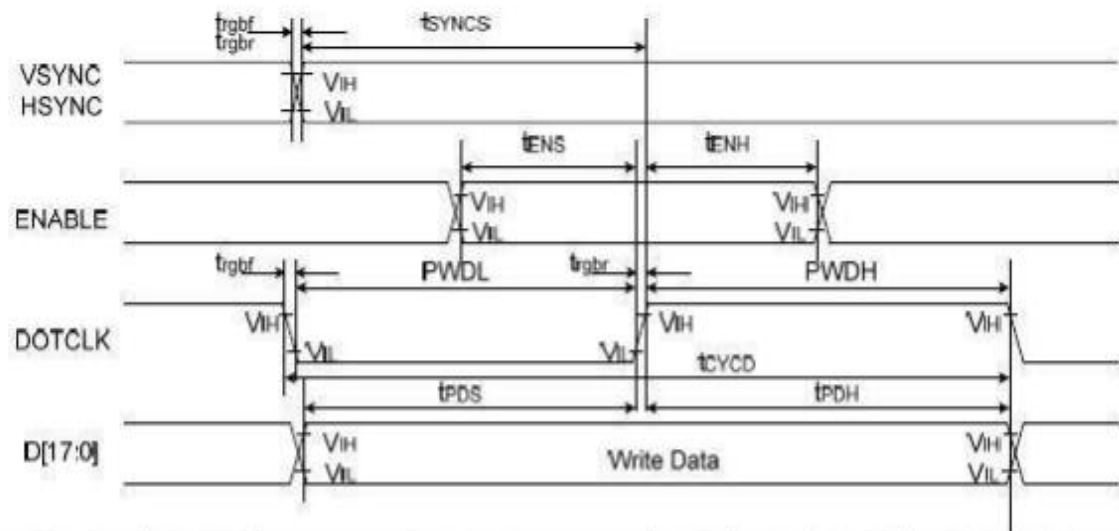


Product Specification

Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	11 / 18

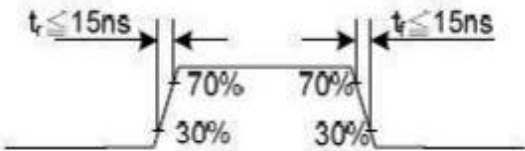
7 Interface Timing

Parallel 18/16-bit RGB Interface Timing Characteristics



Signal	Symbol	Parameter	min	max	Unit	Description
VSYNC / HSYNC	t_{SYNCS}	VSYNC/HSYNC setup time	15	-	ns	18/16-bit bus RGB interface mode
	t_{SYNCH}	VSYNC/HSYNC hold time	15	-	ns	
ENABLE	t_{ENS}	ENABLE setup time	15	-	ns	
	t_{ENH}	ENABLE hold time	15	-	ns	
DB[17:0]	t_{POS}	Data setup time	15	-	ns	
	t_{PDH}	Data hold time	15	-	ns	
DOTCLK	PWDH	DOTCLK high-level period	15	-	ns	
	PWDL	DOTCLK low-level period	15	-	ns	
	t_{CYCD}	DOTCLK cycle time	66	-	ns	
	t_{rgb}, t_{rgb}	DOTCLK, HSYNC, VSYNC rise/fall time	-	15	ns	

Note: $T_a = -30$ to $70\text{ }^{\circ}\text{C}$, $IOVCC=1.65\text{V}$ to 3.6V , $VCI=2.5\text{V}$ to 3.3V , $AGND=DGND=0\text{V}$



Pixel Timing

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	12 / 18

8 Reliability Condition for LCD

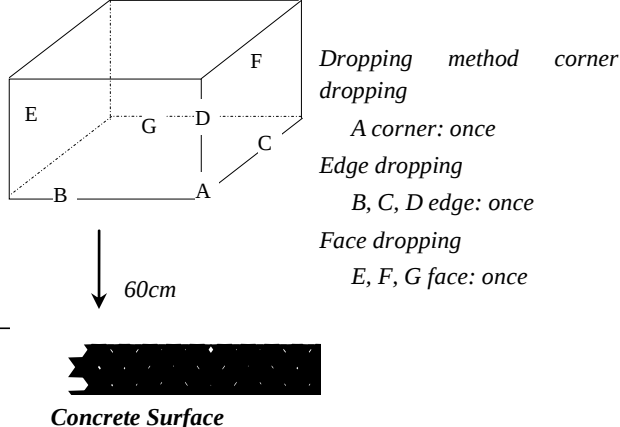
No change on display and in operation under the following test condition.

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: 10~55Hz One cycle 60 seconds to 3 direction of X, Y, Z each 15 minutes.	--
7.	Drop Test	To be measured after dropping from 60cm high on the concrete surface in packing state.  Dropping method corner dropping A corner: once Edge dropping B, C, D edge: once Face dropping E, F, G face: once Concrete Surface	--

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.

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

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	13 / 18

10 Incoming Inspection Standards



Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	14 / 18

10.1 VISUAL & FUNCTION INSPECTION STANDARD

10.1.1 Inspection conditions

Inspection performed under the following conditions is recommended.

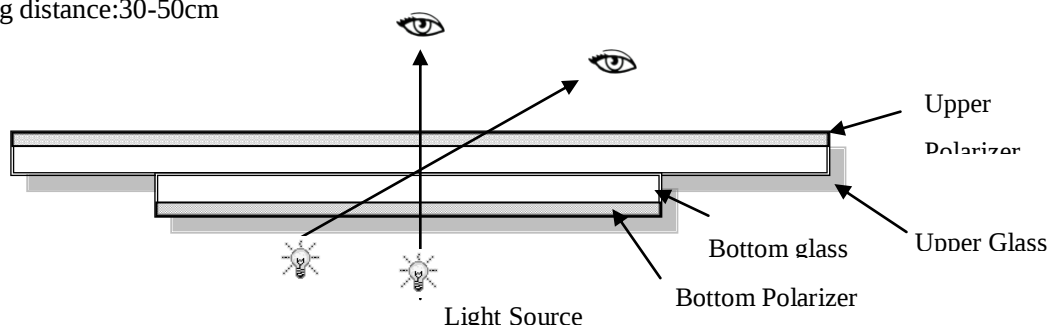
Temperature : $25 \pm 5^{\circ}\text{C}$

Humidity : $65\% \pm 10\% \text{RH}$

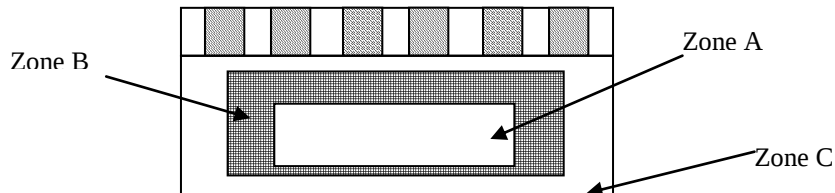
Viewing Angle : Normal viewing Angle.

Illumination: Single fluorescent lamp (300 to 700Lux)

Viewing distance:30-50cm



10.1.2 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.

10.1.3 Sampling Plan

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	15 / 18

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

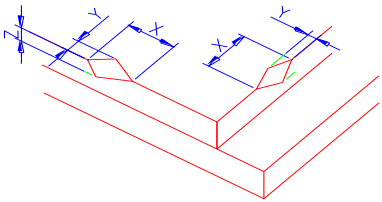
AQL:

Major defect	Minor defect
0.65	1.5

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

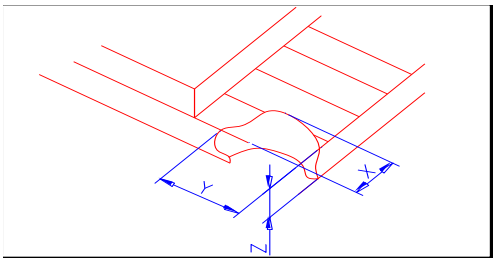
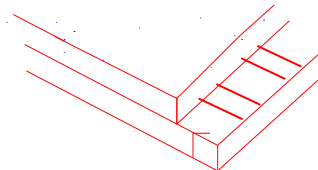
No	Items to be inspected	Criteria	Classification of defects
1	Functional defects	1) No display, Open or miss line 2) Display abnormally, Short 3) Backlight no lighting, abnormal lighting. 4) TP no function	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing 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.	

10.1.4 Criteria (Visual)

Number	Items	Criteria(mm)						
1.0 LCD Crack/Broken	(1) The edge of LCD broken	 <table> <tr> <th>X</th><th>Y</th><th>Z</th></tr> <tr> <td>≤3.0mm</td><td><Inner border line of the seal</td><td>≤T</td></tr> </table>	X	Y	Z	≤3.0mm	<Inner border line of the seal	≤T
X	Y	Z						
≤3.0mm	<Inner border line of the seal	≤T						
NOTE: X: Length Y: Width								

Product Specification

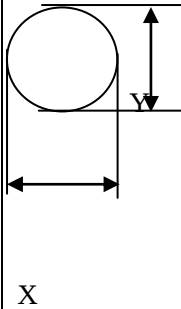
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	16 / 18

Z: Height L: Length of ITO, T: Height of LCD	(2)LCD corner broken	 <table border="1" data-bbox="893 698 1313 799"><tr><td>X</td><td>Y</td><td>Z</td></tr><tr><td>≤3.0mm</td><td>≤L</td><td>≤T</td></tr></table>	X	Y	Z	≤3.0mm	≤L	≤T
	X	Y	Z					
≤3.0mm	≤L	≤T						
(3) LCD crack	 Crack Not allowed							

Number	Items	Criteria (mm)
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Product Specification

Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	17 / 18

2.0	Spot defect	① light dot (LCD/TP/Polarizer black/white spot , light dot, pinhole, dent, stain)			
					

Product Specification				
Amotec	Model: XTPQ28TP02-01	Rev. No.	Issued Date.	Page.
		A	2016.04.21	18 / 18

	Line defect (LCD/TP /Polarizer black/white line, scratch, stain)	<table><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><tr><td>$\Phi\leq0.03$</td><td>Ignore</td><td colspan="2">Ignore</td><td rowspan="3">Ignore</td></tr><tr><td>$0.03<W\leq0.05$</td><td>$L\leq3.0$</td><td colspan="2">$N\leq2$</td></tr><tr><td>$0.05<W\leq0.08$</td><td>$L\leq2.0$</td><td colspan="2">$N\leq2$</td></tr><tr><td>$0.08<W$</td><td colspan="4">Define as spot defect</td></tr></table>	Width(mm)	Length(mm)	Acceptable Qty			A	B	C	$\Phi\leq0.03$	Ignore	Ignore		Ignore	$0.03<W\leq0.05$	$L\leq3.0$	$N\leq2$		$0.05<W\leq0.08$	$L\leq2.0$	$N\leq2$		$0.08<W$	Define as spot defect			
Width(mm)	Length(mm)	Acceptable Qty																										
		A	B	C																								
$\Phi\leq0.03$	Ignore	Ignore		Ignore																								
$0.03<W\leq0.05$	$L\leq3.0$	$N\leq2$																										
$0.05<W\leq0.08$	$L\leq2.0$	$N\leq2$																										
$0.08<W$	Define as spot defect																											
3.0	Polarizer Bubble	<table><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><tr><td>$\Phi\leq0.2$</td><td colspan="2">Ignore</td><td rowspan="4">Ignore</td></tr><tr><td>$0.2<\Phi\leq0.4$</td><td colspan="2">2(distance $\geq 10\text{mm}$)</td></tr><tr><td>$0.4<\Phi\leq0.6$</td><td colspan="2">1</td></tr><tr><td>$0.6<\Phi$</td><td colspan="2">0</td></tr></table>	Zone Size (mm)	Acceptable Qty			A	B	C	$\Phi\leq0.2$	Ignore		Ignore	$0.2<\Phi\leq0.4$	2(distance $\geq 10\text{mm}$)		$0.4<\Phi\leq0.6$	1		$0.6<\Phi$	0							
Zone Size (mm)	Acceptable Qty																											
	A	B	C																									
$\Phi\leq0.2$	Ignore		Ignore																									
$0.2<\Phi\leq0.4$	2(distance $\geq 10\text{mm}$)																											
$0.4<\Phi\leq0.6$	1																											
$0.6<\Phi$	0																											
4.0	SMT	According to IPC-A-610C class II standard . Function defect and missing part are major defect ,the others are minor defect.																										