ORIENT DISPLAY

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SPECIFICATION
FOR
LCD MODULE

MODULE NO: AFS320240TG-3.5-E3000-T
REVISION NO: 02

Customer's Approval:

	SIGNATURE	DATE
PREPARED BY (RD ENGINEER)	FR. LI	JUN-25-2011
CHECKED BY	Y LH	JUN-25-2011
APPROVED BY	SEAN	JUN-25-2011

DOCUMENT REVISION HISTORY

Version	DATE	DESCRIPTION	CHANGED BY
00	Apr-21-2011	First Issue	Ylh
01	May-05-2011	Changed pin explanation	lhm
02	Jun-25-2011	Changed "Chapter 10"	Fr.li

CONTENTS

1. <u>Features & Mechanical Specifications</u>

Item	Contents	Unit
	LCD	
LCD Type	TFT / Transmissive / Normal White	--
Viewing direction	6 O'clock	--
Backlight	White LED BackLight	--
Interface	RGB interface	--
Driver IC	NT39016D	--
Outline Dimension	77.1(W) × 64.1(H) × 4.35(T)	mm
Glass area (W×H×T)	74.1 ×56.8 /61.9 × 0.5	mm
Active area (W×H)	70.08 ×52.56	mm
Number of Dots	320(RGB) × 240	--
Dot pitch (W×H)	0.073 × 0.219	mm
Pixel pitch (W×H)	0.219 × 0.219	mm
Operating Temperature	-20 ～ +70	℃
Storage temperature	-30 ～ +80	℃

2. Dimensional Outline

Pin Table:

PIN	Explanation	PIN	Explanation
1	LED-K	31	G5
2	LED-K	32	G6
3	LED-A	33	G7
4	LED-A	34	R0
5	GND	35	R1
6	XR	36	R2
7	YD	37	R3
8	XL	38	R4
9	YU	39	R5
10	GND	40	R6
11	NC	41	R7
12	NC	42	HSYNC
13	NC	43	YSYNC
14	/RESET	44	DCLK
15	SPENA	45	NC
16	SPCLK	46	NC
17	SPDAT	47	VDD
18	B0	48	VDD
19	B1	49	NC
20	B2	50	NC
21	B3	51	NC
22	B4	52	NC
23	B5	53	NC
24	B6	54	NC
25	B7	55	NC
26	G0	56	NC
27	G1	57	NC
28	G2	58	DEN
29	G3	59	GND
30	G4	60	GND

Revision Table:

REV	DESCRIPTION	DATE
A00	First issue	Jul-20-2010
A01	Changed Pin Explanation	MAY-05-2011

Title Block:

ORIENT DISPLAY

MODEL NUMBER: AFS320240TG-3.5-E3000T

PROJECTION: C/D

PART NO: AFS320240TG-3.5-E3000T

SCALE: FIT		
SHEET: 1	OF	1
GENERAL TOL: ± 0.2	UNIT mm	
APPROVALS		DATE
APP: Rio		May-05-2011
CHK: Sean		May-05-2011
DWN: Alfred		May-05-2011

DO NOT SCALE THIS DRAWING.

CIRCUIT DIAGRAM

Viewing Direction

TFT 3.5"
320(RGB)X240dots

Specification:
1). Viewing angle: 6 O'clock
2). Display mode: TFT/Transmissive/Normal White
3). Operating temp.: -20°C~+70°C
   Storage temp.: -30°C~+80°C
4). IC: NT39016D
5). Backlight: 6 chip White LED , Vf=19.2V, If=20mA
6). All the raw material are Rohs complicant
7). Dimensions with mark "*" are important, with mark "()" are referenced

Figure 1. Dimensional outline

3. Block Diagram
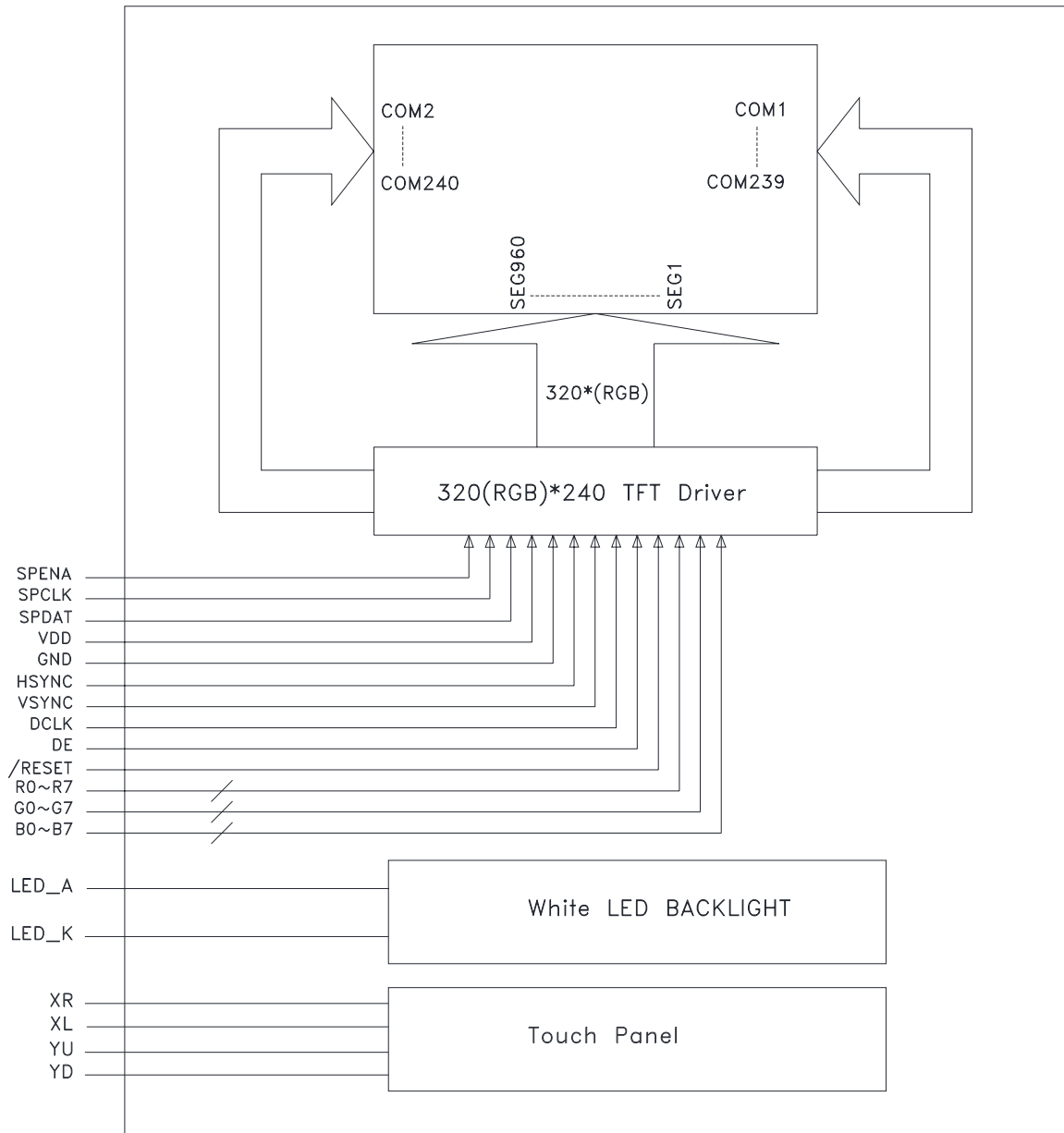
Figure 2. Block diagram

4. Pin Description

PIN No.	SYMBOL	Function
1,2	LED_K	Backlight LED Cathode
3,4	LED_A	Backlight LED Anode
5	GND	Ground
6	XR	Touch Panel XR Position
7	YD	Touch Panel YD Position
8	XL	Touch Panel XL Position
9	YU	Touch Panel YU Position
10	GND	Ground
11,12,13	NC	No Connection
14	/RESET	Reset pin. (Active Low)
15	SPENA	3-Wire Communication Enable. Active Low
16	SPCLK	3-Wire Communication Clock input.
17	SPDAT	3-Wire Communication Data input/output
18~25	B0~B7	B data bus
26~33	G0~G7	G data bus
34~41	R0~R7	R data bus
42	HSYNC	Horizontal Sync input
43	VSYNC	Vertical Sync input
44	DCLK	Clock for Input Data
45,46	NC	No Connection
47,48	VCC	Power supply
49~57	NC	No Connection
58	DEN	Data Input Enable.
59,60	GND	Ground

5. Absolute Maximum Ratings

Item	Symbol	Rating	Unit
Supply Voltage range	VDD	-0.5 to +5.0	V
Operating Temperature range	TOP	-20 to +70	℃
Storage Temperature range	TST	-30 to +80	℃

6. Electrical Characteristics

DC Characteristics

Item	Symbol	Min.	Type.	Max.	Unit
Logic Supply Voltage	VDD	3.0	-	3.6	V

7. Backlight Characteristics

White LED × 6   **(Ta = 25°C)**

Item	Symbol	Condition	Min	Typ	Max	Unit
Forward Voltage	VF	IF = 20mA	-	19.2	21.6	V
Uniformity	△Bp	-	80	-	-	%
LCD Brightness	Lv	IF = 20mA	250	280	-	cd/m^2

8. Electro-Optical Characteristics

Light source: C light   Ta=25℃

Item		Symbol	Condition	Min	Typ.	Max.	Unit	Remark
View Angles		θT	CR≧10	30	40		Degree	Note 2 With EWV polarizer
		θB		50	60			
		θL		50	60			
		θR		50	60			
Contrast Ratio		CR	θ=0°		350			Note3
Response Time		Ton	25℃		25	40	ms	Note4
		Toff						
Chromaticity	White	X		0.261	0.311	0.361		Measured by C light.
		Y		0.300	0.350	0.400		
	RED	X		0.586	0.636	0.686		
		Y		0.300	0.350	0.400		
	GREEN	X		0.261	0.311	0.361		
		Y		0.501	0.551	0.601		
	BLUE	X		0.084	0.134	0.184		
		Y		0.101	0.151	0.201		
NTSC					50		%	Note 5
Transmittance				6.9	7.5		%	With EWV polarizer, without DBEF

Rubbing Direction

PI Rubbing 示意图
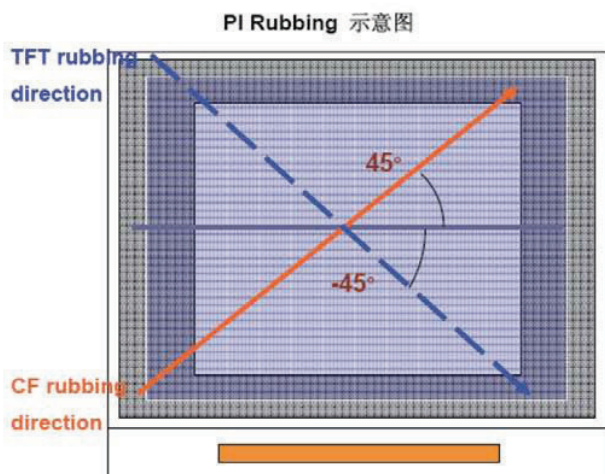
Note 1: Definition of optical measurement system.

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.

Photo detector

Field

500mm

TFT-LCD Module

LCD Panel

The center of the screen

Item	Photo Detector	Field
Contrast Ratio		
Luminance	SR-3	1°
Chromaticity		
Lum Uniformity		
Response Time	BM-7A	2°
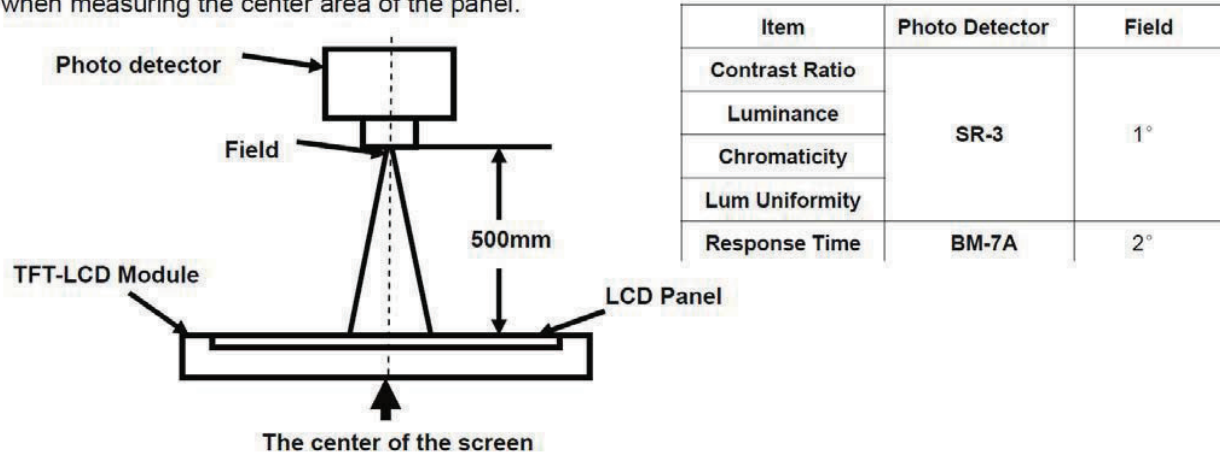
Note 2: Definition of viewing angle range and measurement system.

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

Normal line
$\theta = \Phi = 0°$

$\Phi = 90°$
12 o'clock direction

θ_L

θ_T

θ_R

$\Phi = 180°$

θ_B

$\Phi = 0°$

Active Area

$\Phi = 270°$
6 o'clock direction
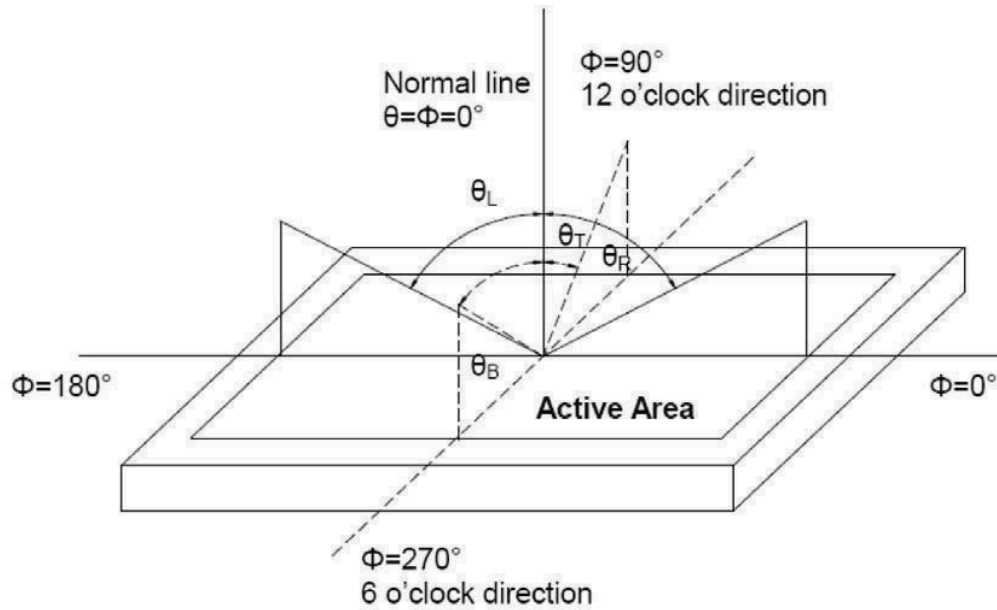
Fig. 1 Definition of viewing angle

Note 3: Definition of contrast ratio

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

"White state ":The state is that the LCD is driven by V_{white}.

"Black state": The state is that the LCD is driven by V_{black}.

V_{white}: To be determined V_{black}: 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%.
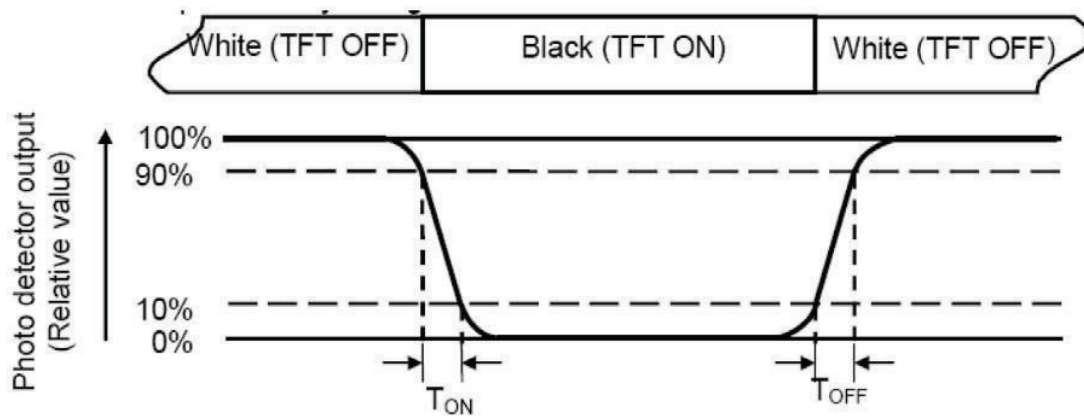
Note 5: Definition of color chromaticity (CIE1931)
Color coordinates measured at center point of LCD.

9. Instruction Description

NT39016 3-Wire Control Register List (Default)

3-Wire Registers				Register Description
D[15:10]	Name	Init.	R/W	Function Description
000000b	R00	07h	R/W	System control register
000001b	R01	00h	R/W	Timing Controller function register
000010b	R02	03h	R/W	Operation control register
000011b	R03	CCh	R/W	Input data Format control register
000100b	R04	46h	R/W	Source Timing delay control register
000101b	R05	0Dh	R/W	Gate Timing delay control register
000110b	R06	00h	R/W	Reserved
000111b	R07	00h	R/W	Internal function control register
001000b	R08	08h	R/W	RGB Contrast control register
001001b	R09	40h	R/W	RGB Brightness control register
001010b	R0A	88h	R/W	Hue / Saturation control register
001011b	R0B	88h	R/W	R / B Sub-Contrast control register
001100b	R0C	20h	R/W	R Sub-Brightness control register
001101b	R0D	20h	R/W	B Sub-Brightness control register
001110b	R0E	10h	R/W	VCOMDC Level Control Register
001111b	R0F	A4h	R/W	VCOMAC Level Control Register
010000b	R10	04h	R/W	VGAM2 level control register
010001b	R11	24h	R/W	VGAM3/4 level control register
010010b	R12	24h	R/W	VGAM5/6 level control register
011110b	R1E	00h	R/W	VCOMDC Trim function control register
100000b	R20	00h	R/W	Wide and narrow display mode control register

NT39016 3-Wire Register Bit Definition (Default)

Reg.	Bit [7]	Bit [6]	Bit [5]	Bit [4]	Bit [3]	Bit [2]	Bit [1]	Bit [0]
R00	PAT3	PAT2	PAT1	PAT0	PWMPDB	X	STBYB	RESETB
R01	X	X	X	SWD2	SWD1	SWD0	DITHB	CFTYP
R02	SKIPMOD	HDNC1	HDNC0	X	FPOL	VSET	UPDN	SHLR
R03	DENPOL	CLKPOL	HSDPOL	VSDPOL	SEL3	SEL2	SEL1	SEL0
R04	DDLY7	DDLY6	DDLY5	DDLY4	DDLY3	DDLY2	DDLY1	DDLY0
R05	X	HDLY6	HDLY5	HDLY4	HDLY3	HDLY2	HDLY1	HDLY0
R06	X	X	X	X	X	X	X	X
R07	FRAD1	FRAD0	INVSL1	INVSL0	PAL	PALM	-	AVGY
R08	X	X	X	CON4	CON3	CON2	CON1	CON0
R09	X	BRI6	BRI5	BRI4	BRI3	BRI2	BRI1	BRI0
R0A	HUE3	HUE2	HUE1	HUE0	SAT3	SAT2	SAT1	SAT0
R0B	SCONB1	SCONB0			SCONR1	SCONR0		
R0C	X	X	SBRIR5	SBRIR4	SBRIR3	SBRIR2	SBRIR1	SBRIR0
R0D	X	X	SBRIB5	SBRIB4	SBRIB3	SBRIB2	SBRIB1	SBRIB0
R0E	X	OTP_BYPS	VCDCSL5	VCDCSL4	VCDCSL3	VCDCSL2	VCDCSL1	VCDCSL0
R0F	VGLSL1	VGLSL0	VGHSL1	VGHSL0	VCACSL3	VCACSL2	VCACSL1	VCACSL0
R10	X	X	X	GAMEN	X	V2GAM2	V2GAM1	V2GAM0
R11	X	X	V4GAM2	V4GAM1	V4GAM0	V3GAM2	V3GAM1	V3GAM0
R12	X	X	V6GAM2	V6GAM1	V6GAM0	V5GAM2	V5GAM1	V5GAM0
R1E	TRMEN7	TRMEN6	TRMEN5	TRMEN4	TRMEN3	TRMEN2	TRMEN1	TRMEN0
R20	X	X	X	X	X	X	WNSEL1	WNSEL0

Note: Register function active at the falling edge of VSD except STBYB, RESETB register bits.

10. AC Characteristics

10.1 3-Wire Timing Diagram
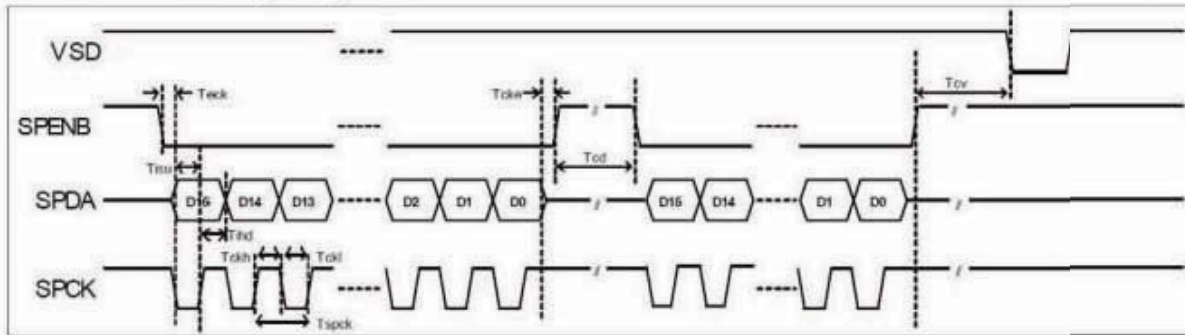
Serial clock	Tspck	320	-	-	ns	
SPCK pulse duty	Tscdut	40	50	60	%	
Serial data setup time	Tisu	120	-	-	ns	
Serial data hold time	Tihd	120	-	-	ns	
Serial clock high/low	Tssw	120	-	-	ns	
Chip select distinguish	Tcd	1	-	-	us	
SPENA to VSD	Tcv	1	-	-	us	

3-wire serial communication AC timing
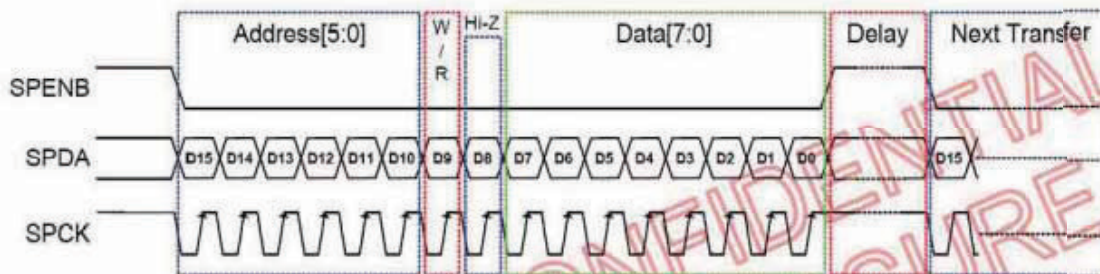
3-Wire Command Format:

Bit	Description
D15-D10	Register Address [5:0].
D9	W/R control bit. "1" for Write; "0" for Read
D8	Hi-Z bit during read mode. Any data within this bits will be ignored during write mode
D7-D0	Data for the W/R operation to the address indicated by Address phase

3-Wire Writer Format:

MSB															LSB
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Register Address [5:0]						1	X	DATA (Issue by external controller)							

3-Wire Read Format:

MSB															LSB
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Register Address [5:0]						0	Hi-Z	DATA (Issue by NT39016)							

Input Data Timing
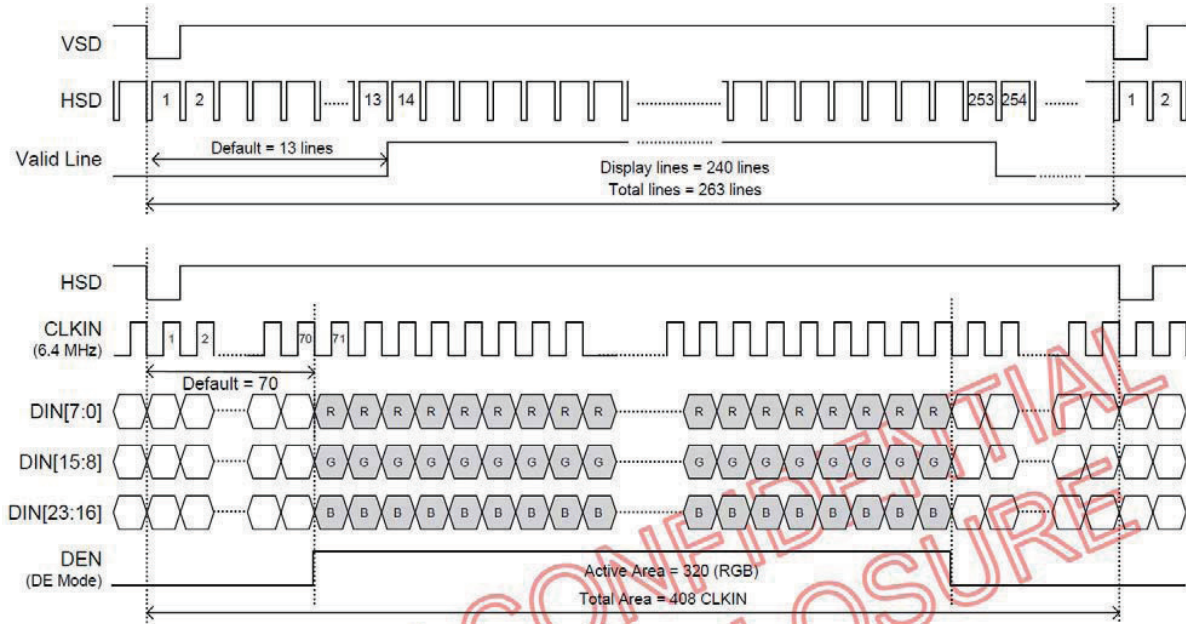
11.Quality Specifications

All The raw material are Rohs complicant.

11.1 Standard of the product appearance test

Manner of appearance test: The inspection should be performed in using 20W x 2 fluorescent lamps. Distance between LCM and fluorescent lamps should be 100 cm or more. Distance between LCM and inspector eyes should be 30 cm or more.

Viewing direction for inspection is 45° from vertical against LCM.
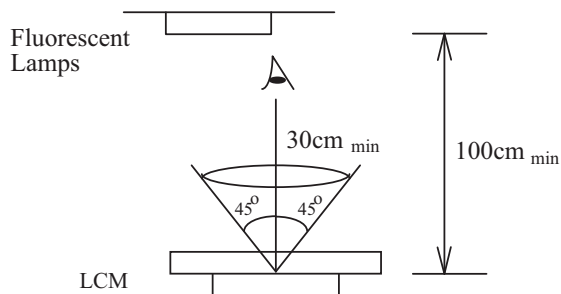
Definition of zone:
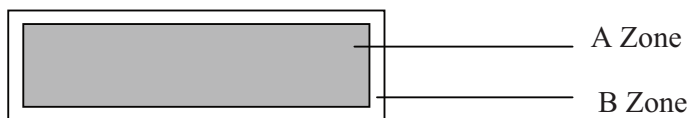
A Zone: viewing area
B Zone: outside viewing area

11.2 Specification of quality assurance

AQL inspection standard
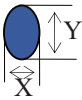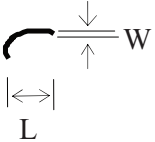
Sampling method: MIL-STD-105E, Level II, single sampling
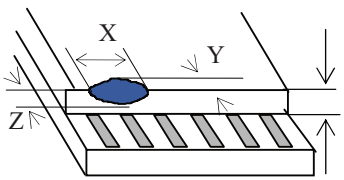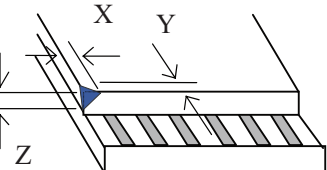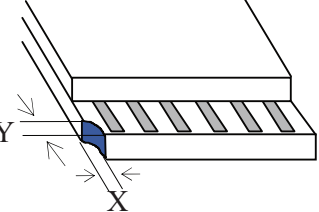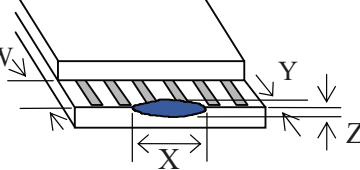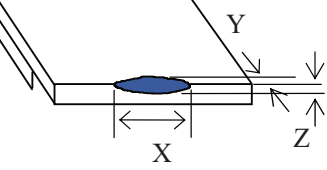
Defect classification (Note: * is not including)
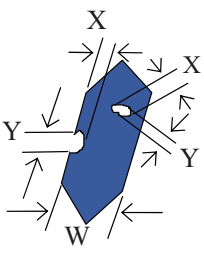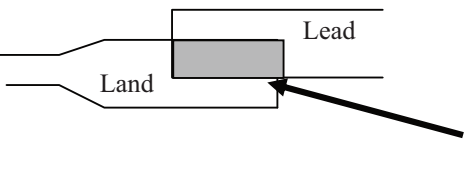
Classify		Item	Note	AQL
Major	Display state	Short or open circuit	1	0.65
		LC leakage		
		Flickering		
		No Display		
		Wrong Viewing Direction		
		Contrast defect (dim, ghost)	2	
		Back-light	1,8	
	Non-display	Flat Cable or pin reverse	10	
		Wrong or missing component	11	
Minor	Display state	Background color deviation	2	1.0
		Black spot and dust	3	
		Line Defect, Scratch	4	
		Rainbow	5	
		Chip	6	
		Pin hole	7	
	Polarizer	Protruded	12	
		Bubble and foreign material	3	
		Poor connection	9	
		Poor connection	10	
	TAB	Position, Bonding strength	13	
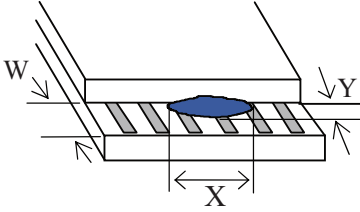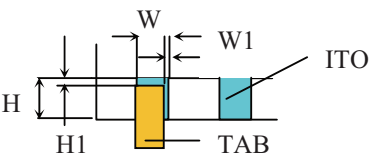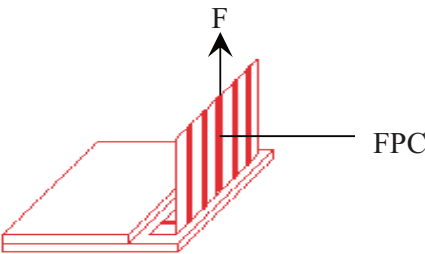
Note on defect classification

No	Item	Criterion
1	Short or open circuit	Not allow
	LC leakage	
	Flickering	
	No display	
	Wrong viewing direction	
	Wrong Back-light	
2	Contrast defect	Refer to approval sample
	Background color deviation	

3 — Point defect, Black spot, dust (including Polarizer)

$\phi = (X+Y)/2$

Point Size	Acceptable Qty.
$\phi \leq 0.10$	Disregard
$0.10 < \phi \leq 0.20$	3
$0.20 < \phi \leq 0.25$	2
$0.25 < \phi \leq 0.30$	1
$\phi > 0.30$	0

Unit：mm

4 — Line defect, Scratch

Line		Acceptable Qty.
L	W	
---	$0.015 \geq W$	Disregard
$3.0 \geq L$	$0.03 \geq W$	2
$2.0 \geq L$	$0.05 \geq W$	
$1.0 \geq L$	$0.1 > W$	1
---	$0.05 < W$	Applied as point defect

Unit: mm

5	Rainbow	Not more than two color changes across the viewing area.

No	Item	Criterion
6	Chip Remark: 　X: Length direction 　Y: Short direction 　Z: Thickness direction 　t: Glass thickness 　W: Terminal Width	**Acceptable criterion** | X	Y	Z | |---|---|---| | ≤2 | 0.5mm | ≤t/2 | **Acceptable criterion** | X | Y | Z | |---|---|---| | ≤2 | 0.5mm | ≤t | **Acceptable criterion** | X | Y | Z | |---|---|---| | ≤3 | ≤2 | ≤t | | shall not reach to ITO | | | **Acceptable criterion** | X | Y | Z | |---|---|---| | Disregard | ≤0.2 | ≤t | **Acceptable criterion** | X | Y | Z | |---|---|---| | ≤5 | ≤2 | ≤t/3 |

No.	Item	Criterion
7	Segment pattern W = Segment width $\phi = (X+Y)/2$	(1) Pin hole $\phi < 0.10$mm is acceptable. <table><tr><td>Point Size</td><td>Acceptable Qty</td></tr><tr><td>$\phi \leqslant 1/4W$</td><td>Disregard</td></tr><tr><td>$1/4W < \phi \leqslant 1/2W$</td><td>1</td></tr><tr><td>$\phi > 1/2W$</td><td>0</td></tr></table> Unit: mm
8	Back-light	(1) The color of backlight should correspond its specification. (2) Not allow flickering
9	Soldering	(1) Not allow heavy dirty and solder ball on PCB. (The size of dirty refer to point and dust defect) (2) Over 50% of lead should be soldered on Land. Lead Land 50% lead
10	Wire	(1) Copper wire should not be rusted (2) Not allow crack on copper wire connection. (3) Not allow reversing the position of the flat cable. (4) Not allow exposed copper wire inside the flat cable.
11*	PCB	(1) Not allow screw rust or damage. (2) Not allow missing or wrong putting of component.

No	Item	Criterion
12	Protruded W: Terminal Width	 Acceptable criteria: $Y \leq 0.4$
13	TAB	1. Position $W1 \leq 1/3W$ $H1 \leq 1/3H$ 2 FPC bonding strength test P (=F/FPC bonding width) $\geq$650gf/cm ,(speed rate: 1mm/min) 5pcs per SOA (shipment)
14	Total no. of acceptable Defect	A. Zone Maximum 2 minor non-conformities per one unit. Defect distance: each point to be separated over 10mm B. Zone It is acceptable when it is no trouble for quality and assembly in customer's end product.

11.3 Reliability of LCM

Reliability test condition:

Item	Condition	Time (hours)	Assessment
High temp. Storage	60°C	48	No abnormalities in functions and appearance
High temp. Operating	50°C	48	
Low temp. Storage	-20°C	48	
Low temp. Operating	-10°C	48	
Humidity	40°C/ 90%RH	48	
Temp. Cycle	-20°C ← 25°C →60°C (60 min ← 5 min → 60min)	10cycles	

Recovery time should be 24 hours minimum. Moreover, functions, performance and appearance shall be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions room temperature (20±8°C), normal humidity (below 65% RH), and in the area not exposed to direct sun light.

11.4 Precaution for using LCD/LCM

LCD/LCM is assembled and adjusted with a high degree of precision. Do not attempt to make any alteration or modification. The followings should be noted.

General Precautions:
1. LCD panel is made of glass. Avoid excessive mechanical shock or applying strong pressure onto the surface of display area.
2. The polarizer used on the display surface is easily scratched and damaged. Extreme care should be taken when handling. To clean dust or dirt off the display surface, wipe gently with cotton, or other soft material soaked with isoproply alcohol, ethyl alcohol or trichlorotriflorothane, do not use water, ketone or aromatics and never scrub hard.
3. Do not tamper in any way with the tabs on the metal frame.
4. Do not made any modification on the PCB without consulting Orient Display.
5. When mounting a LCM, make sure that the PCB is not under any stress such as bending or twisting. Elastomer contacts are very delicate and missing pixels could result from slight dislocation of any of the elements.
6. Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels and also cause rainbow on the display.
7. Be careful not to touch or swallow liquid crystal that might leak from a damaged cell. Any liquid crystal adheres to skin or clothes, wash it off immediately with soap and water.

Static Electricity Precautions:
1. CMOS-LSI is used for the module circuit; therefore operators should be grounded whenever he/she comes into contact with the module.
2. Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.
3. Do not touch the connection terminals of the display with bare hand; it will cause disconnection or defective insulation of terminals.
4. The modules should be kept in anti-static bags or other containers resistant to static for storage.
5. Only properly grounded soldering irons should be used.
6. If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.
7. The normal static prevention measures should be observed for work clothes and working benches.
8. Since dry air is inductive to static, a relative humidity of 50-60% is recommended.

Soldering Precautions:
1. Soldering should be performed only on the I/O terminals.
2. Use soldering irons with proper grounding and no leakage.
3. Soldering temperature: $280°C \pm 10°C$
4. Soldering time: 3 to 4 second.
5. Use eutectic solder with resin flux filling.
6. If flux is used, the LCD surface should be protected to avoid spattering flux.
7. Flux residue should be removed.

Operation Precautions:
1. The viewing angle can be adjusted by varying the LCD driving voltage Vo.
2. Since applied DC voltage causes electro-chemical reactions, which deteriorate the display, the applied pulse waveform should be a symmetric waveform such that no DC component remains. Be sure to use the specified operating voltage.
3. Driving voltage should be kept within specified range; excess voltage will shorten display life.
4. Response time increases with decrease in temperature.
5. Display color may be affected at temperatures above its operational range.
6. Keep the temperature within the specified range usage and storage. Excessive temperature and humidity could cause polarization degradation, polarizer peel-off or generate bubbles.
7. For long-term storage over 40°C is required, the relative humidity should be kept below 60%, and avoid direct sunlight.

Limited Warranty
Orient Display's LCDs and modules are not consumer products, but may be incorporated by Orient Display's customers into consumer products or components thereof, Orient Display does not warrant that its LCDs and components are fit for any such particular purpose.

1. The liability of Orient Display is limited to repair or replacement on the terms set forth below. Orient Display will not be responsible for any subsequent or consequential events or injury or damage to any personnel or user including third party personnel and/or user. Unless otherwise agreed in writing between Orient Display and the customer, Orient Display will only replace or repair any of its LCD which is found defective electrically or visually when inspected in accordance with Orient Display general LCD inspection standard. (Copies available on request)
2. No warranty can be granted if any of the precautions state in handling liquid crystal display above has been disregarded. Broken glass, scratches on polarizer mechanical damages as well as defects that are caused accelerated environment tests are excluded from warranty.
3. In returning the LCD/LCM, they must be properly packaged; there should be detailed description of the failures or defect.