TITLE : HT14X13-102 Product Specification

Rev. O

Hyundai Display Technology Inc.

REVISION HISTORY

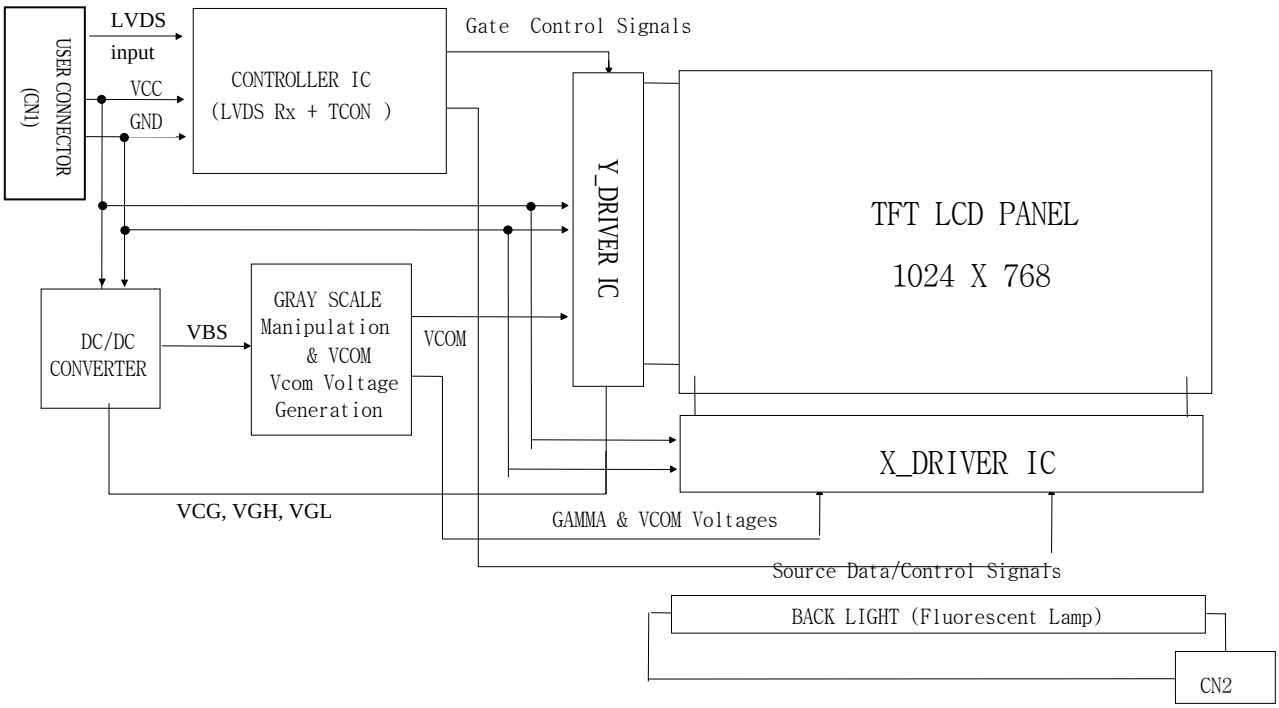
REV.	ECN NO.	DESCRIPTION OF CHANGES	DATE	PREPARED
O		Initial Release	01.09.03	K.S. SHIN

Contents

1.0 GENERAL DESCRIPTION

1.1 Introduction

[HT14X13-102] 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 14.1 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 262,144 colors. The TFT-LCD panel used for this module is a low reflection and higher color type. Therefore, this module is suitable for Notebook PC. The DC/AC inverter for back-light driving is not built in this model.



1.2 Features

- Low driving voltage and low power consumption
- Thin and light weight
- 3.3 V power supply
- 1 Channel LVDS Interface
- Single CCFL (Bottom side/Horizontal Direction)
- 262,144 colors
- Data enable signal mode
- Side Mounting Frame

1.3 General Specification

The followings are general specifications at the model [HT14X13-102](listed in Table 1.)

<Table 1. General Specifications>

Parameter	Specification	Unit	Remarks
Active area	285.696 (H) ×214.272(V)	mm	
Number of pixels	1024(H) ×768(V)	pixels	
Pixel pitch	0.279(H) ×0.279(V)	mm	
Pixel arrangement	RGB Vertical stripe		
Display colors	262,144	colors	
Display mode	Normally white		
Dimensional outline	298.5(W)±0.5×227.5(V) ±0.5×5.7(D)[typ]/6.0(D)[max]	mm	
Weight	530[typ]	g	
Back-light	CCFL, Horizontal-lamp type		Note 1

Note 1. 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. The operational and non-operational maximum voltage and current values are listed in Table 2.

< Table 2. Absolute Maximum Ratings>

Parameter	Symbol	Min	Max	Unit	Remarks
Power Supply Voltage	V_{DD}	-0.3	4.6	V	
Logic Supply Voltage	V_{IN}	-0.3	V_{DD}+0.3	V	
Operating Temperature	T_{OP}	0	+50	℃	
Storage Temperature	T_{SP}	-20	+60	℃	

3.0 ELECTRICAL SPECIFICATIONS

3.1 Electrical Specifications

< Table 3. Electrical specifications >

Parameter		Min	Typ	Max	Unit	Remarks
Power Supply Voltage	V_{DD}	3.0	3.3	3.6	V	Note 1
Permissible Input Ripple Voltage	V_{RF}			100	mV	At V_{DD} = 3.3V
Power Supply Current	I_{DD}		350		mA	Note 1
High Level Differential Input Signal Voltage	V_{IH}		-	+100	mV	Note 2
Low Level Differential Input Signal Voltage	V_{IL}	-100	-		mV	
Back-light Lamp Voltage	V_{BL}		580		V_{rms}	Note 3
Back-light Lamp Current	I_{BL}	3.0	6.0	7.0	mA	Note 3
Back-light Lamp operating Frequency	F_L	40	60	80	kHz	One Lamp, Note 4
Lamp Start Voltage				1,210	V_{rms}	At Ta = 25℃
				1,500		At Ta = 0℃
Lamp Life		10,000	15,000		Hrs	At I_{BL} = 6mA , Note5
Power Consumption	P_D		1.2		W	Typ. @ Color Bar
	P_{BL}		3.5		W	Note6,I_{BL}=6mA
	P_{total}		4.7		W	

Notes :

1. The supply voltage is measured and specified at the interface connector of LCM. The current draw and power consumption specified is for 3.3V at 25℃.
2. LVDS Common Mode Voltage , VCM = 1.2[V]
3. Reference value, which is measured with Samsung Electric SIC-180 Inverter. (V_{BLMIN} is value at I_{BLMIN} and V_{BLMAX} is value at I_{BLMAX})
4. 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

5. End of Life shall be determined by the time when any of the falling is satisfied under continuous lighting at 25℃ and I_{BL} = 6mA.
   - Intensity drops to 50% of the Initial Value.
   - Driving(Start-up) Voltage during minimum temperature operation is 1300 $V_{rms.}$
6. Calculated value for reference (VBL ×IBL)

4.0 OPTICAL SPECIFICATION

4.1 Overview

The test of Optical specifications shall be measured in a dark room (ambient luminance ≤ 1 lux and temperature = 25±2℃) with the equipment of Luminance meter system (Goniometer system and TOPCONE BM-5) and test unit shall be located at an approximate distance 50cm from the LCD surface at a viewing angle of Θ and Φ equal to 0°. We refer to $\Theta_{Ø=0}$ (=Θ_3) as the 3 o'clock direction (the "right"), $\Theta_{Ø=90}$ (= Θ_{12}) as the 12 o'clock direction ("upward"), $\Theta_{Ø=180}$ (= Θ_9) as the 9 o'clock direction ("left") and $\Theta_{Ø=270}$(= Θ_6) as the 6 o'clock direction ("bottom"). While scanning Θ and/or Ø, the center of the measuring spot on the Display surface shall stay fixed. The backlight should be operating for 30 minutes prior to measurement. VDD shall be 3.3+/- 0.3V at 25°C. Optimum viewing angle direction is 6 o'clock.

4.2 Optical Specifications

<Table 4. Optical Specifications>

Parameter		Symbol	Condition	Min	Typ	Max	Unit	Remark
Viewing Angle range	Horizontal	Θ_3	CR > 10	40			Deg.	Note 1
		Θ_9		40			Deg.	
	Vertical	Θ_{12}		15			Deg.	
		Θ_6		30			Deg.	
Luminance Contrast ratio		CR	Θ = 0°	150	200			Note 2
Average Luminance of White		Y_w	Θ = 0° IBL =6mA	120	150		cd/m^2	Note 3
White luminance uniformity		Δ Y				1.3		Note 4
White Chromaticity		x_w	Θ = 0°	0.275	0.305	0.335		Note 5
		y_w		0.301	0.331	0.361		
Reproduction Of color	Red	x_R	Θ = 0°		0.563			
		y_R			0.324			
	Green	x_G			0.303			
		y_G			0.539			
	Blue	x_B			0.150			
		y_B			0.139			
Response Time	Rise(T_r)	T_r	Ta= 25° C Θ = 0°			40	ms	Note 6
	Decay(T_d)	T_d				50		
Cross Talk		CT	Θ = 0°			2.0	%	Note 7

Note:

1. Viewing angle is the angle at which the contrast ratio is greater than 10. The viewing angles

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 FIGURE1 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 FIGURE1 shown in Appendix) Luminance Contrast Ratio (CR) is defined mathematically as CR = Luminance when displaying a white raster / 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. The White luminance uniformity on LCD surface is then expressed as : ΔY = Maximum Luminance of five points / Minimum Luminance of five points (see FIGURE 3).

5. 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.

6. The electro-optical response time measurements shall be made as shown in FIGURE 4 (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.

7. 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 (Refer to FIGURE 5).

5.0 INTERFACE CONNECTION

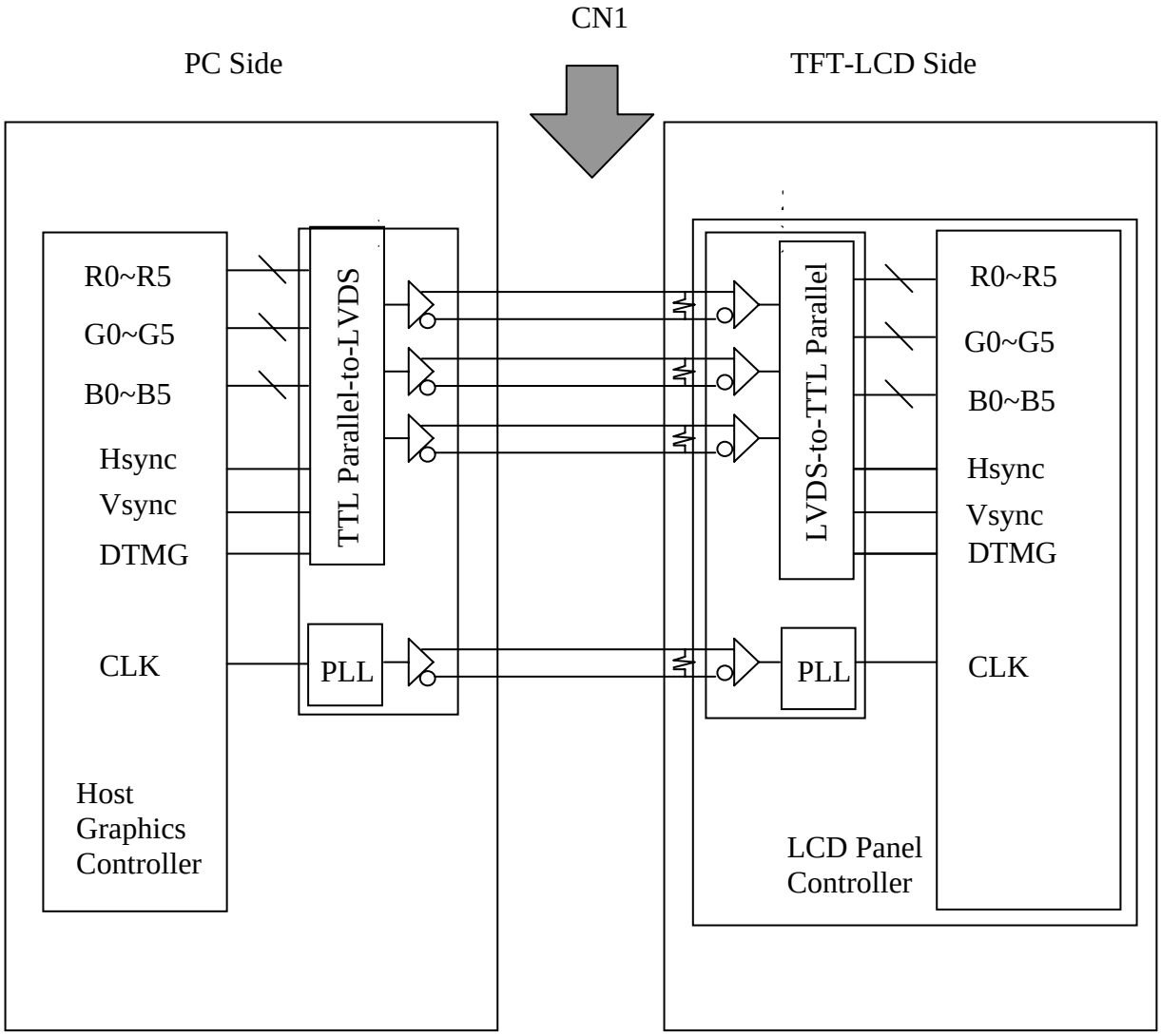
5.1 Electrical Interface Connection

The electronics interface connector is a model FI-XB20S-HF10 manufactured by JAE or equivalent. The mating connector part number is FI-XB20M,FI-X20H or equivalent. The connector interface pin assignments are listed in Table 5.

<Table 5. Pin Assignments for the Interface Connector>

NO.	Symbol	Function
1	VDD1	Power Supply : +3.3V
2	VDD2	Power Supply : +3.3V
3	VSS1	Ground
4	VSS2	Ground
5	RIN0-	Transmission Data of 0 Negative -
6	RIN0+	Transmission Data of 0 Positive +
7	VSS3	Ground
8	RIN1-	Transmission Data of 1 Negative -
9	RIN1+	Transmission Data of 1 Positive +
10	VSS4	Ground
11	RIN2-	Transmission Data of 2 Negative -
12	RIN2+	Transmission Data of 2 Positive +
13	VSS5	Ground
14	CLK-	Sampling Clock of Negative -
15	CLK+	Sampling Clock of Positive +
16	VSS6	Ground
17	NC1	No Connection
18	NC2	No Connection
19	VSS7	Ground
20	VSS8	Ground

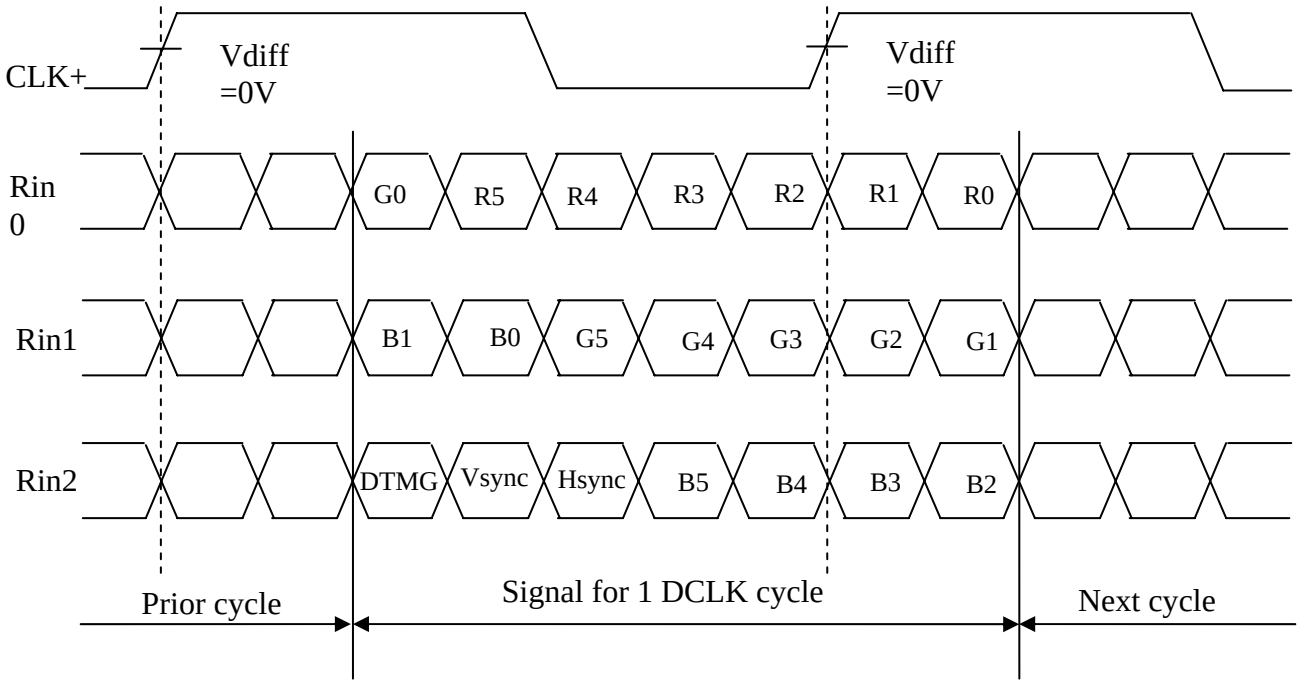
5.2 LVDS Interface



NOTE

1) LVDS cable impedance is 100 ohms per signal line, when two signal are used differentially
2) Transmitter: TI SN75LVDS84, or equivalent. Transmitter is not contained in Module

5.3 LVDS Input signals



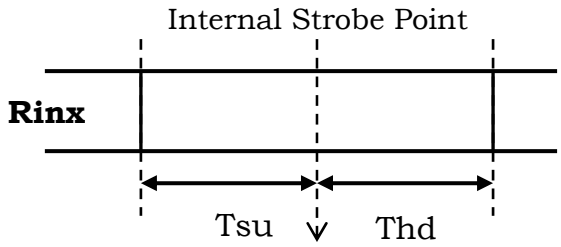
< Pin connection in case of using TI SN75LVDS84 >

Input signal	Transmitter	Input signal	Transmitter
DCLK	CLK IN(26)	G4	IN10(10)
R0	IN0(44)	G5	IN11(12)
R1	IN1(45)	B0	IN12(13)
R2	IN2(47)	B1	IN13(15)
R3	IN3(48)	B2	IN14(16)
R4	IN4(1)	B3	IN15(18)
R5	IN5(3)	B4	IN16(19)
G0	IN6(4)	B5	IN17(20)
G1	IN7(6)	Hsync	IN18(22)
G2	IN8(7)	Vsync	IN19(23)
G3	IN9(9)	DTMG	IN20(25)

5.4.LVDS Characteristics

<Table 6. LVDS Characteristics>

Parameter	Symbol	Min	Typ	Max	Units
Potential Difference of High Level Input	VTH			100	mV
Potential Difference of Low Level Input	VTL	-100			mV
Input Common Mode Voltage	VCM	1.0	1.2	1.4	V
Data Setup Time	Tsu	600			pS
Data Hold Time	Thd	600			pS



5.5.Back-light Interface

The Back-light interface connector is a model BHSR-02VS-1 manufactured by JST or equivalent. The connector interface pin assignments are listed in Table 7.

<Table 7. Back-light Electrical Interface>

Terminal No.	Symbol	Function	Color
1	VL	CCFL Power Supply(High Voltage)	Pink
2	GL	CCFL Power Supply(GND Side)	Black

6.0 SIGNAL TIMING SPECIFICATION

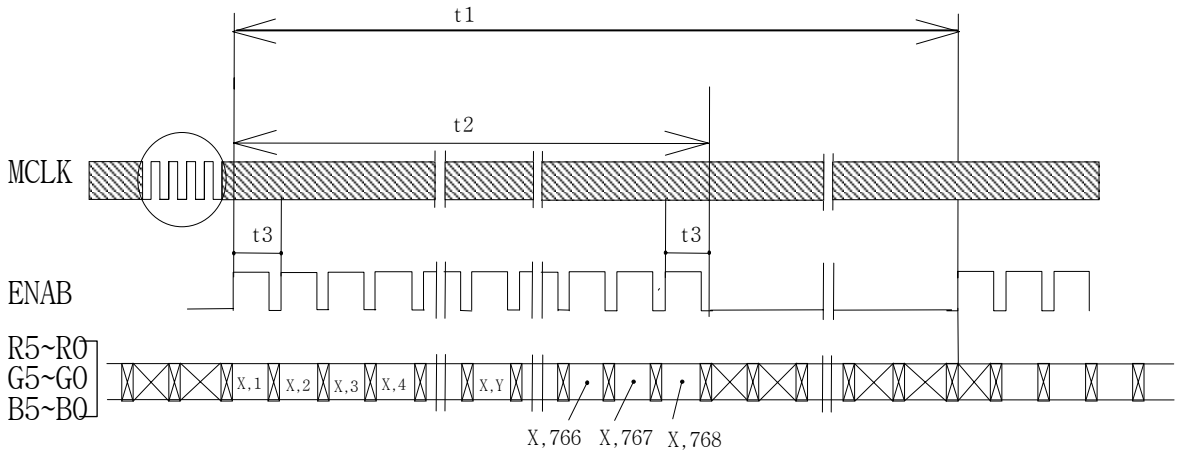
The specification of the signal timing parameters is listed in Table 8.

<Table 8. Signal Timing Specification.>

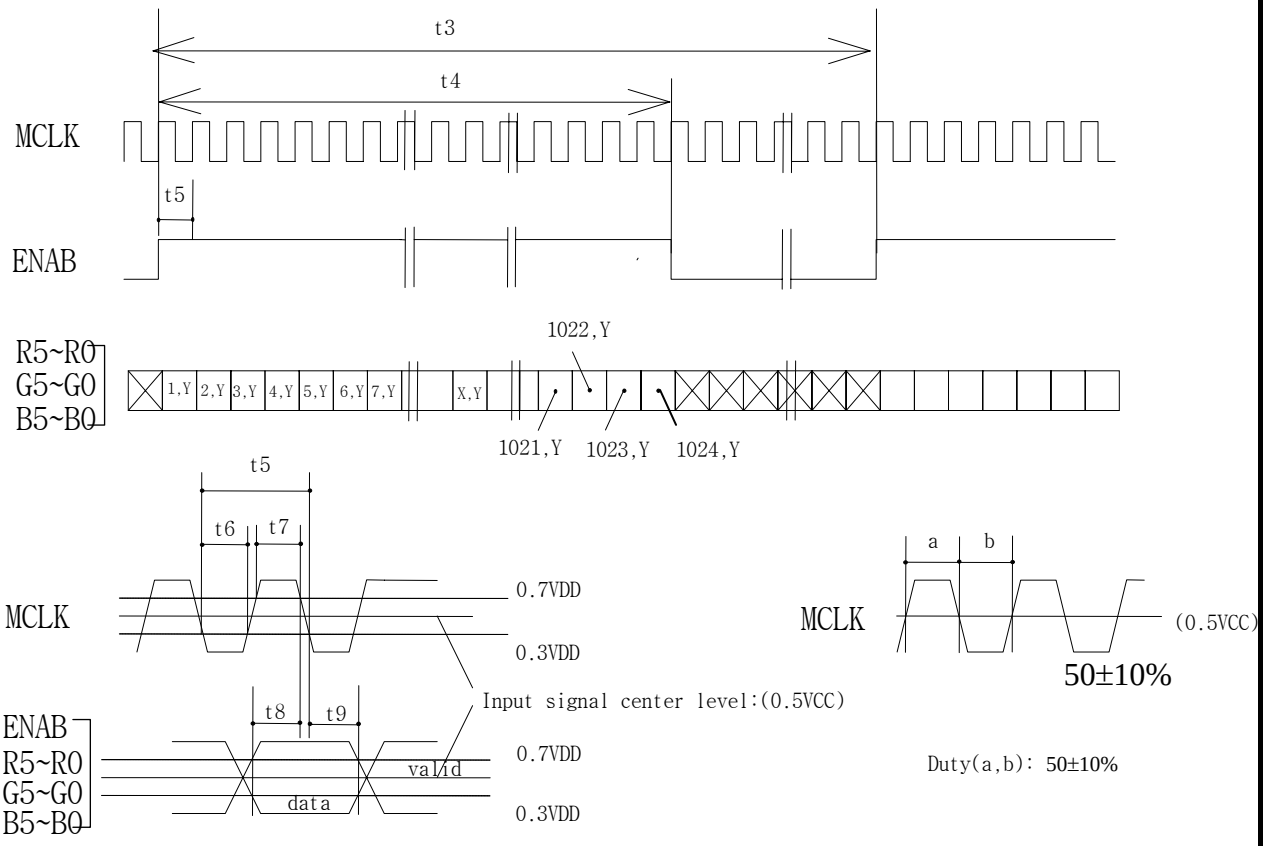
ITEM	Symbol	Min	Typ	Max	Unit	Remarks
Frame Period	t1	801 X t3	806 X t3 16.67	812 X t3	- ms	60Hz
Vertical Display Period	t2	768 X t3	768 X t3 15.88	768 X t3	- ms	
One Line Scanning Period	t3	1280 X t5	1344 X t5 20.67	1364 X t5	- us	48.38KHz
Horizontal Display Period	t4	1024 X t5	1024 X t5 15.75	1024 X t5	- us	
Clock Time	t5		15.38		ns	65MHz
Clock “L” Time	t6	5.0			ns	
Clock “H” Time	t7	4.0			ns	
Set up Time	t8	3.5			ns	
Hold Time	t9	3.5			ns	

7.0 SIGNAL TIMING WAVEFORMS

7.1 Vertical Timing Waveforms



7.2 Horizontal Timing Waveforms

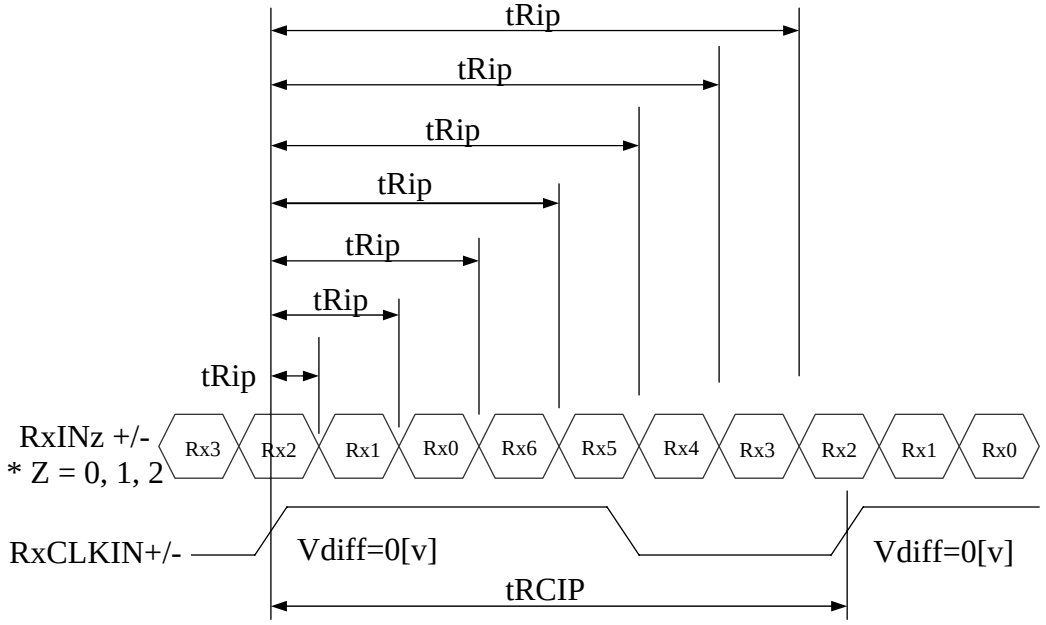


7.3 LVDS Rx Interface Timing Parameter

The specification of the LVDS Rx interface timing parameter is listed in Table 9.

<Table 9. LVDS Rx Interface Timing Specification>

Item	Symbol	Min	Typ	Max	Unit	Remark
PLL Set	tRPLL	-	-	10.0	msec	
CLKIN Period	tRCIP		15.38	50	nsec	
Input Data 0	tRIP1	-0.2	0.0	+0.2	nsec	
Input Data 1	tRIP0	tRICP/7-0.2	tRICP/7	tRICP/7+0.2	nsec	
Input Data 2	tRIP6	2 ×tRICP/7-0.2	2 ×tRICP/7	2 ×tRICP/7+0.2	nsec	
Input Data 3	tRIP5	3 ×tRICP/7-0.2	3 ×tRICP/7	3 ×tRICP/7+0.2	nsec	
Input Data 4	tRIP4	4 ×tRICP/7-0.2	4 ×tRICP/7	4 ×tRICP/7+0.2	nsec	
Input Data 5	tRIP3	5 ×tRICP/7-0.2	5 ×tRICP/7	5 ×tRICP/7+0.2	nsec	
Input Data 6	tRIP2	6 ×tRICP/7-0.2	6 ×tRICP/7	6 ×tRICP/7+0.2	nsec	



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

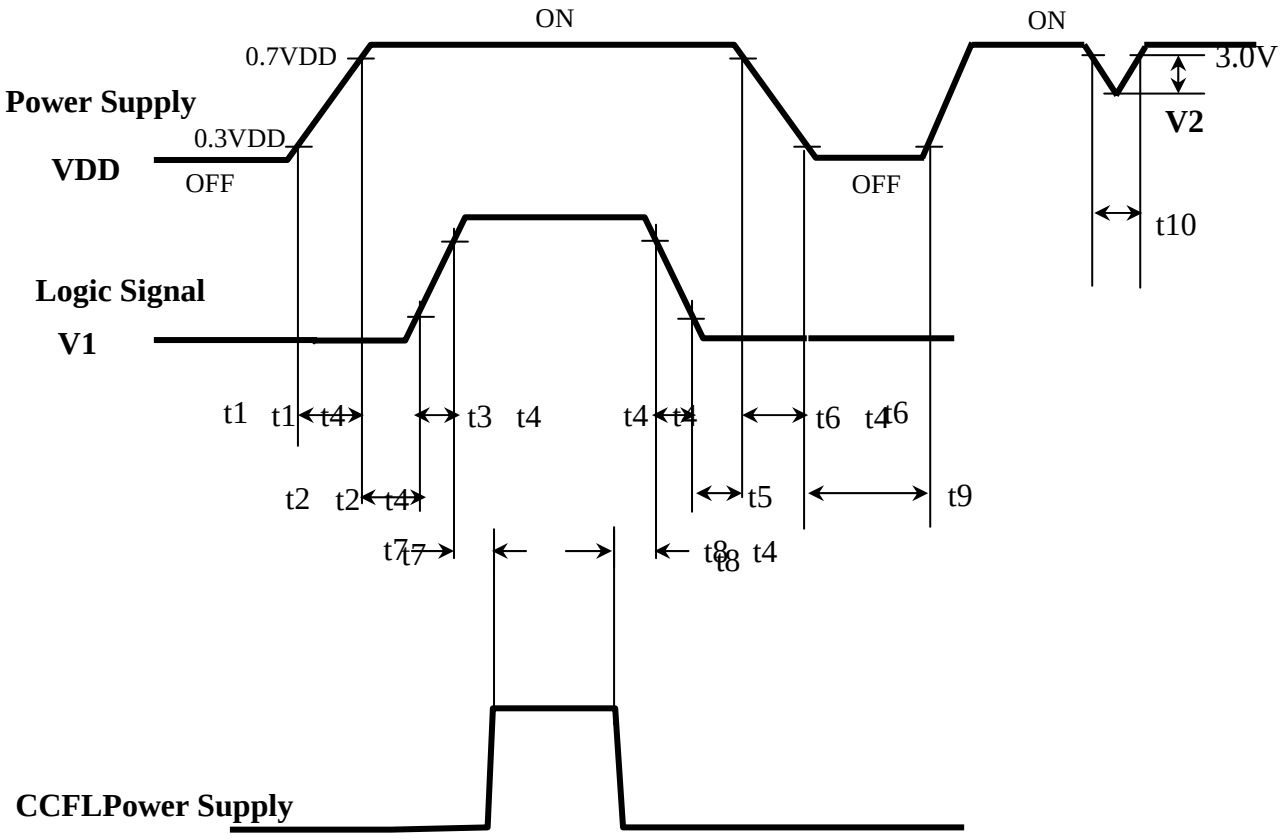
Each color is displayed in sixty-four gray scales from a 6 bit data signal input. A total of 262,144 colors are derived from the resultant 18 bit data. Table 10. shows the input signals, basic display colors and gray scale for each color.

<Table 10. Input signals, Basic display colors and Gray scale for each color.>

Colors & Gray Scale		Data Signal																	
		Red						Green						Blue					
	Odd & Even	R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	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
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Light Blue	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Purple	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	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
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	1	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑	↓						↓						↓					
	↓	↓						↓						↓					
	Brighter	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	↓	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	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	1	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	↑	↓						↓						↓					
	↓	↓						↓						↓					
	Brighter	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
	↓	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	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	1
	Darker	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	1	1	1	1	0	1
	↓	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	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	1	0	0	0	0	0	1	0	0	0	0	0	1
	Darker	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0
	↑	↓						↓						↓					
	↓	↓						↓						↓					
	Brighter	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	1
	↓	1	1	1	1	1	0	1	1	1	1	1	0	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

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



t1 ≤ 10 ms	t6 ≤ 10 ms
0 ≤ t2 ≤ 50 ms	t7 ≥ 100 ms
0 ≤ t3 ≤ 50 ms	t8 ≥ 200 ms
0 ≤ t4 ≤ 50 ms	t9 ≥ 1s
0 ≤ t5 ≤ 50 ms	t10 ≤ 10 ms (Note2.)

2.4 V ≤ V2 ≤ 3.0V (Note3.)

* SET 0V ≤ V1(t) ≤ VDD(t)
HERE, V1(t), VDD(t) indicate the transitive state of V1, VDD when the power supply is turned ON or OFF

Note1. : Do not keep the interface signal high-impedance when power is on.
Note2. : Momentary Voltage Drop Time.
Note3. : Momentary Drop Voltage.

10.0 MECHANICAL CHARACTERISTICS

10.1 Dimensional Requirements

FIGURE 6 (located in Appendix) shows mechanical outlines for the model [HT14X13-102]. Other parameters are shown in Table 11.

<Table 11. Dimensional Parameters.>

Parameter	Specification	Unit
Active area	285.696 (H) ×214.272(V)	mm
Number of pixels	1024(H) ×768(V)	pixels
	(1 pixel = R + G + B dots)	
Pixel pitch	0.279(H) ×0.279(V)	mm
Pixel arrangement	RGB Vertical stripe	
Display colors	262,144	colors
Display mode	Normally white	
Dimensional outline	298.5±0.5(W) ×227.5±0.5(V) ×5.7(D)typ./6.0(D)max	mm
Weight	530 Typical	gram
Back-light	CCFL, Horizontal-lamp type	

10.2 Mounting

See FIGURE 6. (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 50cm from the screen with an overhead light level of 350lux.

11.0 RELIABLITY TEST

The Reliability test items and its conditions are shown in below.

<Table 12. Reliability test>

No	Test Items	Conditions
1	High temperature storage test	Ta = 60 ℃, 240 hrs
2	Low temperature storage test	Ta = -20 ℃, 240 hrs
3	High temperature & high humidity operation test	Ta = 50 ℃, 80%RH, 240hrs
4	High temperature operation test	Ta = 50 ℃, 240hrs
5	Low temperature operation test	Ta = 0 ℃, 240hrs
6	Thermal shock	Ta = -20 ℃ ↔ 60 ℃ (0.5 hr), 100 cycle
7	Vibration test (non-operating)	1.5G,10~500Hz for X,Y,Z axis 30 minutes for each axis
8	Shock test (non-operating)	50G,18msec,trapezoidal 220G,2msec,half sine
9	Electrostatic discharge test (non-operating)	Air : 150 pF, 330Ω, 15 KV Contact : 150 pF, 330Ω, 8 KV

12.0 HANDLING & CAUTIONS

(1) Cautions when taking out the module

- Pick the pouch only, when taking out module from a shipping package.

(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 back - light 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.

(3) Cautions for the operation

- When the module is operating, do not lose CLK, ENAB signals. If any one of these signals is lost, the LCD panel would be damaged.
- Obey the supply voltage sequence. If wrong sequence were applied, the module would be damaged.

(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.

(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.

(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 PACKING INFORMATION

HYDIS Provides the standard shipping container for customers, unless customer specifies their packing information.

14.0 APPENDIX

Figure 1. Measurement Set Up

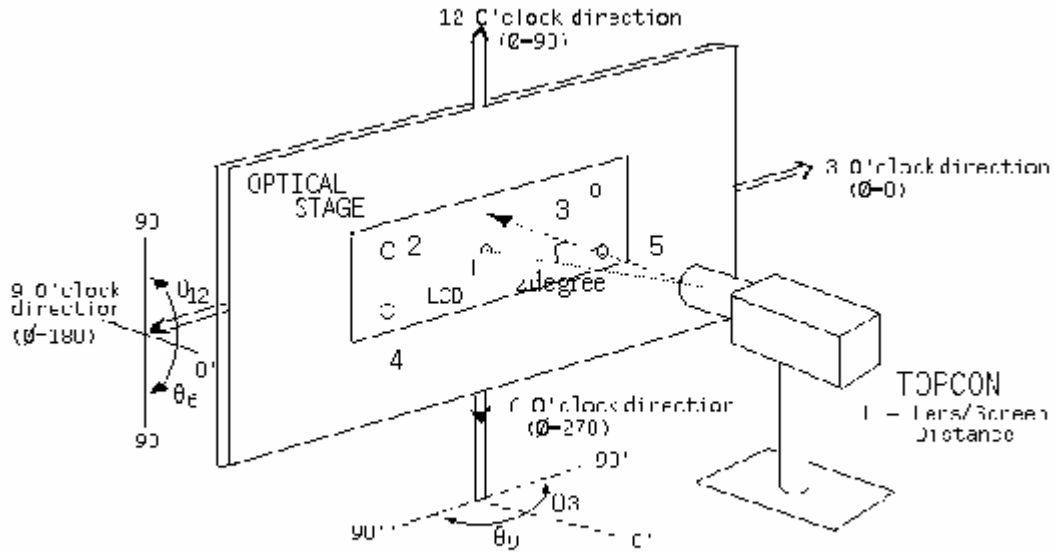


Figure 2. Average Luminance Measurement Locations

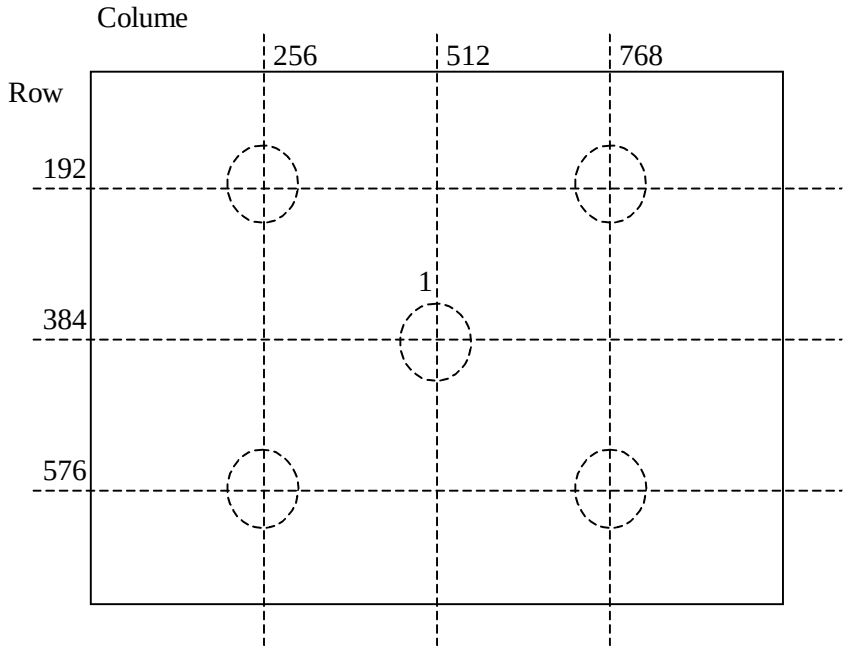


Figure 3. Uniformity Measurement Locations

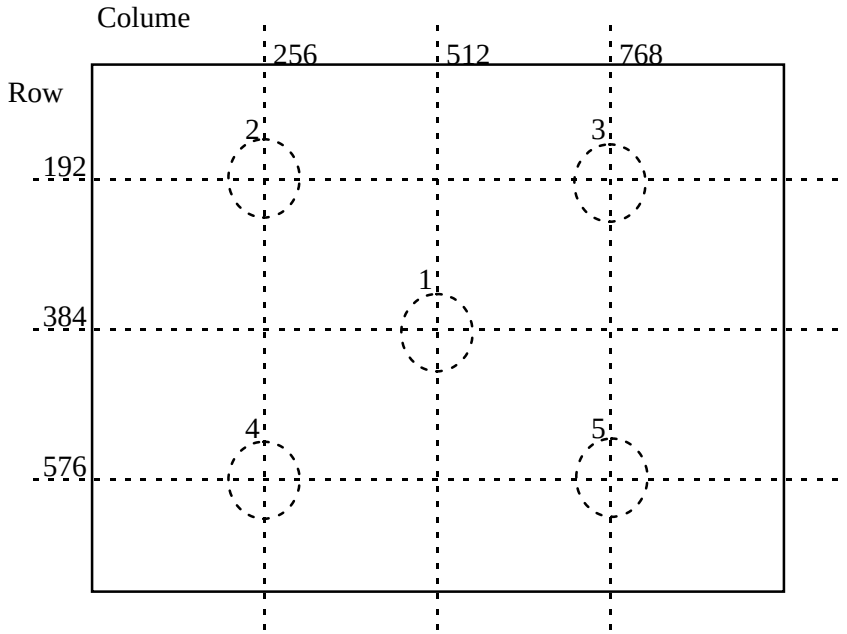


Figure 4. Response Time Testing

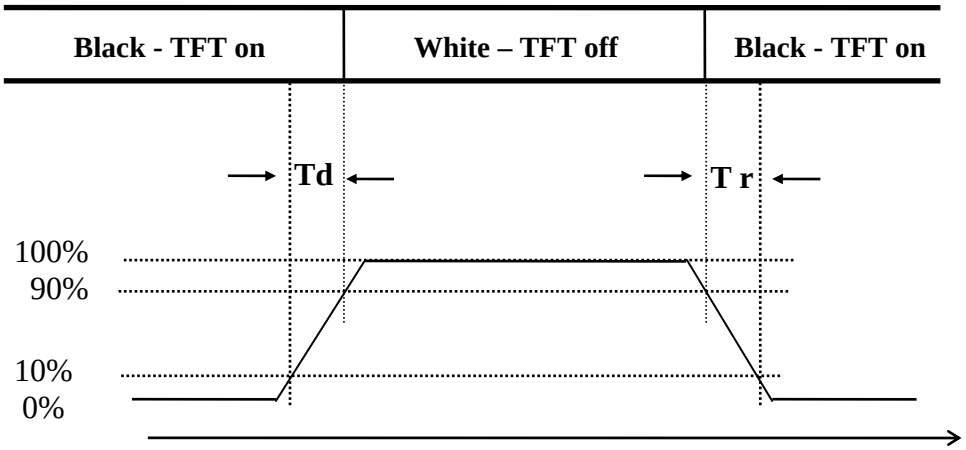
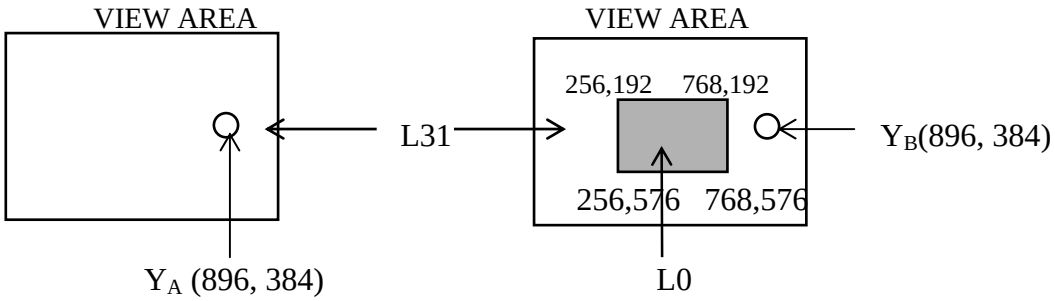


Figure 5. Cross Modulation Test Description



$$\text{Cross-Talk (\%)} = \left| \frac{Y_B - Y_A}{Y_B} \right| \times 100$$

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

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

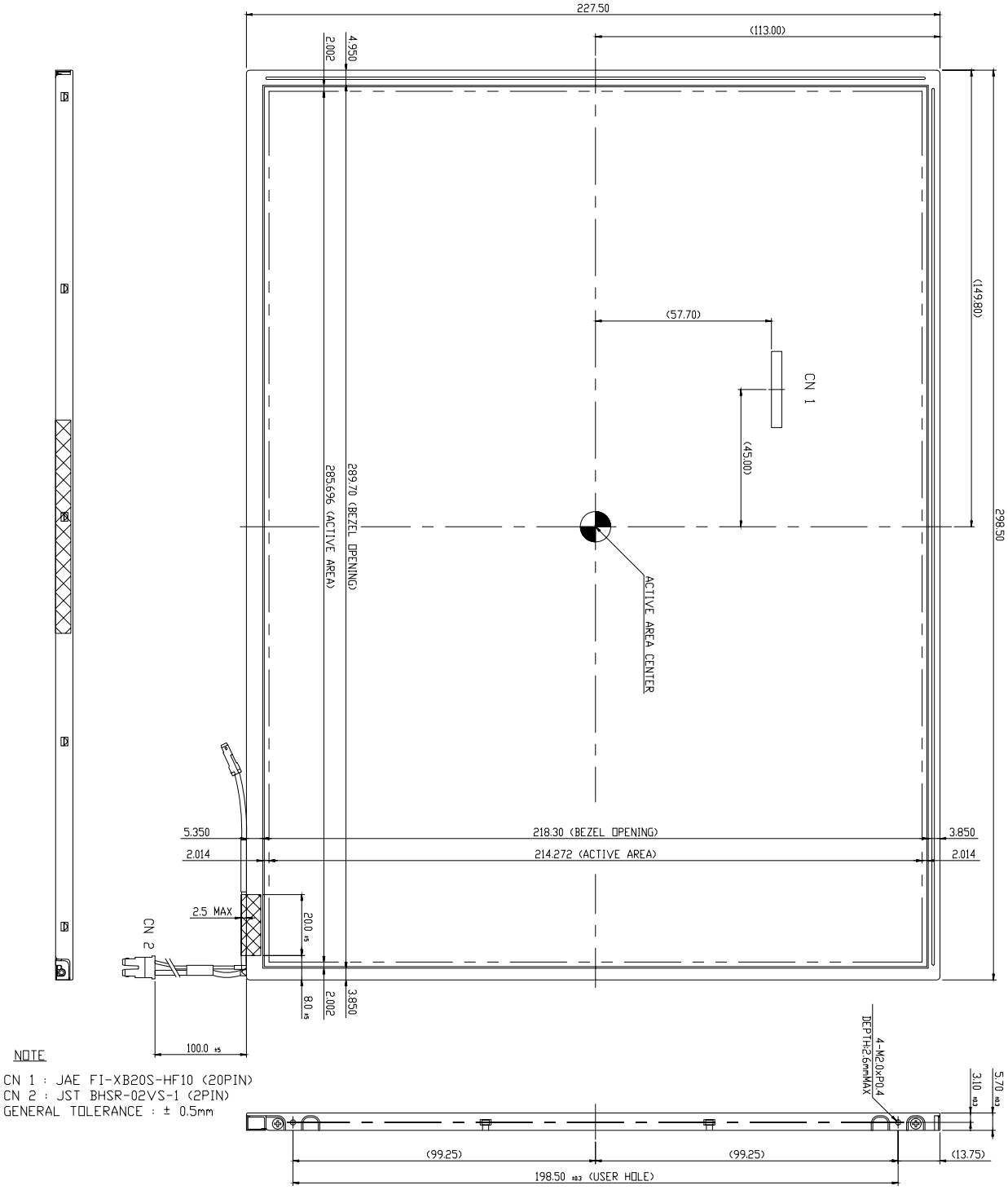


Figure 7. TFT-LCD Module Outline Dimensions (Back view)