SPECIFICATION
FOR
TFT MODULE

MODULE NO:AFS320240TG-3.5-H100001
REVISION NO: 02

Customer's Approval:

	SIGNATURE	DATE
PREPARED BY (RD ENGINEER)	XJZ	2011-12-8
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DOCUMENT REVISION HISTORY

Version	DATE	DESCRIPTION	CHANGED BY
00	May-11-2011	First Issue	Fr.li
01	Jul-22-2011	Revised "Dimensional Outline"	Fr.li
02	Oct-13-2011	Revised "Dimensional Outline"	Fr.li
02	Feb-29-2012	Revised "Dimensional Outline"	Fr.li

CONTENTS

1. Features & Mechanical Specifications

Item	Contents	Unit
	LCD	
LCD Type	TFT / Transmissive / Normally White	--
Viewing direction	6:00	--
Backlight	White LED x 6 in Series	--
Interface	8-bit Serial RGB Interface	--
Driver IC	HX8238D	--
Outline Dimension	77.2(W) × 64.1(H) × 4.3(T)	mm
Glass area (W×H×T)	75.1× 61.9× 1.0	mm
Active area (W×H)	70.08 ×52.56	mm
Number of Dots	320(RGB)×240	--
Dot pitch (W×H)	0.219 × 0.219	mm
Pixel pitch (W×H)	0.073 × 0.219	mm
Operating Temperature	-20 ～ +70	℃
Storage temperature	-30 ～ +80	℃

2. Dimensional Outline
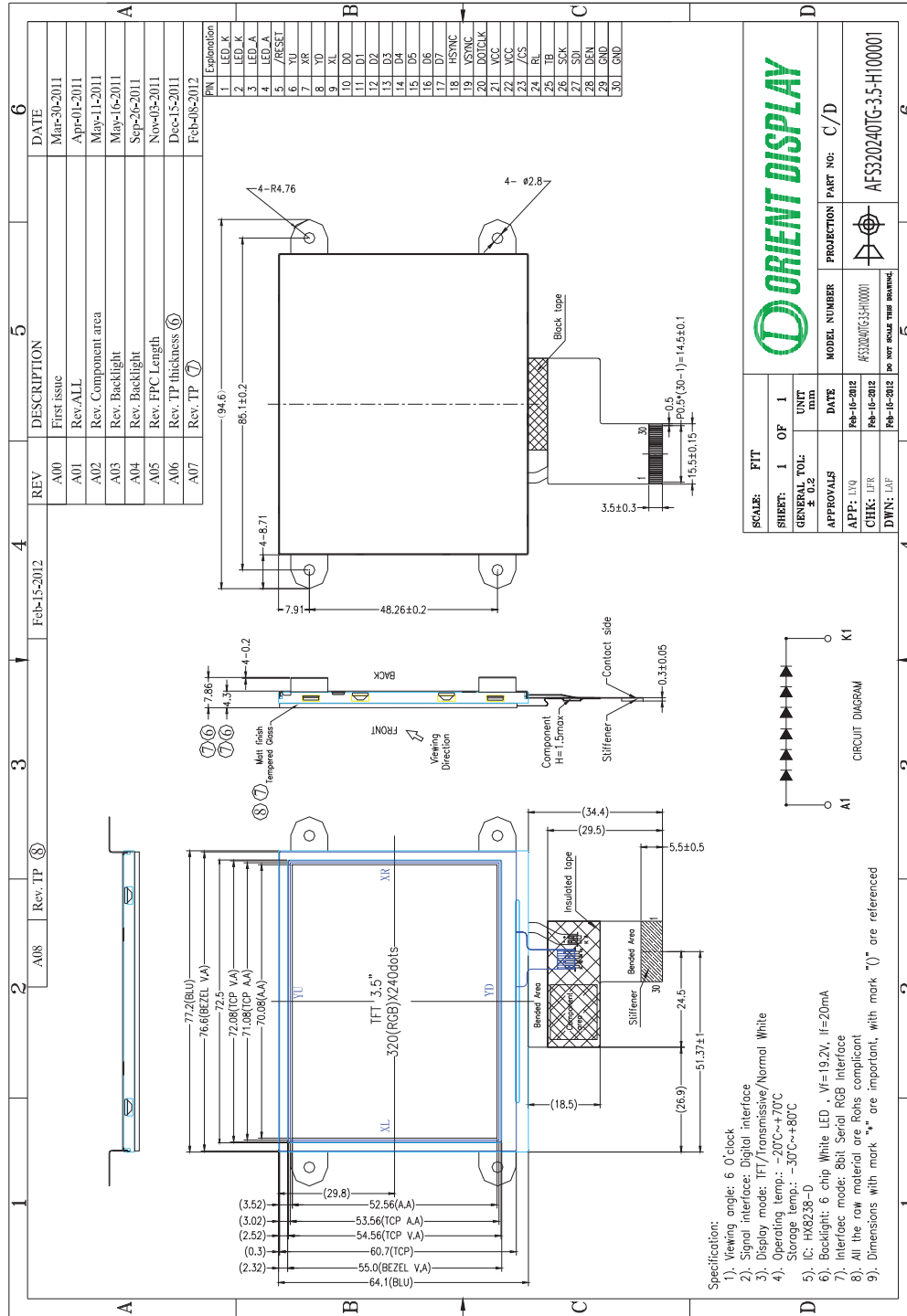
Figure 1. Dimensional outline

3. Block Diagram
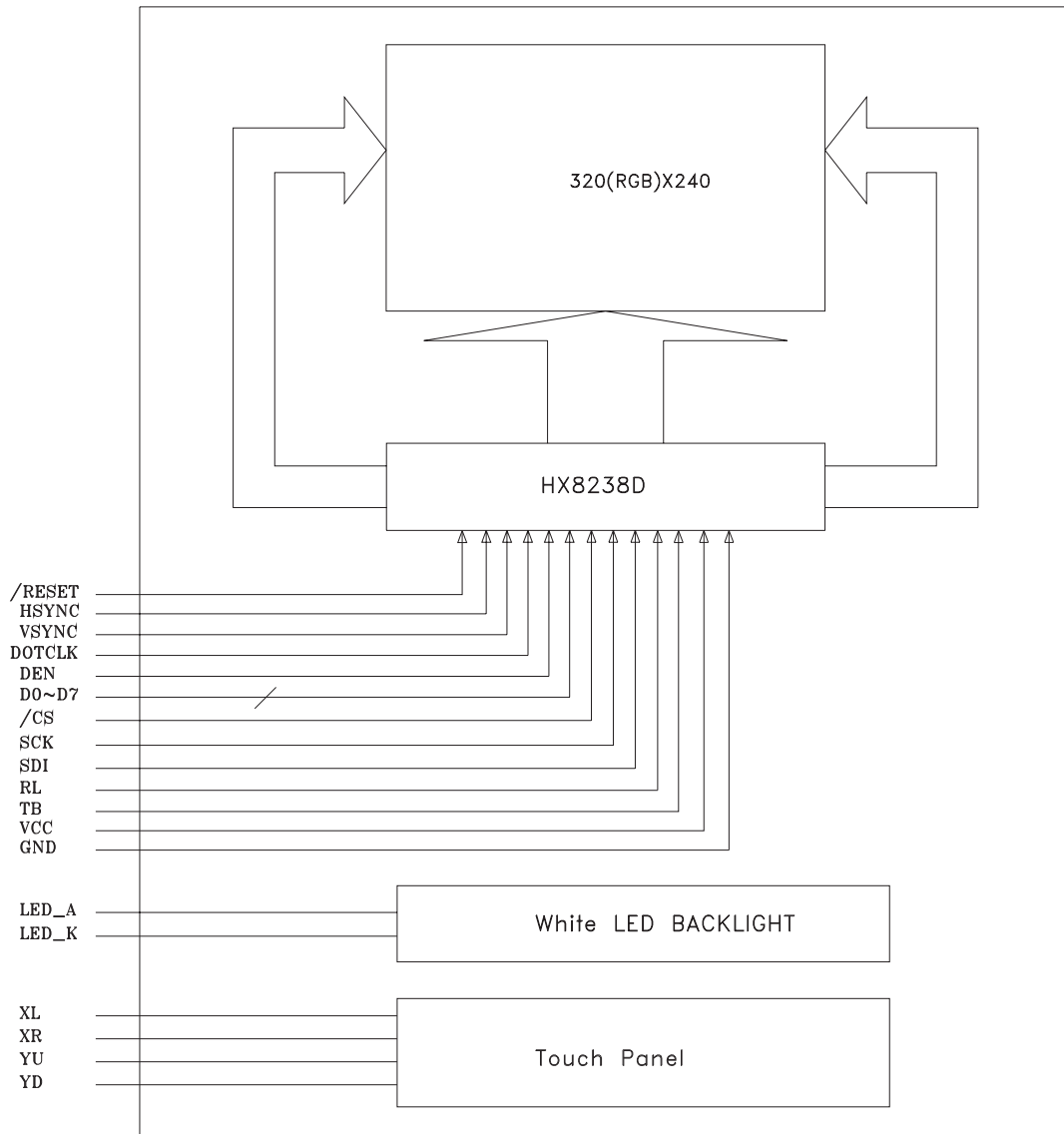
Figure 2. Block diagram

4. Pin Description

PIN No.	SYMBOL	Function
1, 2	LED_K	LED Backlight Cathode
3, 4	LED_A	LED Backlight Anode
5	/RESET	System Reset Pin
6	YU	Touch Panel YU Position
7	XR	Touch Panel XR Position
8	YD	Touch Panel YD Position
9	XL	Touch Panel XL Position
10	D0	Date Input Pin
11	D1	Date Input Pin
12	D2	Date Input Pin
13	D3	Date Input Pin
14	D4	Date Input Pin
15	D5	Date Input Pin
16	D6	Date Input Pin
17	D7	Date Input Pin
18	HSYNC	Line synchronization signal
19	VSYNC	Frame synchronization signal
20	DOTCLK	Dot-clock signal
21, 22	VCC	Power Supply
23	/CS	Chip select pin of serial interface
24	RL	Input pin to select the Source driver data shift direction. - Connect to VCC for display first RGB data at S0-S2 - Connect to GND for display first RGB data at S959-S957
25	TB	Input pin to select the Gate driver scan direction. - Connect to GND for Gate scan from G239 to G0 (reverse scan) - Connect to VCC for Gate scan from G0 to G239 (normal scan)
26	SCK	Clock pin of serial interface
27	SDI	Data input pin in serial mode
28	DEN	Display enable pin
29, 30	GND	Ground

5. Absolute Maximum Ratings

Item	Symbol	Rating	Unit
Power supply	VCC	-0.3 to +4 .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
Supply Voltage	VCC	2.5	3.3	3.6	V

7. Backlight Characteristics

White LED $\times$ 6 in Series **(Ta = 25°C)**

Item	Symbol	Condition	Min	Typ	Max	Unit
Forward Voltage	VF	IF=20mA	-	19.2	-	V
Uniformity	$\triangle$Bp	-	80	-	-	%
Luminance for LCD	Lv	IF=20mA	-	4000	-	cd/m^2

8. Electro-Optical Characteristics

Item		Symbol	Conditions	Specifications			Unit	Note
				Min.	Typ.	Max.		
Transmittance		T%			7.4		%	All left side data are based on CMO's following condition –T6 NTSC: 60% LC:5091 Light : C light (Machine:BM5A) Normal Polarizer Without DBEF **"Simulation Data Reference Only"**
Contrast Ratio		CR		200	300		--	
Response Time		T_R			15	30	ms	
		T_F			35	50	ms	
Chromaticity	Red	X_R	Viewing normal angle $\theta_X = \theta_Y = 0°$	0.609	0.639	0.669		
		Y_R		0.314	0.344	0.374		
	Green	X_G		0.264	0.294	0.324		
		Y_G		0.557	0.587	0.617		
	Blue	X_B		0.102	0.132	0.162		
		Y_B		0.106	0.136	0.166		
	White	X_W		0.282	0.312	0.342		
		Y_W		0.319	0.349	0.379		
Viewing Angle	Hor.	θ_{X+}	Center CR≥10		45		deg.	
		θ_{X-}			45			
	Ver.	θ_{Y+}			15			
		θ_{Y-}			35			

*Note (1) Definition of Contrast Ratio (CR):

The contrast ratio can be calculated by the following expression.

Contrast Ratio (CR) = L63 / L0

L63: Luminance of gray level 63

L0: Luminance of gray level 0
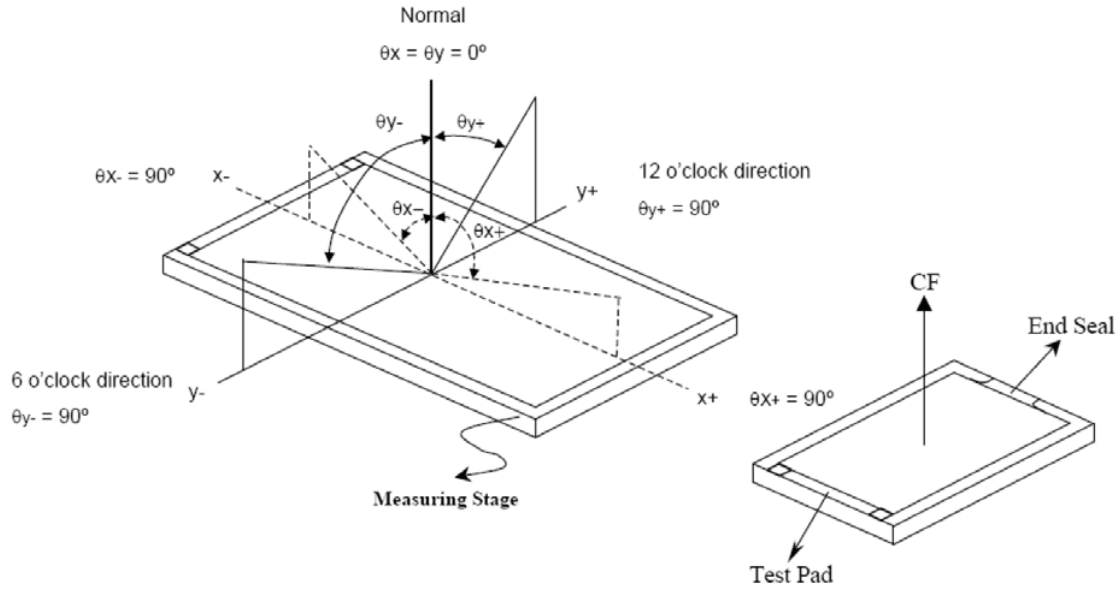
CR = CR (10)

CR (X) is corresponding to the Contrast Ratio of the point X at Figure in Note (5).

*Note (2) Definition of Response Time (TR, TF):
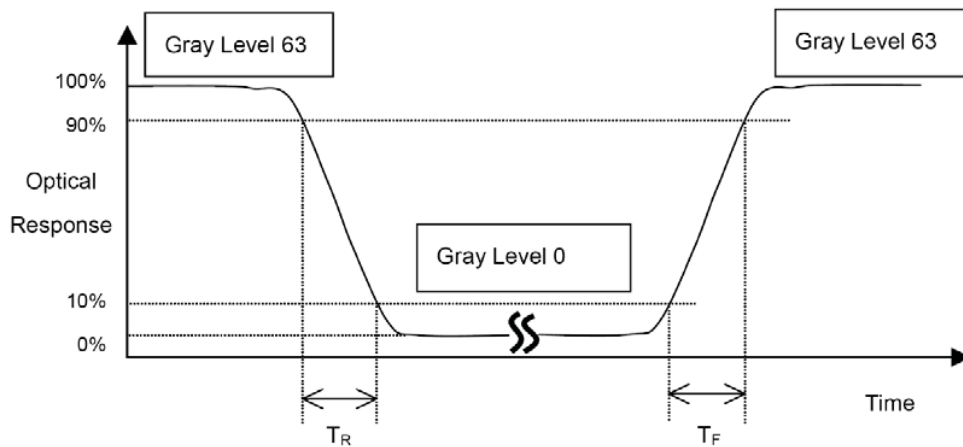
*Note(3) Definition of Viewing Angle

*** The above "Viewing Angle" is the measuring position with Largest Contrast Ratio; not for good image quality. View Direction for good image quality is 12 O'clock.   Module maker can increase the "Viewing Angle" by applying Wide View Film.

*Note (4) Measurement Set-Up:

The LCD module should be stabilized at a given temperature for 20 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 20 minutes in a windless room.
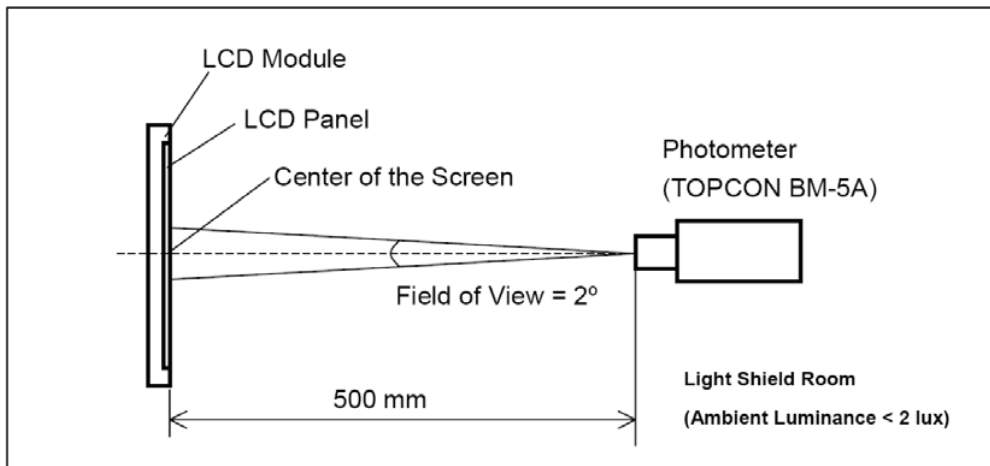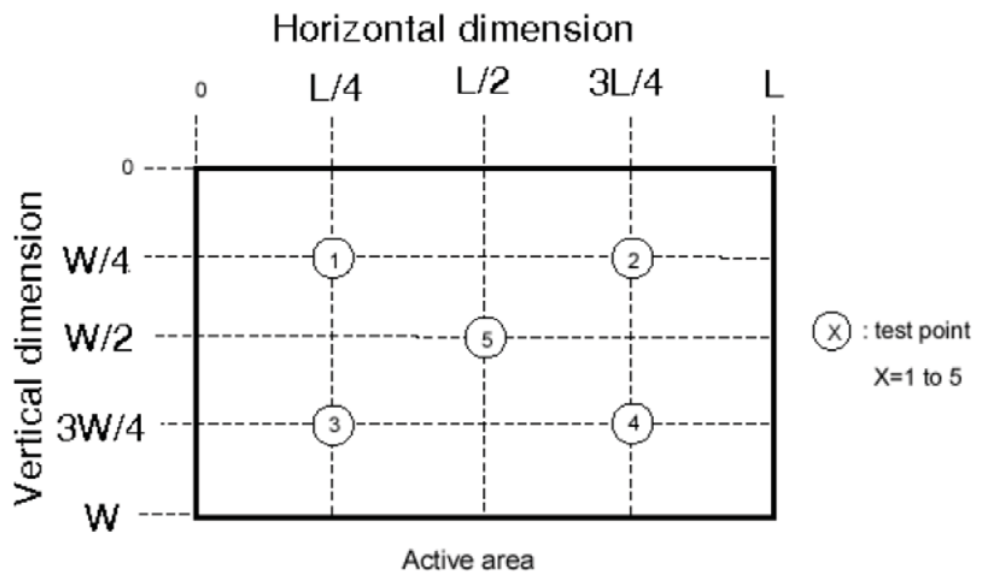
9. Instruction Description

| Reg#	Register	R/W	R/S	IB15	IB14	IB13	IB12	IB11	IB10	IB9	IB8	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
SR	Status Read	1	0	L7	L6	L5	L4	L3	L2	L1	L0	0	0	0	0	0	0	0	0
R01h	Driver output control	0	1	0	RL	REV	PINV	BGR	SM	TB	CPE	0	0	0	0	0	0	0	0
R02h	LCD driver AC control	0	1	0	0	0	0	0	0	B/C	0	0	0	0	0	0	0	0	0
R03h	Power control (1)	0	1	DCT3	DCT2	DCT1	DCT0	BTF	BT2	BT1	BT0	DC3	DC2	DC1	DC0	AP2	AP1	AP0	0
R04h	Data and color filter control	0	1	0	0	0	0	0	PALM	BLT1	BLT0	OEA1	OEA0	SEL2	SEL1	SEL0	SWD2	SWD1	SWD0
R05h	Function control	0	1	GHN	XDK	GDIS	LPF	DEP	CKP	VSP	HSP	DEO	DIT	0	PWM	0	FB2	FB1	FB0
R06h	Reserved	Reserved																	
R08h	LED control	0	1	0	0	0	PWMS	PWMF3	PWMF2	PWMF1	PWMF0	DUTY7	DUTY6	DUTY5	DUTY4	DUTY3	DUTY2	DUTY1	DUTY0
R0Ah	Contrast/ Brightness control	0	1	0	BR6	BR5	BR4	BR3	BR2	BR1	BR0	0	0	0	CON4	CON3	CON2	CON1	CON0
R0Bh	Frame cycle control	0	1	NO1	NO0	SDT1	SDT0	0	EQ2	EQ1	EQ0	0	0	0	0	0	0	0	0
R0Dh	Power control (2)	0	1	0	VRC2	VRC1	VRC0	0	0	VDS1	VDS0	0	0	VRH5	VRH4	VRH3	VRH2	VRH1	VRH0
R0Eh	Power control (3)	0	1	0	0	1	VDV6	VDV5	VDV4	VDV3	VDV2	VDV1	VDV0	0	0	0	0	0	0
R0Fh	Gate scan starting Position	0	1	0	0	0	0	0	0	0	0	SCN7	SCN6	SCN5	SCN4	SCN3	SCN2	SCN1	SCN0
R16h	Horizontal Porch	0	1	XLIM8	XLIM7	XLIM6	XLIM5	XLIM4	XLIM3	XLIM2	XLIM1	XLIM0	0	0	0	0	0	0	0
R17h	Vertical Porch	0	1	STH1	STH0	HBP6	HBP5	HBP4	HBP3	HBP2	HBP1	HBP0	VBP6	VBP5	VBP4	VBP3	VBP2	VBP1	VBP0
R1Eh	Power control (4)	0	1	0	0	0	0	0	0	0	0	nOTP	VCM6	VCM5	VCM4	VCM3	VCM2	VCM1	VCM0
R27h	Reserved	Reserved																	
R28h	Reserved	Reserved																	
R29h	Reserved	Reserved																	
R2Bh	Reserved	Reserved																	
R30h	γ control (1)	0	1	0	0	0	0	0	PKP12	PKP11	PKP10	0	0	0	0	0	PKP02	PKP01	PKP00
R31h	γ control (2)	0	1	0	0	0	0	0	PKP32	PKP31	PKP30	0	0	0	0	0	PKP22	PKP21	PKP20
R32h	γ control (3)	0	1	0	0	0	0	0	PKP52	PKP51	PKP50	0	0	0	0	0	PKP42	PKP41	PKP40
R33h	γ control (4)	0	1	0	0	0	0	0	PRP12	PRP11	PRP10	0	0	0	0	0	PRP02	PRP01	PRP00
R34h	γ control (5)	0	1	0	0	0	0	0	PKN12	PKN11	PKN10	0	0	0	0	0	PKN02	PKN01	PKN00
R35h	γ control (6)	0	1	0	0	0	0	0	PKN32	PKN31	PKN30	0	0	0	0	0	PKN22	PKN21	PKN20
R36h	γ control (7)	0	1	0	0	0	0	0	PKN52	PKN51	PKN50	0	0	0	0	0	PKN42	PKN41	PKN40
R37h	γ control (8)	0	1	0	0	0	0	0	PRN12	PRN11	PRN10	0	0	0	0	0	PRN02	PRN01	PRN00
R3Ah	γ control (9)	0	1	0	0	0	VRP14	VRP13	VRP12	VRP11	VRP10	0	0	0	0	VRP03	VRP02	VRP01	VRP00
R3Bh	γ control (10)	0	1	0	0	0	VRN14	VRN13	VRN12	VRN11	VRN10	0	0	0	0	VRN03	VRN02	VRN01	VRN00

Note: * means don't care

Software settings will override hardware pin (eg, BGR bits override BGR pin definition)

10. AC Characteristics

10.1 Serial RGB Timing

Characteristics		Symbol	Min.		Typ.		Max.		Unit
			24 bit	8 bit	24 bit	8 bit	24 bit	8 bit	
DOTCLK Frequency		fDOTCLK	-	-	6.5	19.5	10	30	MHz
DOTCLK Period		tDOTCLK	100	33.3	154	51.3	-	-	ns
Horizontal Frequency (Line)		fH	-		14.9		22.35		KHz
Vertical Frequency (Refresh)		fV	-		60		90		Hz
Horizontal Back Porch		tHBP	-	-	68	204	-	-	tDOTCLK
Horizontal Front Porch		tHFP	-	-	20	60	-	-	tDOTCLK
Horizontal Data Start Point		tHBP	-	-	68	204	-	-	tDOTCLK
Horizontal Blanking Period		tHBP + tHFP	-	-	88	264	-	-	tDOTCLK
Horizontal Display Area		HDISP	-	-	320	960	-	-	tDOTCLK
Horizontal Cycle		Hcycle	-	-	408	1224	450	1350	tDOTCLK
Vertical Back Porch		tVBP	-		18		-		Lines
Vertical Front Porch		tVFP	-		4		-		Lines
Vertical Data Start Point		tVBP	-		18		-		Lines
Vertical Blanking Period		tVBP + tVFP	-		22		-		Lines
Vertical Display Area	NTSC	VDISP	-		240		-		Lines
	PAL				280(PALM=0)				
	PAL				288(PALM=1)				
Vertical Cycle	NTSC	Vcycle	-		262		350		Lines
	PAL				313				

Data Transaction Timing in Normal Operating Mode

(1) Horizontal Data Transaction Timing

(2) Vertical Data Transaction Timing
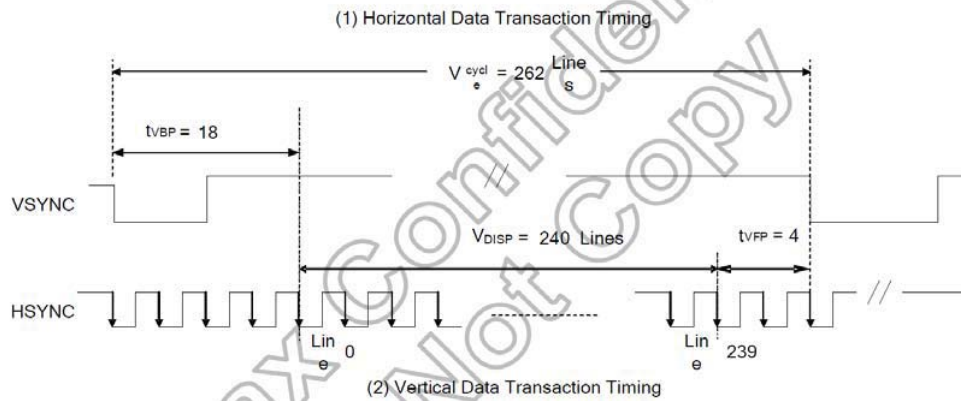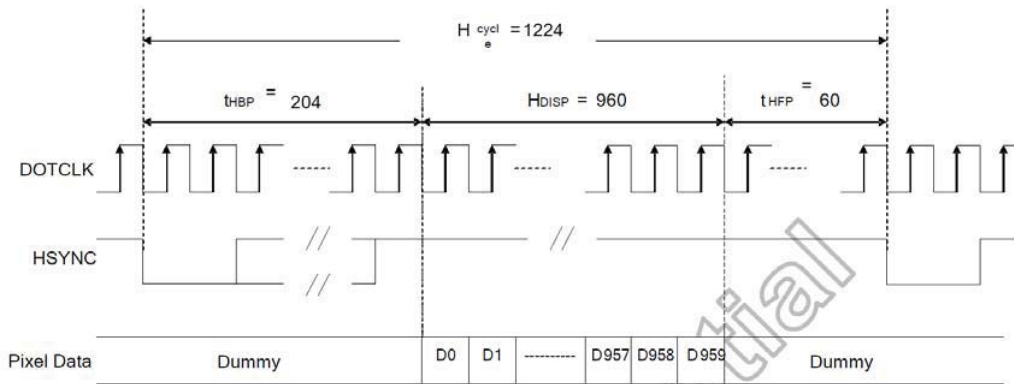
Data Transaction Timing in Serial RGB (8bit) Interface (SYNC Mode)

10.2 SPI Timing

Characteristics	Symbol	Spec.			Unit
		Min.	Typ.	Max.	
Serial Clock Frequency	fclk	-	-	20	MHz
Serial Clock Cycle Time	tclk	50	-	-	ns
Clock Low Width	tsl	25	-	-	ns
Clock High Width	tsh	25	-	-	ns
Clock Rising Time	trs	-	-	30	ns
Clock Falling Time	tfl	-	-	30	ns
Chip Select Hold Time	tcsh	10	-	-	ns
Chip Select High Delay Time	tcsd	20	-	-	ns
Data Setup Time	tds	5	-	-	ns
Data Hold Time	tdh	10	-	-	ns

SPI Timing

● Write SPI

First Transmission (Register)
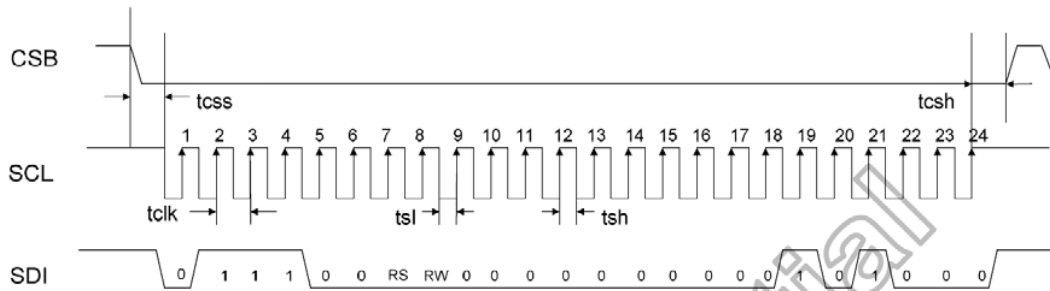
Second Transmission (Data)
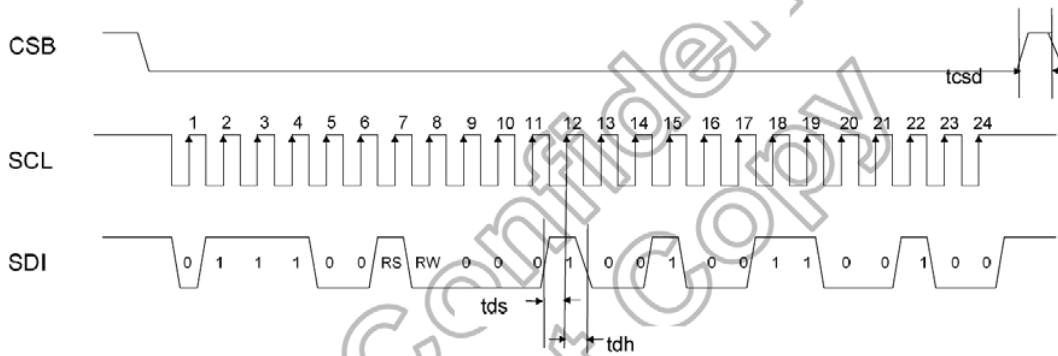
Note: The example writes "0x1264h" to register R28h.
SPID connected to VSS.

(a)SPI interface Timing Diagram & Write SPI Example

● Read SPI

First Transmission (Register)

Second Transmission (Data)
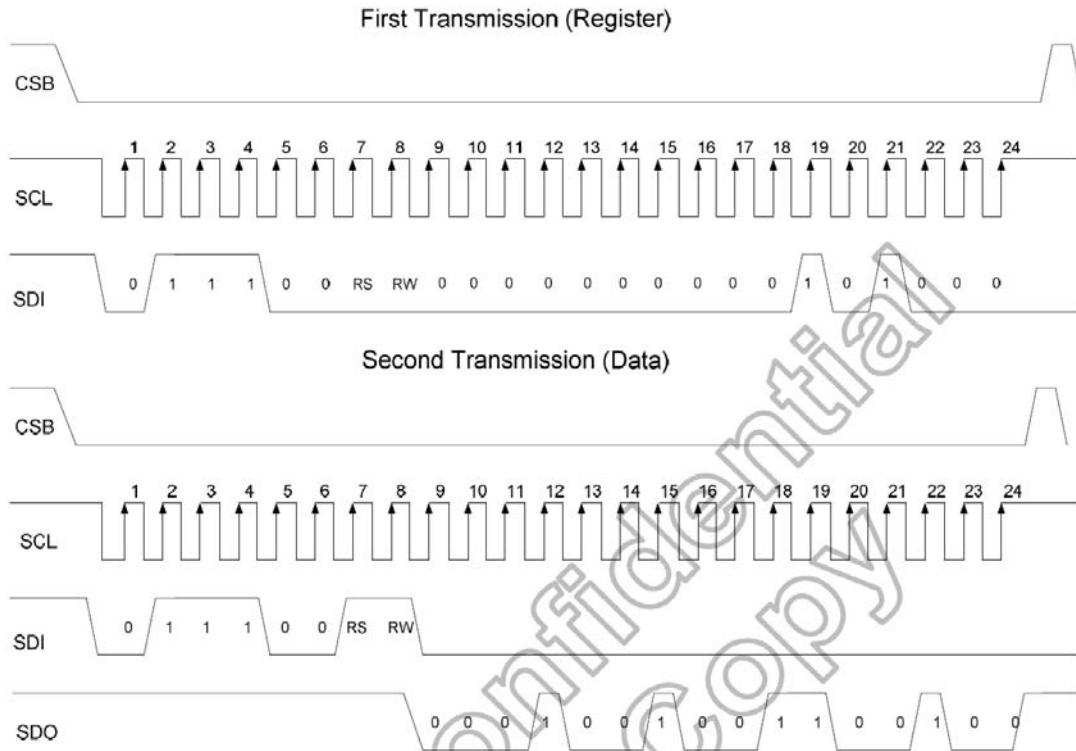
Note: The example Read "0x1264h" from register R28h.

(b) SPI interface Timing Diagram & Read SPI Example

Rising/Falling Time
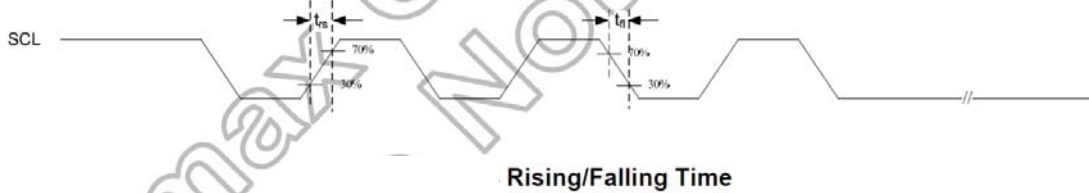
11.Quality Specifications

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.
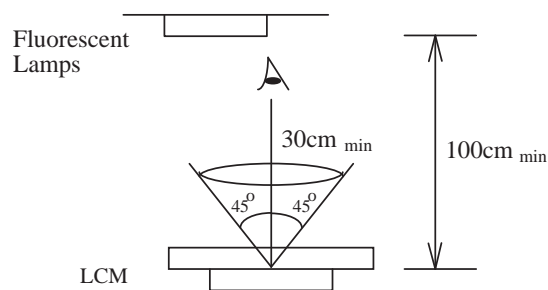
Definition of zone:
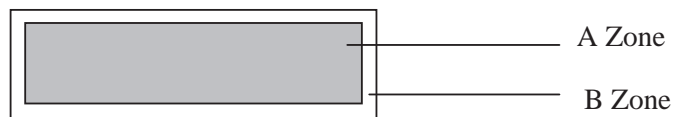
A Zone: viewing area
B Zone: outside viewing area

11.2 Specification of quality assurance
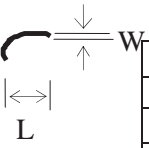
AQL inspection standard

Sampling method: MIL-STD-105E, Level II, single sampling
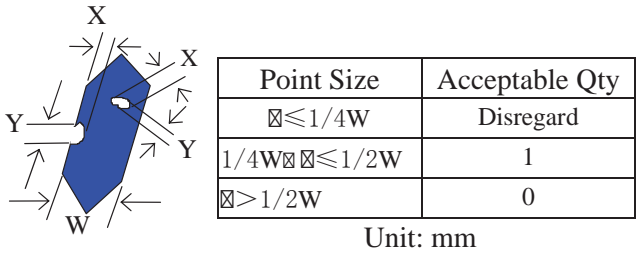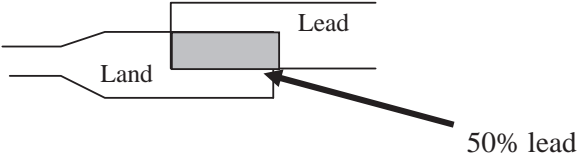
Defect classification (Note: * is not including)
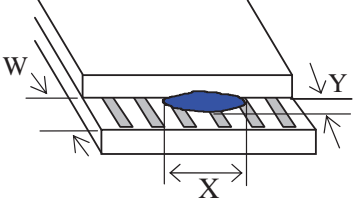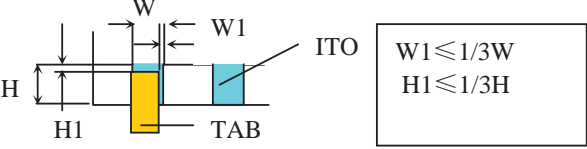
Classify	Item		Note	AQL
Major	Display state	Short or open circuit		0.65
		LC leakage	1	
		Flickering		
		No display		
		Wrong viewing direction		
		Contrast defect (dim, ghost)	2	
		Back-light	1,8	
	Non-display	Flat cable or pin reverse	10	
		Wrong or missing component	11	
Minor	Display state	Background 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	
	Soldering	Poor connection	9	
	Wire	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	

No.	Item	Criterion
3	Point defect, Black spot, dust (including Polarizer) φ = (X+Y)/2	 Unit：mm

Point defect table:

Point Size	Acceptable Qty.
φ≤0.10	Disregard
0.10<φ≤0.20	3
0.20<φ≤0.25	2
0.25<φ≤0.30	1
φ>0.30	0

No.	Item	Criterion
4	Line defect, Scratch	 Unit: mm

Line		Acceptable Qty.
L	W	
---	0.02≥W	Disregard
4.0≥L	0.03≥W>0.02	2
2.0≥L	0.05≥W>0.03	
1.0≥L	0.1>W>0.05	1
---	0.1≤W	Applied as point defect

No.	Item	Criterion
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 ⌀ = (X+Y)/2	(1) Pin hole 　⌀ < 0.10mm is acceptable. X X Y Y W Point Size / Acceptable Qty table below: | Point Size	Acceptable Qty
---	---
⌀≤1/4W	Disregard
1/4W＜⌀≤1/2W	1
⌀＞1/2W	0	 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 ⩽ 0.4
13	TAB	1. Position $W1 \leqslant 1/3W$ $H1 \leqslant 1/3H$ 2 FPC bonding strength test P (=F/FPC bonding width) $\geqslant 650gf/cm$,(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 (hrs)	Assessment
High temp. Storage	60℃	48	
High temp. Operating	50℃	48	
Low temp. Storage	-20℃	48	No abnormalities
Low temp. Operating	-10℃	48	in functions
Humidity	40℃ / 90%RH	48	and appearance
Temp. Cycle	-20℃, ⊠ 25℃, ⊠ 60℃ (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$\pm$8℃), 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 OD.
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

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

1. The liability of OD is limited to repair or replacement on the te rms set forth below. OD 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 OD and the customer, OD will only replace or repair any of its LCD which is found defective electrically or visually when inspected in accordance with OD 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.