HYUNDAI

TITLE: HT15X22-100 (Wacom)
Product Specification
Rev. 0

Hyundai Display Technology Inc.

SPEC. NUMBER	PRODUCT GROUP	REV.	ISSUE DATE	PAGE
S864-1066	TFT-LCD PRODUCT	0	2001.08.06	1 OF 21

RASR 055-3   A4 (210 X 297)

	PRODUCT GROUP	REV.	ISSUE DATE
HYUNDAI	TFT-LCD PRODUCT	0	2001.08.06

REVISION HISTORY

REV.	ECN NO.	DESCRIPTION OF CHANGES	DATE	PREPARED
0	-	Initial Release	'01.08.06	Y.I.Kim

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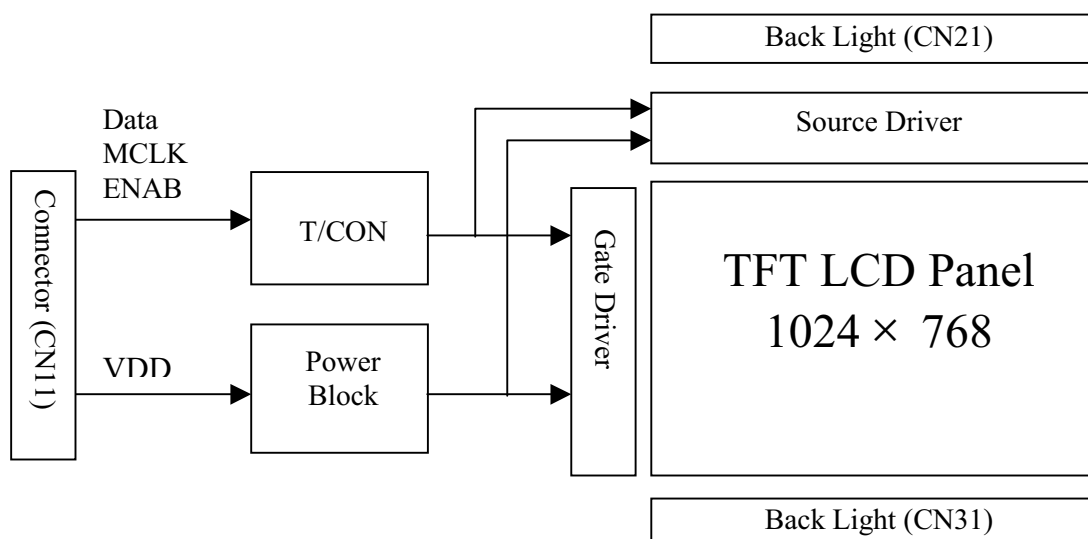RASR 056-1   A4 (210 X 297)

Contents

1.0 GENERAL DESCRIPTION

1.1 Introduction

HT15X22-100 is a color active matrix TFT LCD module using amorphous silicon TFT's (Thin Film Transistors) as an active switching devices. This module has a 15.0 inch diagonally measured active area with XGA resolutions (1024 horizontal by 768 vertical pixel array). Each pixel is divided into RED, GREEN, BLUE dots which are arranged in vertical stripe and this module can display 16,777,216 colors. The TFT-LCD panel used for this module is wide viewing angle (Horizontal viewing angle: 160°, Vertical viewing angle: 160°) by FFS^{TM} (Fringe Field Switching) mode.

```
                                      ┌──────────────────────────┐
                                      │   Back Light (CN21)       │
                                      └──────────────────────────┘
           Data                       ┌──────────────────────────┐
           MCLK                        │      Source Driver        │
           ENAB                       └──────────────────────────┘
  ┌─────────┐    ┌──────────┐   ┌─────┐ ┌──────────────────────┐
  │Connector│───▶│  T/CON   │──▶│Gate │ │                      │
  │ (CN11)  │    └──────────┘   │Drive│ │   TFT LCD Panel      │
  │         │                   │ r   │ │   1024 × 768         │
  │         │    ┌──────────┐   │     │ │                      │
  │         │───▶│  Power   │──▶│     │ │                      │
  │         │ VDD│  Block   │   └─────┘ └──────────────────────┘
  └─────────┘    └──────────┘
                                      ┌──────────────────────────┐
                                      │   Back Light (CN31)       │
                                      └──────────────────────────┘
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1.2 Features
- Desktop type of PC Use
- Display terminals for control system
- Monitors for process controller
- FFS (Fringe Field Switching) Mode
- TTL Interface with 2pixel / clock
- High-speed response
- 256 Gray Scale (8 bits)
- Incorporated edge type back-light (Four lamps, Inverter optional)
- High luminance and Contrast ratio, Low reflection and wide viewing angle
- DE (Data Enable) Mode only

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1.3 General Specifications

Parameter	Specification	Unit	Remarks
Active area	304.128 (H) x 228.096(V)	mm	
Number of pixels	1024(H) x 768(V)	pixels	
Pixel pitch	0.297(H) x 0.297(V)	mm	
Pixel arrangement	RGB Vertical stripe		
Display colors	16,777,216	colors	
Display mode	Normally black		
Dimensional outline	350.0±0.5(H)x266.5±0.5(V)x17.2(D) Typ.	mm	Note 1
Weight	1,500 Max.	g	Note 1
Back-light	Top/Bottom edge side 4-CCFL type		Note 2

Note: 1. Excluding Back-light inverter
2. CCFL (Cold Cathode Fluorescent Lamp)

2.0 ABSOLUTE MAXIMUM RATINGS

The followings are maximum values which, if exceed, may cause faulty operation or damage to the unit.

Parameter	Symbol	Min.	Max.	Unit	Remarks
Power Input Voltage	V_{DD}	-0.3	6.0	V	Ta = 25℃
Logic Input Voltage	V_{IN}	-0.3	4.6	V	
Operating Temperature	T_{OP}	0	+50	℃	
(Humidity)	RH		80	%	≤ 40 ℃
Storage Temperature	T_{SP}	-20	+60	℃	
(Humidity)	RH		90	%	≤ 40 ℃

3.0 ELECTRICAL SPECIFICATIONS

Measuring condition: fv=60Hz, fc=32.5MHz

Ta = 25±2℃

Parameter			Min.	Typ.	Max.	Unit	Remarks
Power Supply	Voltage	V_{DD}	4.5	5.0	5.5	V	
	Current	I_{DD}	−	580	990	mA	Note 1
Input Voltage	Low	V_{IL}	GND	−	0.66	V	Note 2
	High	V_{IH}	2.64	−	3.6	V	
Back-Light Lamp	Voltage	V_{BL}	565	600	−	Vrms	
	Current	I_{BL}	3.0	6.5	7.0	mArms	per CCFL
	Frequency	F_L	30	60	65	KHz	Note 3
	Start Voltage	V_S	−	−	780	Vrms	25℃, Note 4
			−	−	1160	Vrms	0℃, Note 4
	Life Time	Hr	25,000	35,000	−	hrs	
Power Consumption		P_{DD}	−	2.9	−	W	
		P_{BL}	−	15.6	−	W	Note 5
		P_{TOTAL}	−	18.5	−	W	

Notes:
1. Test Pattern of power supply current
   a) Typ: Vertical color bar pattern
   b) Max: Vertical 2 Skip line pattern
2. Input signals are DE, I_{CLK}, RA [7:0], GA [7:0], BA [7:0], RB [7:0], GB [7:0], BB [7:0]
3. The lamp frequency should be selected as different as possible from the horizontal synchronous frequency and its harmonics to avoid interference, which may cause line flow on the display.
4. The voltage above this value should be applied to the lamps for more than 1 second to startup. Otherwise the lamps may not to be turned on.
5. Calculated value for reference ($V_{BL} \times I_{BL}$) x 4 excluding inverter loss.

4.0 OPTICAL SPECIFICATIONS

The measurement shall be executed after 30 minutes warm-up period.
Measuring equipment: TOPCON-BM5.
Measuring condition: fv=60Hz, fc=32.5MHz

Ta = 25 ± 2℃

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Viewing Angle Range	Horizontal	Θ_3	CR > 10	−	80	−	Deg.	Note 1
		Θ_9		−	80	−	Deg.	
	Vertical	Θ_{12}		−	80	−	Deg.	
		Θ_6		−	80	−	Deg.	
Luminance Contrast ratio		CR		250	300	−		Note 2
Luminance of white	Average	Y_{WA}		230	250	−	cd/m^2	Note 3
	Center	Y_{WC}		250	270	−	cd/m^2	Note 4
White luminance uniformity		ΔY		−	−	1.25		Note 5
Reproduction Of color	White	x_W	$\Theta = 0°$ IBL=6.5mA	0.284	0.314	0.344		Note 6
		y_W		0.295	0.325	0.355		
	Red	x_R		0.591	0.621	0.651		
		y_R		0.299	0.329	0.359		
	Green	x_G		0.264	0.294	0.324		
		y_G		0.581	0.611	0.641		
	Blue	x_B		0.113	0.143	0.173		
		y_B		0.075	0.105	0.135		
Response Time (Rise + Decay)		Ttotal		−	45	55	ms	Note 7
Cross Talk		CT		−	−	2.0	%	Note 8

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Note:
1. Viewing angle is the angle at which the contrast ratio is greater than 10. The viewing are determined for the horizontal or 3, 9 o'clock direction and the vertical or 6, 12 o'clock direction with respect to the optical axis which is normal to the LCD surface (see FIGURE 1 shown in Appendix).
2. Contrast measurements shall be made at viewing angle of $\Theta = 0°$ and at the center of the LCD surface. Luminance shall be measured with all pixels in the view field set first to white, then to the dark (black) state. (See FIGURE 1 shown in Appendix) Luminance Contrast Ratio (CR) is defined mathematically.

$$CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$$

3. Average Luminance of white is defined as arithmetic mean of five measurement points across the LCD surface. Luminance shall be measured with all pixels in the view field set first to white. This measurement shall be taken at the locations shown in FIGURE 2 for a total of the measurements per display.
4. Center Luminance of white is defined as center measurement points across the LCD surface. The other condition is same note 4.
5. The White luminance uniformity on LCD surface is then expressed as : ΔY = Maximum Luminance of five points / Minimum Luminance of five points (see FIGURE 2 shown in Appendix).
6. The color chromaticity coordinates specified in Table 4. shall be calculated from the spectral data measured with all pixels first in red, green, blue and white. Measurements shall be made at the center of the panel.
7. The electro-optical response time measurements shall be made as FIGURE 3 shown in Appendix by switching the "data" input signal ON and OFF. The times needed for the luminance to change from 10% to 90% is Td, and 90% to 10% is Tr.
8. Cross-Talk of one area of the LCD surface by another shall be measured by comparing the luminance (Y_A) of a 25mm diameter area, with all display pixels set to a gray level, to the luminance (Y_B) of that same area when any adjacent area is driven dark. (See FIGURE 4 shown in Appendix).

5.0 INTERFACE CONNECTION

5.1 Electrical Interface Connection

CN11   Module Side Connector   :   FX8-80S-SV (HIROSE Electric Co.)

            User Side Connector   :   FX8-80P-SV (HIROSE Electric Co) or equivalent

Pin No	Symbol	Function	Pin No	Symbol	Function
1	GND	Ground	41	GND	Ground
2	RA0	Red Odd data LSB	42	GB0	Green Even data LSB
3	RA1	Red Odd data	43	GB1	Green Even data
4	RA2	"	44	GB2	"
5	RA3	"	45	GB3	"
6	GND	Ground	46	GND	Ground
7	RA4	Red Odd data	47	GB4	Green Even data
8	RA5	"	48	GB5	"
9	RA6	"	49	GB6	"
10	RA7	Red Odd data MSB	50	GB7	Green Even data MSB
11	GND	Ground	51	GND	Ground
12	GA0	Green Odd data LSB	52	BB0	Blue Even data LSB
13	GA1	Green Odd data	53	BB1	Blue Even data
14	GA2	"	54	BB2	"
15	GA3	"	55	BB3	"
16	GND	Ground	56	GND	Ground
17	GA4	Green Odd data	57	BB4	Blue Even data
18	GA5	"	58	BB5	"
19	GA6	"	59	BB6	"
20	GA7	Green Odd data MSB	60	BB7	Blue Even data MSB
21	GND	Ground	61	GND	Ground
22	BA0	Blue Odd data LSB	62	GND	"
23	BA1	Blue Odd data	63	CLK	Clock
24	BA2		64	GND	Ground
25	BA3	"	65	GND	Ground
26	GND	Ground	66	NC	No Connection
27	BA4	Blue Odd data	67	GND	Ground
28	BA5	"	68	GND	Ground
29	BA6	"	69	DE	Data Enable
30	BA7	Blue Odd data MSB	70	NC	No Connection
31	GND	Ground	71	VDD	+5V Power Supply
32	RB0	Red Even data LSB	72	VDD	"
33	RB1	Red Even data	73	VDD	"
34	RB2	"	74	VDD	"
35	RB3	"	75	VDD	"
36	GND	Ground	76	NC	No Connection
37	RB4	Red Even data	77	NC	"
38	RB5	"	78	NC	"
39	RB6	"	79	NC	"
40	RB7	Red Even data MSB	80	GND	Ground

5.2 Data Input Format

(1,1)   (2,1)   (1023,1) (1024,1)

1 Pixel = 3 Dots

(1,768)   (2,768)   (1023,768) (1024,768)

Display Position of Input Data

5.3 Back-light Interface Connection

CN21, CN31   Module Side Connector   : BHR-04VS-1 (JST)
              User Side Connector   : SM04 (4.0) B-BHS-1-TB (JST) or
                                         equivalent

Terminal No.	INPUT [CN21], [CN31]	Color	Function
1	HOT 1	Pink	High Voltage
2	HOT 2	Pink	High Voltage
3	N.C.	-	No Connection
4	COLD	White	Ground

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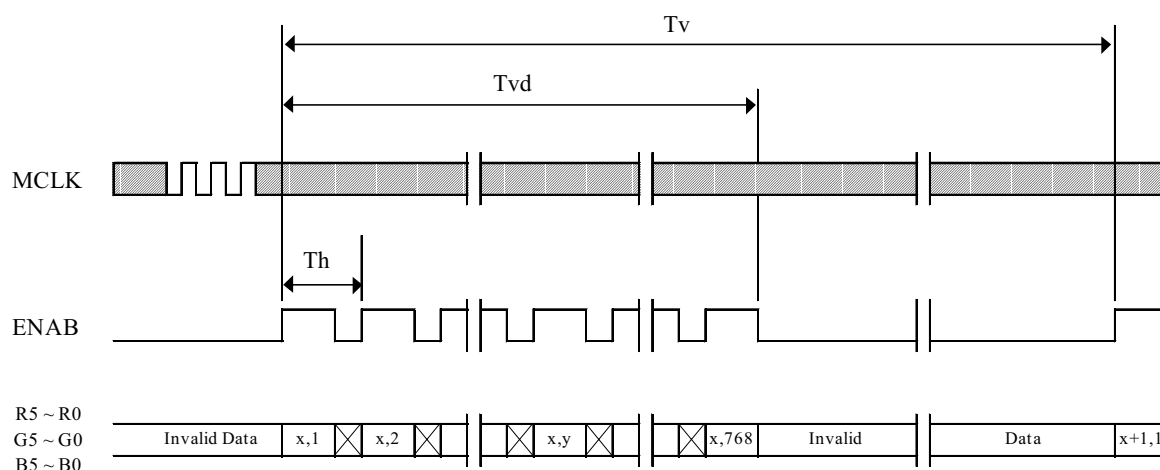RASR 057-1   A4 (210 X 297)

6.0 SIGNAL TIMING SPECIFICATIONS

The Only Data Enable Mode operates the HT15X22-100.

Item		Symbols	Min	Typ	Max	Unit
Clock	Frequency	1/Tc	28	32.5	-	MHz
	High Time	Tch	9	-	-	ns
	Low Time	Tcl	9	-	-	ns
Data	Setup Time	Tds	8	-	-	ns
	Hold Time	Tdh	8	-	-	ns
Data Enable Setup Time		Tes	8	-	-	ns
Frame Period		Tv	778	806	860	lines
Vertical Display Period		Tvd	768	768	768	lines
One Line Scanning Period		Th	592	672	682	clocks
Horizontal Display Period		Thd	512	512	512	clocks

7.0 SIGNAL TIMING WAVEFORMS

7.1 Vertical Timing Waveforms

7.2 Horizontal Timing Waveforms

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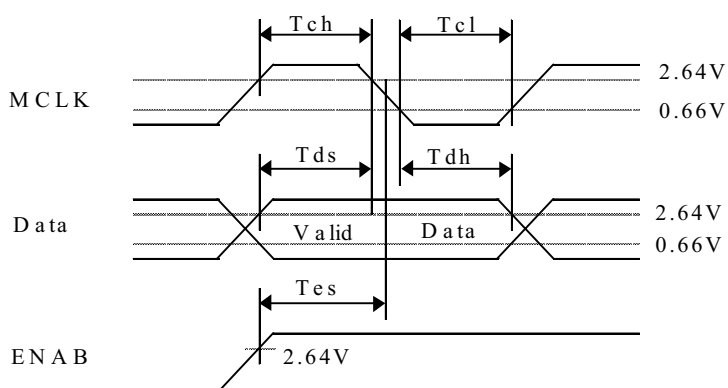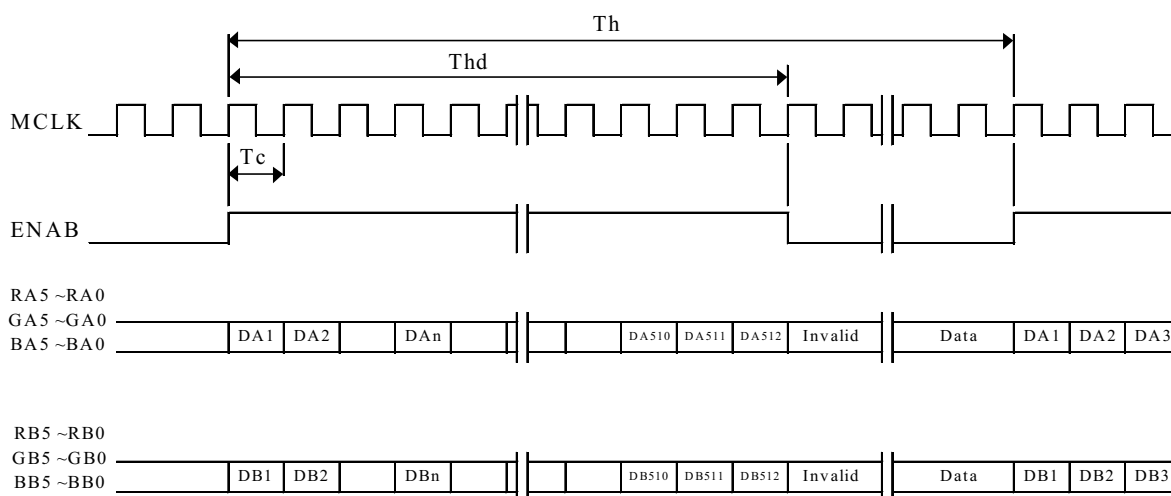
8.0 INPUT SIGNALS, BASIC DISPLAY COLORS & GRAY SCALE OF COLORS

Colors & Gray Scale	Odd & Even	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gray Scale Of Red	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑				↓								↓								↓				
	↓				↓								↓								↓				
	Brighter	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↓	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray Scale Of Green	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↑				↓								↓								↓				
	↓				↓								↓								↓				
	Brighter	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
	↓	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Gray Scale Of Blue	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↑				↓								↓								↓				
	↓				↓								↓								↓				
	Brighter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	↓	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Gray Scale Of White & Black	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	Darker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
	↑				↓								↓								↓				
	↓				↓								↓								↓				
	Brighter	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1
	↓	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

9.0 POWER SEQUENCE

To prevent a latch-up or DC operation of the LCD module, the power on/off sequence shall be as shown in below
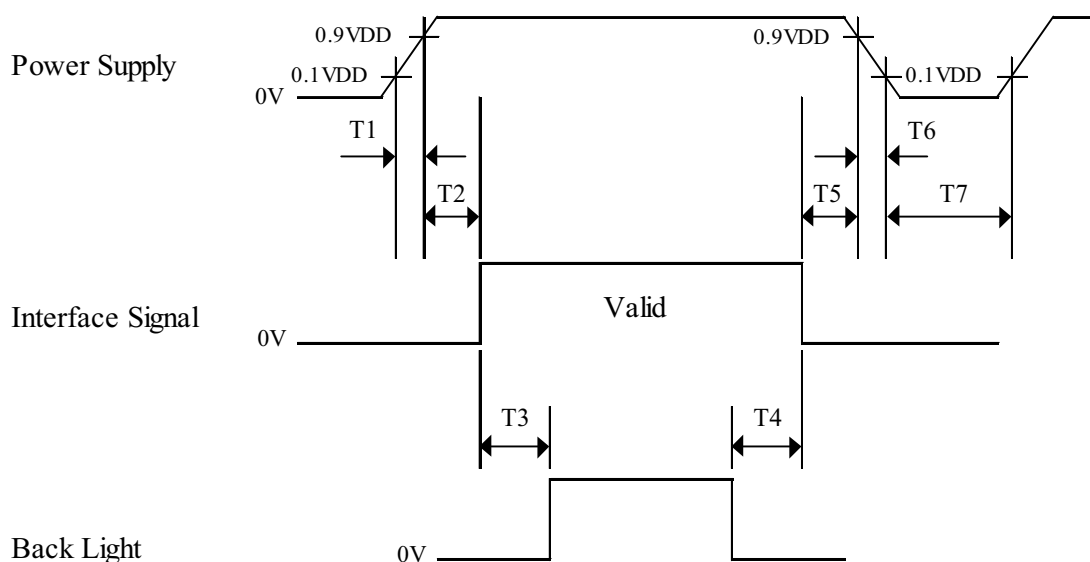
- $0 < T1 \leq 5$ ms
- $0 < T2 \leq 30$ ms
- 110 ms $\leq T3$
- $0 \leq T4$
- $0 < T5 \leq 30$ ms
- $0 < T6 \leq 1$ sec.
- 1 sec $\leq T7$

Notes:
1. When the power supply VDD is 0V, Keep the level of input signals on the low or keep high impedance.
2. Do not keep the interface signal high impedance when power is on.
3. Back Light must be turn on after power for logic and interface signal are valid.

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10.0 MECHANICAL CHARACTERISTICS

10.1 Dimensional Requirements

FIGURE 6 shown in appendix shows mechanical outlines for the model

Parameter	Specification	Unit
Active area	304.128 (H) x 228.096(V)	mm
Number of pixels	1024(H) x 768(V)	pixels
	(1 pixel = R + G + B dot)	
Pixel pitch	0.297(H) x 0.297(V)	mm
Pixel arrangement	RGB Vertical stripe	
Display colors	16,777,216	colors
Display mode	Normally white	
Dimensional outline	350.0±0.5(H) x 266.5±0.5(V) x 17.2(D) typ.	mm
Weight	1500 Max.	gram
Back-light	Top/Bottom edge side 4-CCFL type	

10.2 Mounting

See FIGURE 5 shown in appendix

10.3 anti-Glare and Polarizer Hardness.

The surface of the LCD has an anti-glare coating to minimize reflection and a coating to reduce scratching.

10.4 Light Leakage

There shall not be visible light from the back-lighting system around the edges of the screen as seen from a distance 50 cm from the screen with an overhead light level of 350lux. The manufacture shall furnish limit samples of the panel showing the lightest leakage acceptable.

11.0 RELIABILITY TEST

No	Test Items	Conditions
1	High temperature storage test	Ta = 60 °C, 240 hrs
2	Low temperature storage test	Ta = -20 °C, 240 hrs
3	High temperature & high humidity Operation test	Ta = 50 °C, 80 %RH, 240 hrs
4	High temperature operation test	Ta = 50 °C, 240 hrs
5	Low temperature operation test	Ta = 0 °C, 240 hrs
6	Thermal shock	Ta = -20 °C ↔ 60 °C (30 min), 100 cycle
7	Vibration test (Non-operating)	Frequency : 10 ~ 300 Hz Gravity/AMP : 1.5G Period : X, Y, Z 30 min
8	Shock test (Non-operating)	Gravity : 150G Pulse width : 6ms, half sine wave ± X, ± Y, ± Z Once for each direction
9	Electrostatic discharge test	Air : 150 pF, 330Ω, 15KV Contact : 150 pF, 330Ω, 8KV

Note: Vibration test and shock test execute with unmodified backlight hook condition.

12.0 HANDLING & CAUTIONS

12.1 Cautions when taking out the module
  • Pick the pouch only, when taking out module from a shipping package.

12.2 Cautions for handling the module
  • As the electrostatic discharges may break the LCD module, handle the LCD module with care. Peel a protection sheet off from the LCD panel surface as slowly as possible.
  • As the LCD panel and backlight element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.
  • As the surface of the polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.
  • Do not pull the interface connector in or out while the LCD module is operating.
  • Put the module display side down on a flat horizontal plane.
  • Handle connectors and cables with care.

12.3 Cautions for the operation
  • When the module is operating, do not lose ICLK, DE signals. If any one of these signals were lost, the LCD panel would be damaged.
  • Obey the supply voltage sequence. If wrong sequence were applied, the module would be damaged.

12.4 Cautions for the atmosphere
  • Dewdrop atmosphere should be avoided.
  • Do not store and/or operate the LCD module in a high temperature and/or humidity atmosphere. Storage in an electro-conductive polymer-packing pouch and under relatively low temperature atmosphere is recommended.

12.5 Cautions for the module characteristics
  • Do not apply fixed pattern data signal to the LCD module at product aging.
  • Applying fixed pattern for a long time may cause image sticking.

12.6 Other cautions
  • Do not disassemble and/or re-assemble LCD module.
  • Do not re-adjust variable resistor or switch etc.
  • When returning the module for repair or etc, please pack the module not to be broken. We recommend using the original shipping packages.

13.0 APPENDIX

Figure 1. Measurement Set Up

Measuring distance: 50Cm
Field: 2 degree
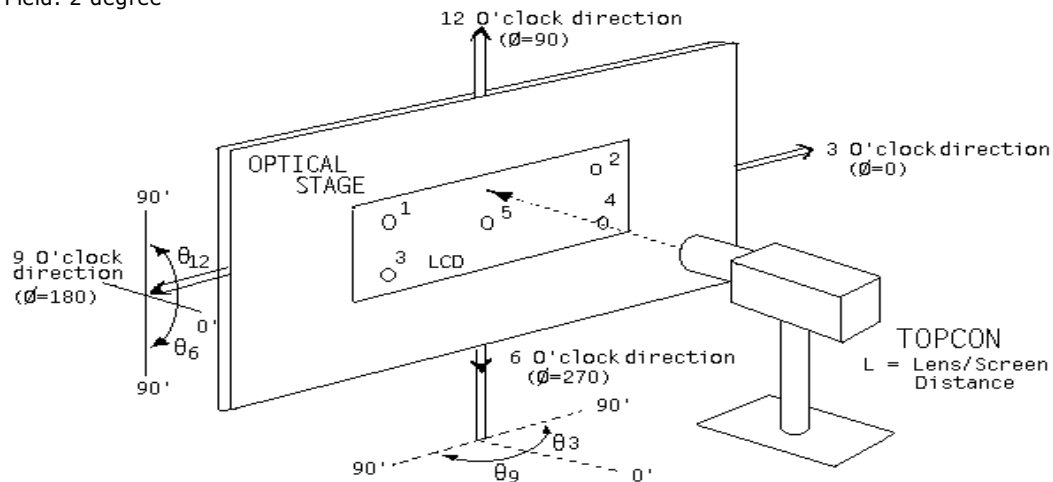
Figure 2. Average Luminance Measurement Locations & Uniformity Measurement Locations

Figure 3. Response Time Testing

Black TFT Off	White TFT On	Black TFT Off
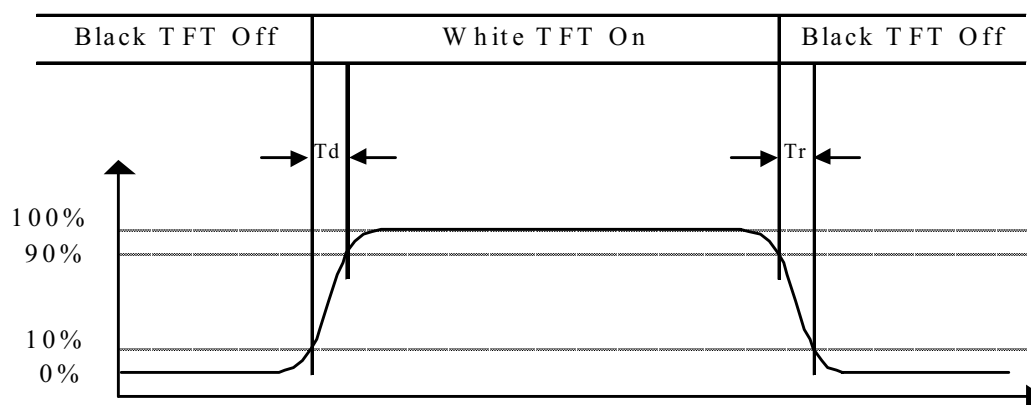
Figure 4. Cross Modulation Test Description

VIEW AREA   VIEW AREA

256. 192   768. 192
256. 576   768. 576
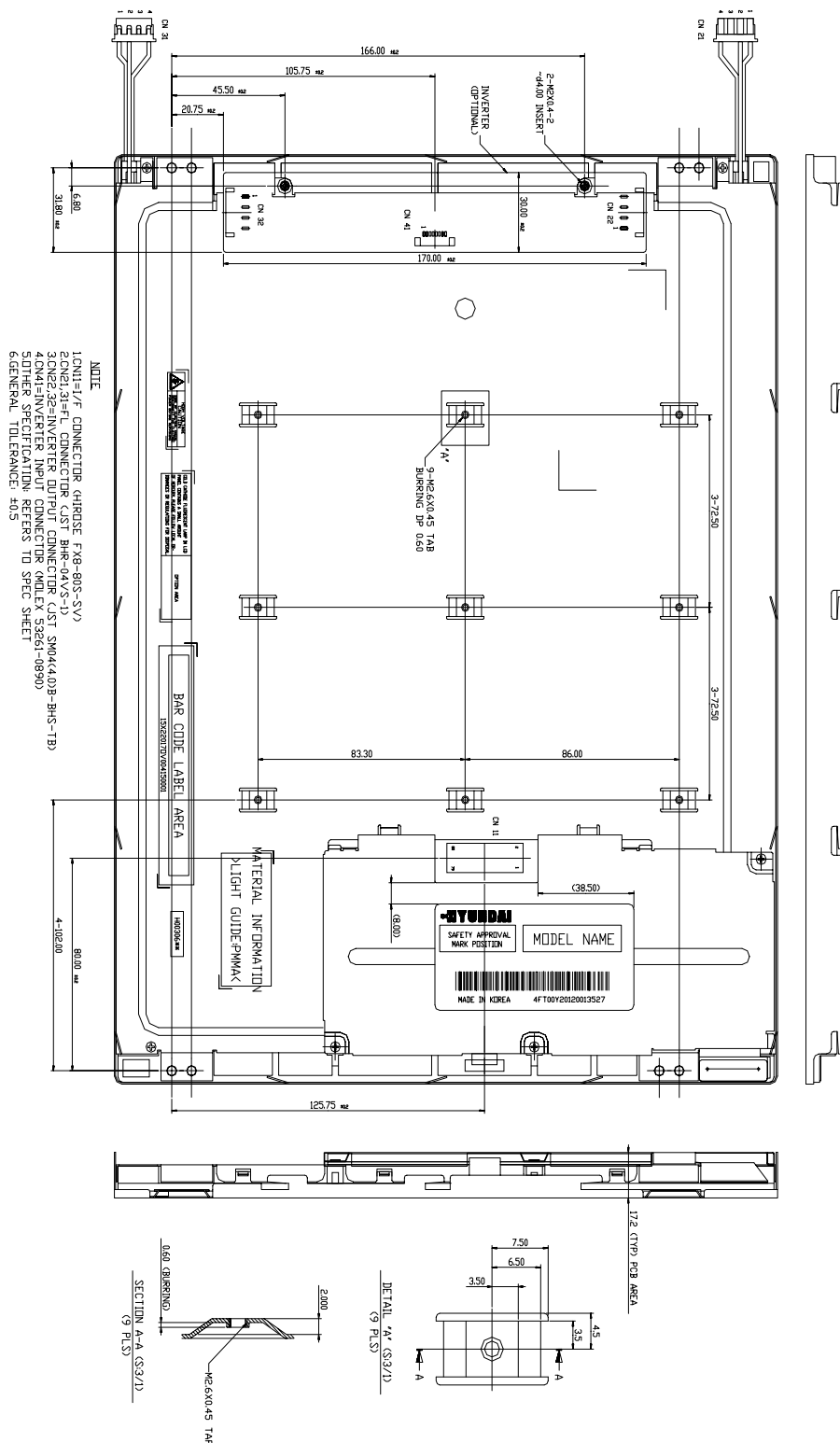
YA (896, 384)   YB (896, 384)
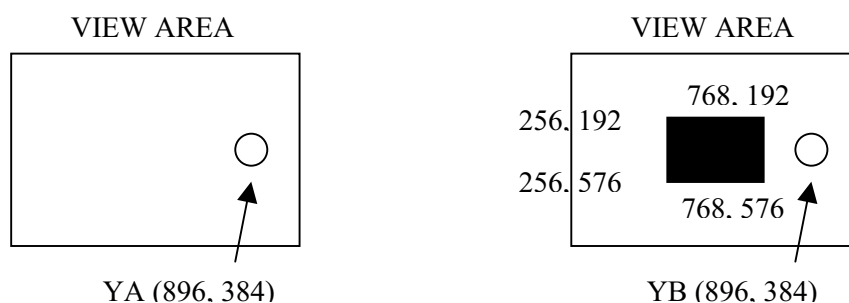
$$\text{Cross-Talk} = \left| \frac{YB - YA}{YA} \right| \times 100$$

Where:

Y_A = Initial luminance of measured area (cd/m^2)

Y_B = Subsequent luminance of measured area (cd/m^2)

The location measured will be exactly the same in both patterns.

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Figure 5. TFT-LCD Module Outline Dimensions (Front view)

Figure 6. TFT-LCD Module Outline Dimensions (Rear view)