

TFT LCD Tentative Specification

MODEL NO.: V470H1 – L03

LCD TV Head Division				
AVP	郭振隆			
QRA Dept.	TVHD/PDD			
	PDDI	PDDII	PDDIII	PDDIV
Approval	Approval	Approval	Approval	Approval
陳永一	蔡永裕	藍文錦	姚正宏	陳建宏
LCD TV Marketing and Project Management Dept.				
Product Manager	吳盈潔			

- CONTENTS -

REVISION HISTORY	3
1. GENERAL DESCRIPTION	4
1.1 OVERVIEW	
1.2 FEATURES	
1.3 APPLICATION	
1.4 GENERAL SPECIFICATIONS	
1.5 MECHANICAL SPECIFICATIONS	
2. ABSOLUTE MAXIMUM RATINGS	5
2.1 ABSOLUTE RATINGS OF ENVIRONMENT	
2.2 ELECTRICAL ABSOLUTE RATINGS	
2.2.1 TFT LCD MODULE	
2.2.2 BACKLIGHT INVERTER UNIT	
3. ELECTRICAL CHARACTERISTICS	7
3.1 TFT LCD MODULE	
3.2 BACKLIGHT UNIT	
3.2.1 CCFL (Cold Cathode Fluorescent Lamp) CHARACTERISTICS	
3.2.2 INVERTER CHARACTERISTICS	
3.2.3 INVERTER INTERFACE CHARACTERISTICS	
4. BLOCK DIAGRAM	13
4.1 TFT LCD MODULE	
5. V470H1-L03 LCD INPUT TERMINAL PIN ASSIGNMENT	14
5.1 TFT LCD MODULE LVDS input	
5.2 TFT LCD MODULE Power input	
5.3 BACKLIGHT UNIT	
5.4 INVERTER UNIT	
5.5 BLOCK DIAGRAM OF INTERFACE	
5.6 LVDS INTERFACE	
5.7 COLOR DATA INPUT ASSIGNMENT	
6. INTERFACE TIMING	22
6.1 INPUT SIGNAL TIMING SPECIFICATIONS	
6.2 POWER ON/OFF SEQUENCE	
7. OPTICAL CHARACTERISTICS	25
7.1 TEST CONDITIONS	
7.2 OPTICAL SPECIFICATIONS	
8. PRECAUTIONS	29
8.1 ASSEMBLY AND HANDLING PRECAUTIONS	
8.2 SAFETY PRECAUTIONS	
9. DEFINITION OF LABELS	30
10. MECHANICAL CHARACTERISTICS	31

1. GENERAL DESCRIPTION

1.1 OVERVIEW

V470H1-L03 is a 47" TFT Liquid Crystal Display module with 20-CCFL Backlight unit and 2ch-LVDS interface. This module supports 1920 x 1080 HDTV format and can display true 16.7M colors (8-bit/color).

The inverter module for backlight is built-in.

1.2 FEATURES

- High brightness (500nits)
- High contrast ratio (1500:1)
- Fast response time (Gray to Gray average 6.5 ms)
- High color saturation (72% NTSC)
- Full HDTV (1920 x 1080 pixels) resolution, true HDTV format
- DE (Data Enable) only mode
- LVDS (Low Voltage Differential Signaling) interface
- Optimized response time for 50/60 Hz frame rate
- Ultra wide viewing angle : Super MVA technology
- 180 degree rotation display option

1.3 APPLICATION

- Standard Living Room TVs.
- Public Display Application.
- Home Theater Application.
- MFM Application.

1.4 GENERAL SPECIFICATIONS

Item	Specification	Unit	Note
Active Area	1039.68(H) x 584.82(V) (47" diagonal)	mm	(1)
Bezel Opening Area	1050.6(H) x 594.4(V)	mm	
Driver Element	a-si TFT active matrix	-	-
Pixel Number	1920x R.G.B. x 1080	pixel	-
Pixel Pitch(Sub Pixel)	0.5415 (H) x 0.1805(V)	mm	-
Pixel Arrangement	RGB vertical stripe	-	-
Display Colors	16.7M	color	-
Display Operation Mode	Transmissive mode / Normally black	-	-
Surface Treatment	Anti-Glare coating (Haze 25%) Hard coating (3H)	-	(2)

Note (1) Please refer to the attached drawings in chapter 9 for more information about the front and back outlines.

Note (2) The spec of the surface treatment is temporarily for this phase. CMO reserves the rights to change this feature.

1.5 MECHANICAL SPECIFICATIONS

Item	Min.	Typ.	Max.	Unit	Note
Module Size	Horizontal (H)	-	1096	-	(1), (2)
	Vertical (V)	-	640	-	
	Depth (D)	50	51	52	
Weight	-	18500	-	g	-

Note (1) Please refer to the attached drawings for more information of front and back outline dimensions.

Note (2) Module Depth does not include connectors.

2. ABSOLUTE MAXIMUM RATINGS

2.1 ABSOLUTE RATINGS OF ENVIRONMENT

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Storage Temperature	T _{ST}	-20	+60	°C	(1)
Operating Ambient Temperature	T _{OP}	0	45	°C	(1), (2)
Shock (Non-Operating)	S _{NOP}	X, Y axis	50	G	(3), (5)
		Z axis	35	G	(3), (5)
Vibration (Non-Operating)	V _{NOP}	-	1.0	G	(4), (5)

Note (1) Temperature and relative humidity range is shown in the figure below.

(a) 90 %RH Max. ($T_a \leq 40^\circ\text{C}$).

(b) Wet-bulb temperature should be 39 °C Max. ($T_a > 40^\circ\text{C}$).

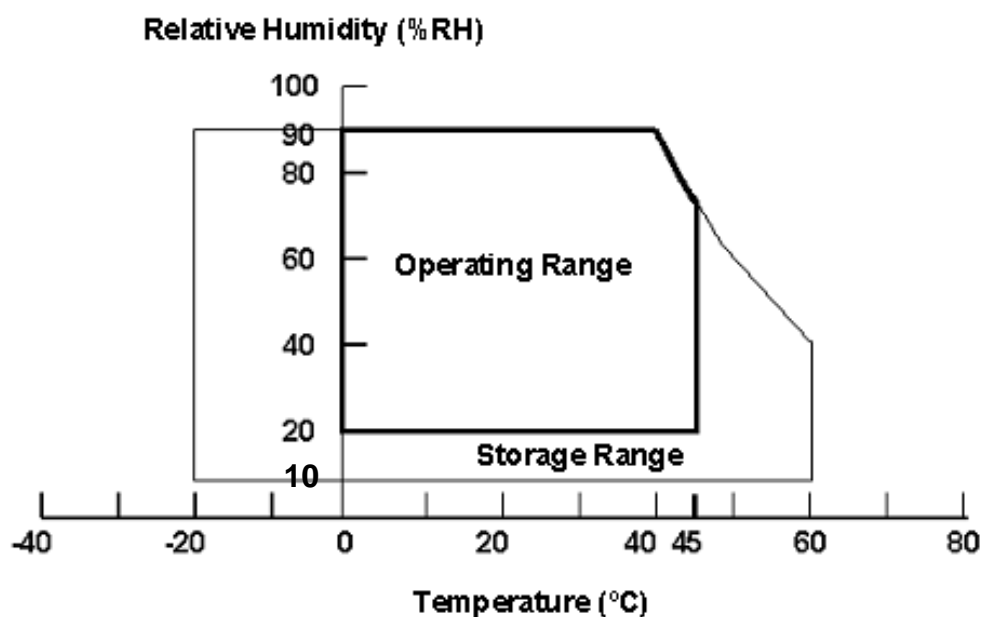
(c) No condensation.

Note (2) The maximum operating temperature is based on the test condition that the surface temperature of display area is less than or equal to 65 °C with LCD module alone in a temperature controlled chamber. Thermal management should be considered in your product design to prevent the surface temperature of display area from being over 65 °C. The range of operating temperature may degrade in case of improper thermal management in your product design.

Note (3) 11 ms, half sine wave, 1 time for $\pm X$, $\pm Y$, and $\pm Z$.

Note (4) 10 ~ 200 Hz, 10 min, 1 time each X, Y, Z.

Note (5) At testing Vibration and Shock, the fixture in holding the module has to be hard and rigid enough so that the module would not be twisted or bent by the fixture. The module would not be twisted or bent by the fixture.



2.2 ELECTRICAL ABSOLUTE RATINGS

2.2.1 TFT LCD MODULE

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Power Supply Voltage	V_{CC}	-0.3	13.5	V	(1)
Logic Input Voltage	V_{IN}	-0.3	3.6	V	

2.2.2 BACKLIGHT INVERTER UNIT

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Lamp Voltage	V_W	—	3000	V_{RMS}	
Power Supply Voltage	V_{BL}	0	30	V	(1)
Control Signal Level	—	-0.3	7	V	(1), (3)

Note (1) Permanent damage to the device may occur if maximum values are exceeded. Function operation should be restricted to the conditions described under Normal Operating Conditions.

Note (2) No moisture condensation or freezing.

Note (3) The control signals include On/Off Control, Internal PWM Control, External PWM Control and Internal/External PWM Selection.

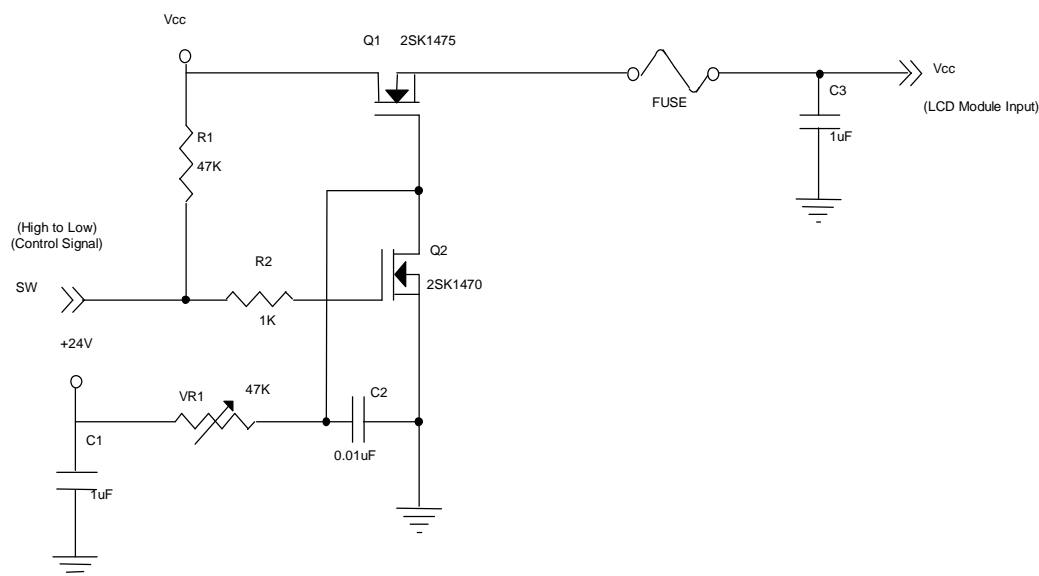
3. ELECTRICAL CHARACTERISTICS

3.1 TFT LCD MODULE ($T_a = 25 \pm 2^\circ\text{C}$)

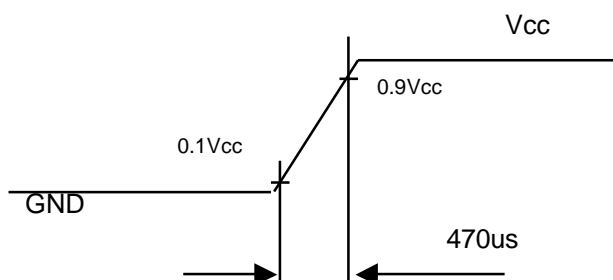
Parameter		Symbol	Value			Unit	Note
			Min.	Typ.	Max.		
Power Supply Voltage		V_{CC}	10.8	12	13.2	V	(1)
Power Supply Ripple Voltage		V_{RP}	-	-	200	mV	
Rush Current		I_{RUSH}	-	-	5.0	A	(2)
Power Supply Current	White	I_{CC}	-	1.7	2.0	A	(3)
	Black		-	0.6	-	A	
	Vertical Stripe		-	1.3	-	A	
LVDS Interface	Differential Input High Threshold Voltage	V_{LVTH}	-	-	+100	mV	
	Differential Input Low Threshold Voltage	V_{LVTL}	-100	-	-	mV	
	Common Input Voltage	V_{LVC}	1.125	1.25	1.375	V	
	Terminating Resistor	R_T	-	100	-	ohm	
CMOS interface	Input High Threshold Voltage	V_{IH}	2.7	-	3.3	V	
	Input Low Threshold Voltage	V_{IL}	0	-	0.7	V	

Note (1) The module should be always operated within the above ranges.

Note (2) Measurement condition:



Vcc rising time is 470us



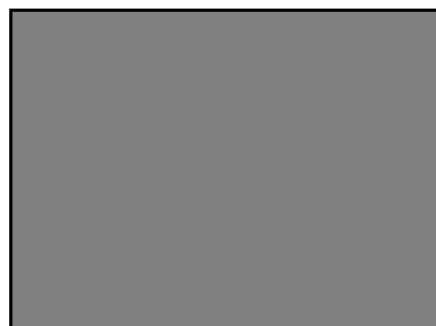
Note (3) The specified power supply current is under the conditions at $V_{cc} = 12V$, $T_a = 25 \pm 2 \text{ }^{\circ}C$, $f_v = 60 \text{ Hz}$, whereas a power dissipation check pattern below is displayed.

a. White Pattern



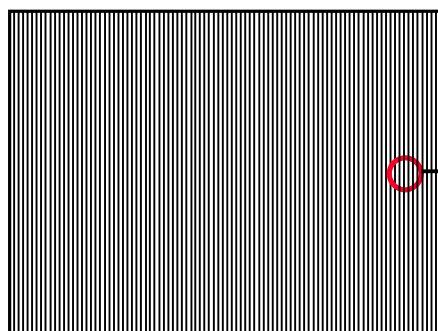
Active Area

b. Black Pattern

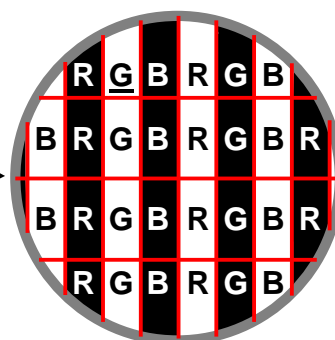


Active Area

c. Vertical Stripe Pattern



Active Area



3.2 BACKLIGHT UNIT

3.2.1 CCFL (Cold Cathode Fluorescent Lamp) CHARACTERISTICS (Ta = 25 ± 2 °C)

Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Lamp Input Voltage	V _L	-	1750	-	V _{RMS}	-
Lamp Current	I _L	5.5	6.0	6.5	mA _{RMS}	(1)
Lamp Turn On Voltage	V _S	-	-	2350	V _{RMS}	(2), Ta = 0 °C
		-	-	2150	V _{RMS}	(2), Ta = 25 °C
Operating Frequency	F _L	40	-	80	KHz	(3)
Lamp Life Time	L _{BL}	50,000	-	-	Hrs	(4)

3.2.2 INVERTER CHARACTERISTICS (Ta = 25 ± 2 °C)

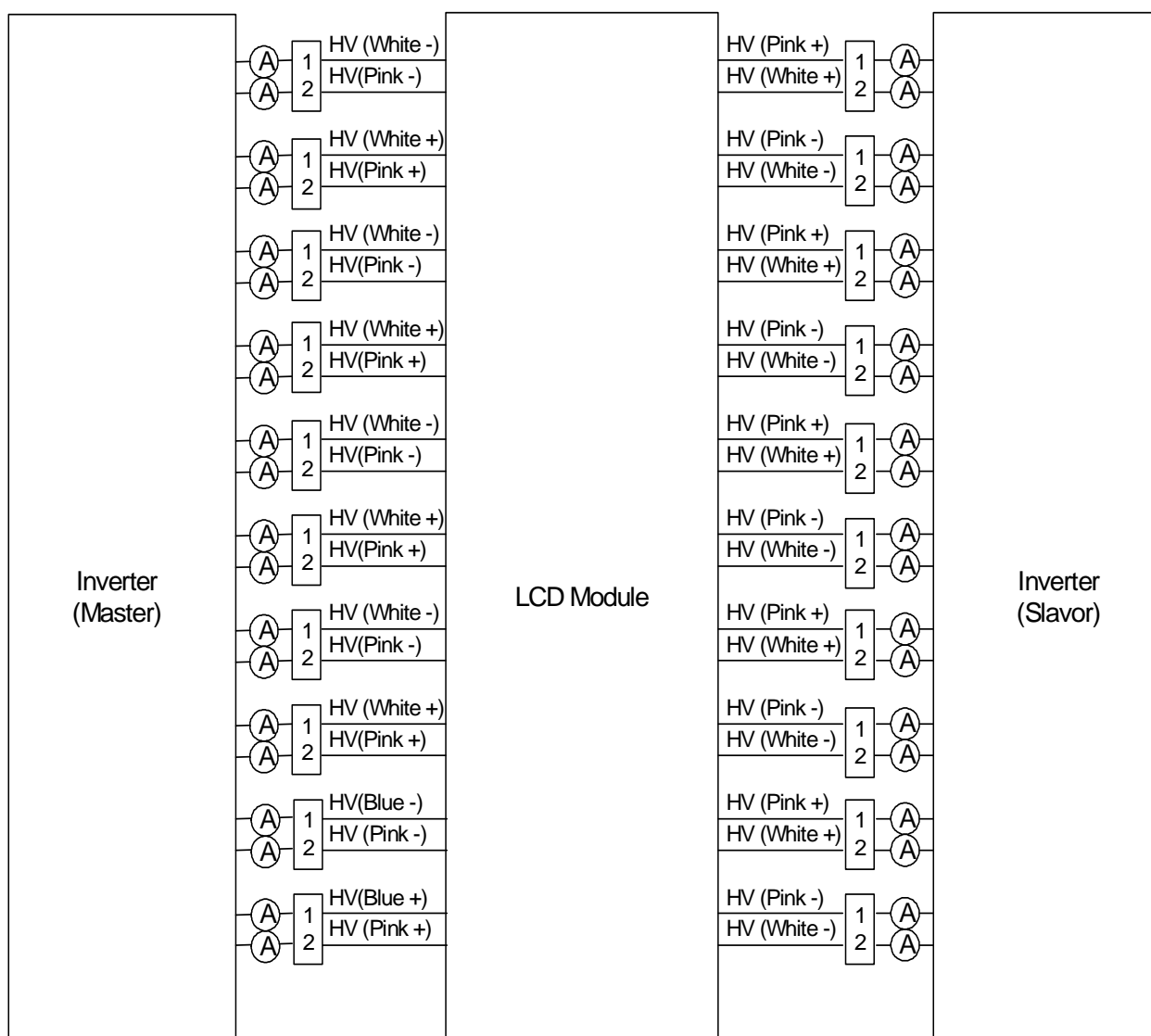
Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Power Consumption	P _{BL}	-	194.4	218	W	(3)(4), I _L = 6.0mA
Power Supply Voltage	V _{BL}	22.8	24	25.2	V _{DC}	
Power Supply Current	I _{BL}	-	8.1	9.1	A	Non Dimming
			8.9	10.5		Turn-on
Input Ripple Noise	-	-	-	500	mV _{P-P}	V _{BL} =22.8V
Backlight Turn on Voltage	V _{BS}	2350	-	-	V _{RMS}	Ta = 0 °C
		2150	-	-	V _{RMS}	Ta = 25 °C
Oscillating Frequency	F _W	44	47	50	kHz	
Dimming frequency	F _B	150	160	170	Hz	
Minimum Duty Ratio	D _{MIN}	-	20	-	%	

Note (1) Lamp current is measured by utilizing AC current probe and its value is average by measuring master and slave board.:

Note (2) The life time of a lamp is defined as when the brightness is larger than 50% of its original value and the effective discharge length is longer than 80% of its original length (Effective discharge length is defined as an area that has equal to or more than 70% brightness compared to the brightness at the center point of lamp.) as the time in which it continues to operate under the condition at Ta = 25 ± 2°C and I_L = 5.5 ~ 6.5 mA_{RMS}.

Note (3) The power supply capacity should be higher than the total inverter power consumption P_{BL}. Since the pulse width modulation (PWM) mode was applied for backlight dimming, the driving current changed as PWM duty on and off. The transient response of power supply should be considered for the changing loading when inverter dimming.

Note (4) The measurement condition of Max. value is based on 47" backlight unit under input voltage 24V, average lamp current 6.5 mA and lighting 30 minutes later.



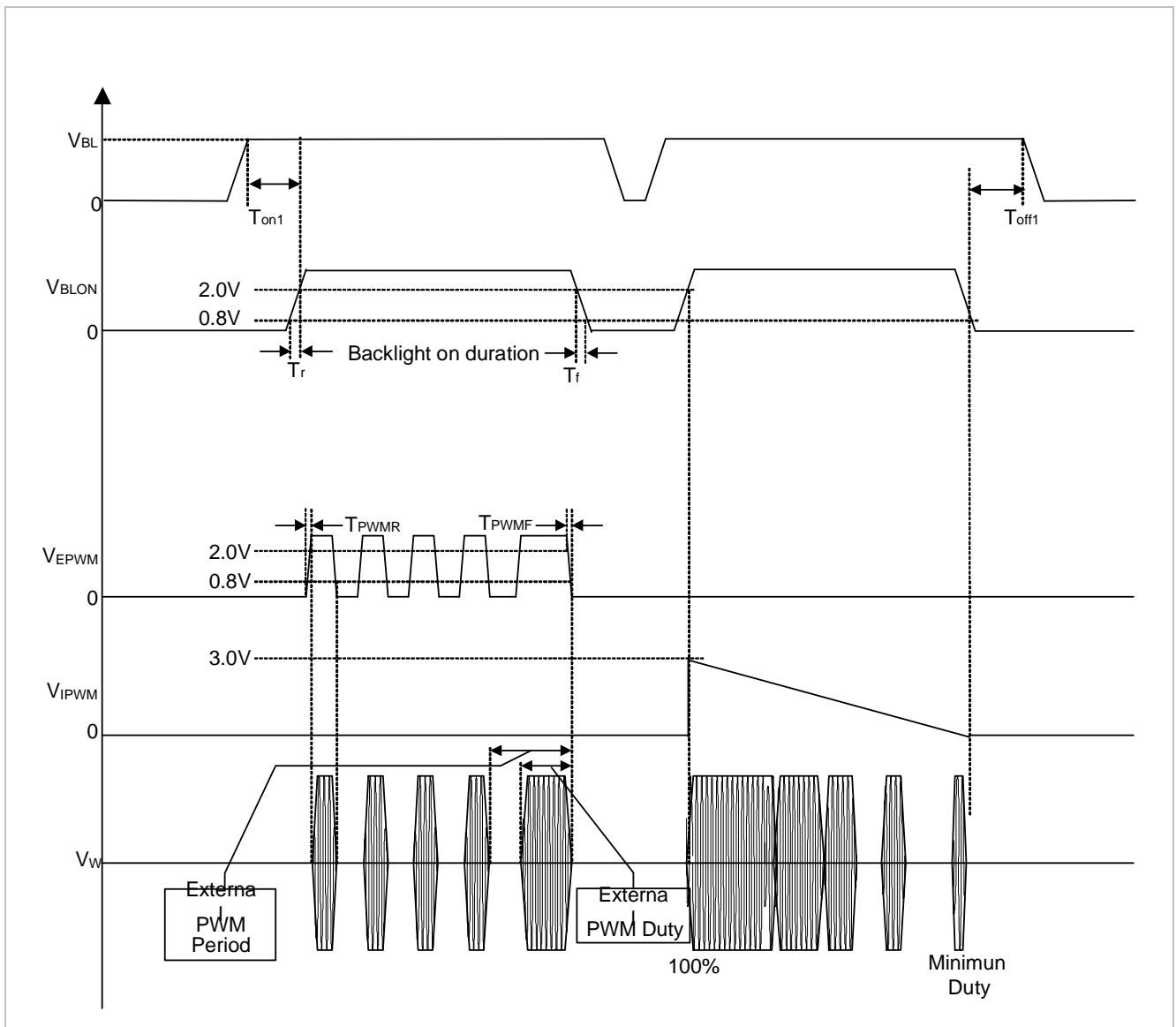
3.2.3 INVERTER INTERFACE CHARACTERISTICS

Parameter		Symbol	Test Condition	Value			Unit	Note
				Min.	Typ.	Max.		
On/Off Control Voltage	ON	V _{BLON}	—	2.0	—	5.0	V	
	OFF		—	0	—	0.8	V	
Status Signal		ERR	—	—	—	—	—	Normal: Open collector Abnormal: GND (Note 4)
Internal PWM Control Voltage	MAX	V _{IPWM}	V _{SEL} = L	2.85	3.0	3.15	V	maximum duty ratio
	MIN			—	0	—	V	minimum duty ratio
External PWM Control Voltage	HI	V _{EPWM}	V _{SEL} = H	2.0	—	5.0	V	duty on
	LO			0	—	0.8	V	duty off
Control Signal Rising Time		Tr	—	—	—	100	ms	
Control Signal Falling Time		Tf	—	—	—	100	ms	
PWM Signal Rising Time		T _{PWMR}	—	—	—	50	us	
PWM Signal Falling Time		T _{PWMF}	—	—	—	50	us	
Input impedance		R _{IN}	—	1	—	—	MΩ	
BLON Delay Time		T _{on}	—	1	—	—	ms	
BLON Off Time		T _{off}	—	1	—	—	ms	

Note (2) The power sequence and control signal timing are shown in the following figure.

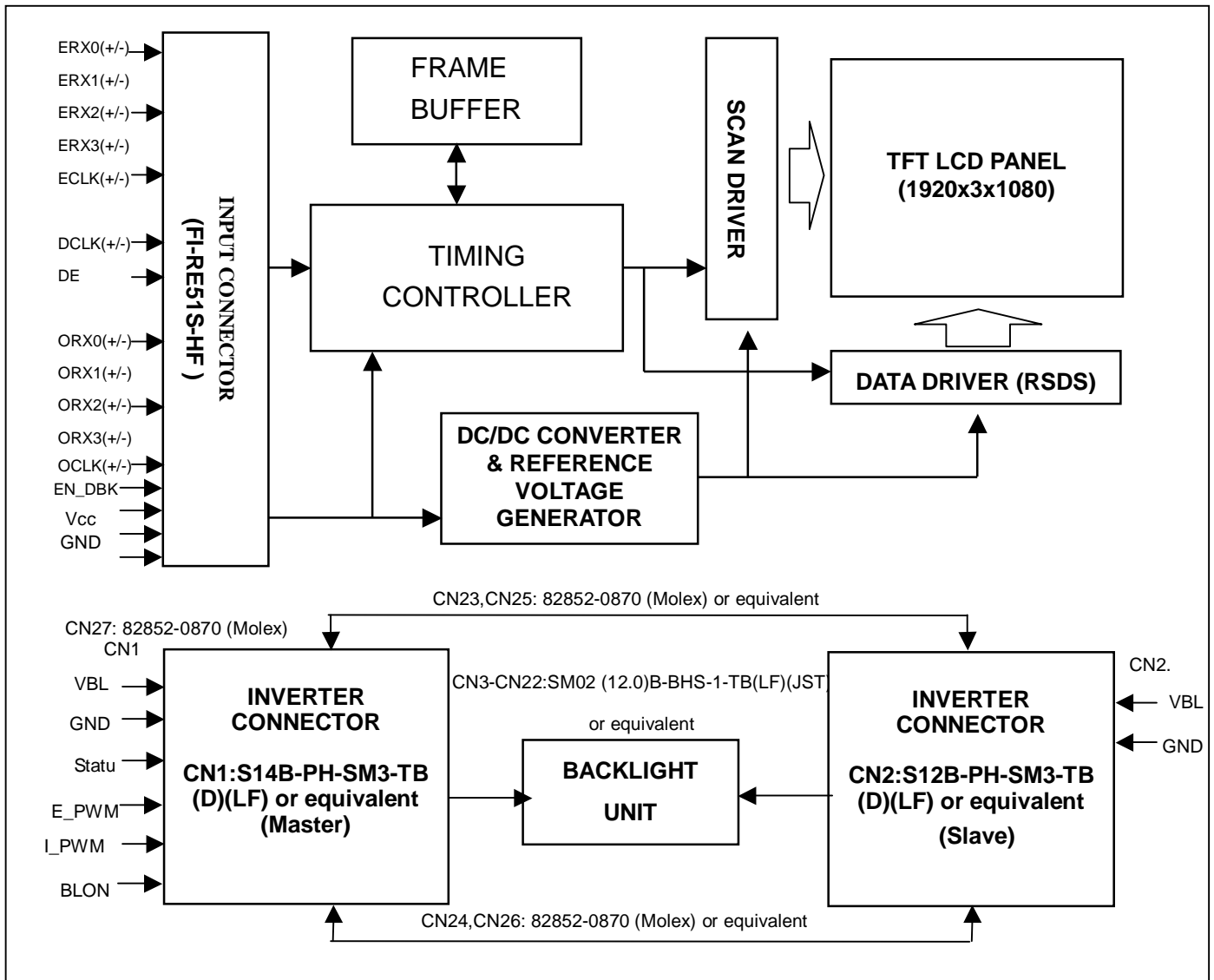
Note (3) The power sequence and control signal timing must follow the figure below. For a certain reason, the inverter has a possibility to be damaged with wrong power sequence and control signal timing.

Note (4) When inverter protective function is triggered, ERR will pull low



4. BLOCK DIAGRAM OF INTERFACE

4.1 TFT LCD MODULE



5. INPUT TERMINAL PIN ASSIGNMENT

5.1 TFT LCD Module

Pin	Name	Description	Note
1	N.C.	No Connection	(2)
2	N.C.	No Connection	(2)
3	N.C.	No Connection	(2)
4	N.C.	No Connection	(2)
5	N.C.	No Connection	(2)
6	N.C.	No Connection	(2)
7	N.C.	No Connection	(2)
8	RPF	Display Rotation	(3)
9	ODSEL	Overdrive Lookup Table Selection	(4)
10	N.C.	No Connection	(2)
11	EN_DBL	Enable Dynamic Backlight	
12	ORX0-	Odd pixel, Negative LVDS differential data input. Channel 0	
13	ORX0+	Odd pixel, Positive LVDS differential data input. Channel 0	
14	ORX1-	Odd pixel, Negative LVDS differential data input. Channel 1	
15	ORX1+	Odd pixel, Positive LVDS differential data input. Channel 1	
16	ORX2-	Odd pixel, Negative LVDS differential data input. Channel 2	
17	ORX2+	Odd pixel, Positive LVDS differential data input. Channel 2	
18	GND	Ground	
19	OCLK-	Odd pixel, Negative LVDS differential clock input.	
20	OCLK+	Odd pixel, Positive LVDS differential clock input.	
21	GND	Ground	
22	ORX3-	Odd pixel, Negative LVDS differential data input. Channel 3	
23	ORX3+	Odd pixel, Positive LVDS differential data input. Channel 3	
24	N.C.	No Connection	(2)
25	N.C.	No Connection	(2)
26	N.C.	No Connection	(2)
27	N.C.	No Connection	(2)
28	ERX0-	Even pixel, Negative LVDS differential data input. Channel 0	
29	ERX0+	Even pixel, Positive LVDS differential data input. Channel 0	
30	ERX1-	Even pixel, Negative LVDS differential data input. Channel 1	
31	ERX1+	Even pixel, Positive LVDS differential data input. Channel 1	
32	ERX2-	Even pixel, Negative LVDS differential data input. Channel 2	
33	ERX2+	Even pixel, Positive LVDS differential data input. Channel 2	
34	GND	Ground	
35	ECLK-	Even pixel, Negative LVDS differential clock input.	
36	ECLK+	Even pixel, Positive LVDS differential clock input.	
37	GND	Ground	
38	ERX3-	Even pixel, Negative LVDS differential data input. Channel 3	
39	ERX3+	Even pixel, Positive LVDS differential data input. Channel 3	
40	N.C.	No Connection	(2)
41	N.C.	No Connection	(2)
42	N.C.	No Connection	(2)
43	N.C.	No Connection	(2)
44	GND	Ground	
45	GND	Ground	
46	GND	Ground	
47	GND	Ground	
48	VCC	Power input (+12V)	

49	VCC	Power input (+12V)	
50	VCC	Power input (+12V)	
51	VCC	Power input (+12V)	

Note (1) Connector part no.: FI-RE51S-HF (JAE).

Mating part no.: FI-RE51HL (JAE).

Note (2) Please be reserved to open.

Note (3) Low : normal display (default), High : display with 180 degree rotation

Note (4) Overdrive lookup table selection. The overdrive lookup table should be selected in accordance to the frame rate to optimize image quality.

ODSEL	Note
L	Lookup table was optimized for 60 Hz frame rate.
H	Lookup table was optimized for 50 Hz frame rate.

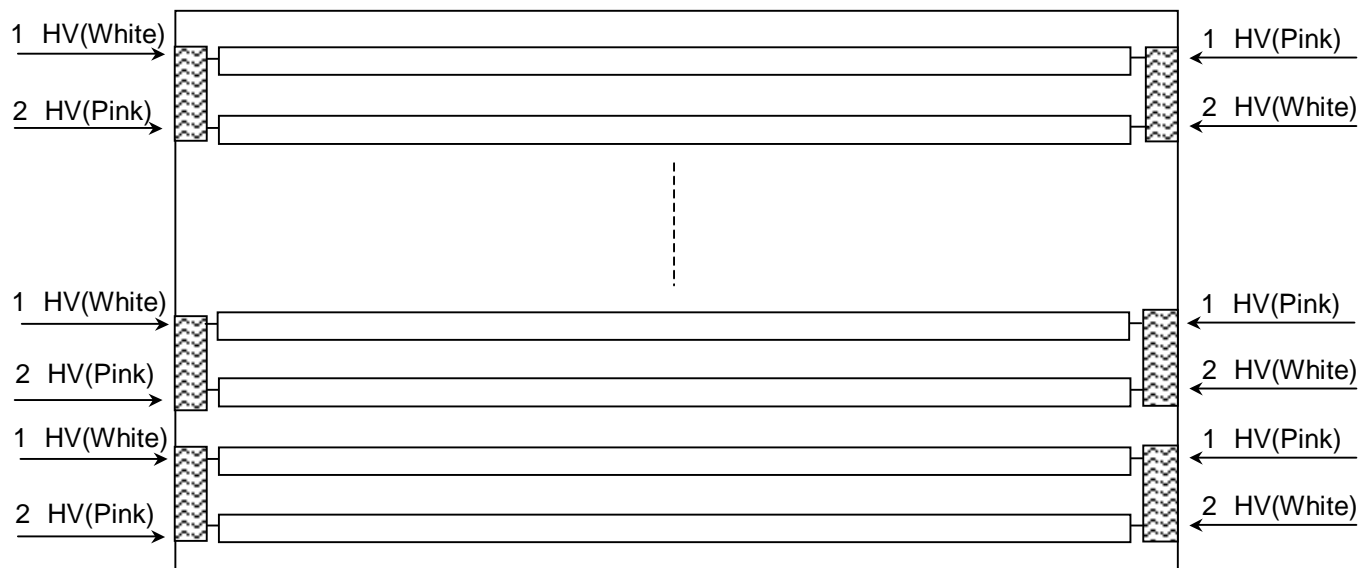
5.2 BACKLIGHT UNIT

The pin configuration for the housing and the leader wire is shown in the table below.

CN3-CN26: BHR-04VS-1 (JST).

Pin	Name	Description	Wire Color
1	HV	High Voltage	Pink
2	HV	High Voltage	White

Note (1) The backlight interface housing for high voltage side is a model BHR-04VS-1, manufactured by JST. The mating header on inverter part number is SM02 (12.0)B-BHS-1-TB(LF).



5.3 INVERTER UNIT

CN1 (Header): S14B-PH-SM3-TB (D)(LF)(JST) or equivalent.

Pin No.	Symbol	Description
1	VBL	+24V _{DC} power input
2		
3		
4		
5		
6	GND	GND
7		
8		
9		
10		
11	Status	Normal (Open collector) Abnormal (GND)
12	E_PWM	External PWM control signal
13	I_PWM	Internal PWM Control Signal
14	BLON	Backlight on/off control

Notice:

1. PIN 12:External PWM Control (Use Pin 12): Pin 13 must open.
2. PIN 13:Internal PWM Control (Use Pin 13): 0V~3.0V and Pin 12 must open.
3. Pin 12(E_PWM) and Pin 13(I_PWM) can't open in same period.

CN2 (Header): S12B-PH-SM3-TB (D)(LF)(JST) or equivalent.

Pin No.	Symbol	Description
1	VBL	+24V _{DC} power input
2		
3		
4		
5		
6	GND	GND
7		
8		
9		
10		
11	NC	NC
12	NC	NC

CN3-CN22 (Header): SM02(12.0)B-BHS-1-TB (LF)(JST) or equivalent

Pin No.	Symbol	Description
1	CCFL HOT	CCFL high voltage
2	CCFL HOT	CCFL high voltage

CN23-CN26 (Header): 7151-E20N (E&T) or equivalent

Pin No.	Symbol	Description
1	Control Signal	Board to Board
2		Board to Board
3		Board to Board
4		Board to Board
5		Board to Board
6		Board to Board
7		Board to Board
8		Board to Board
9		Board to Board
10		Board to Board

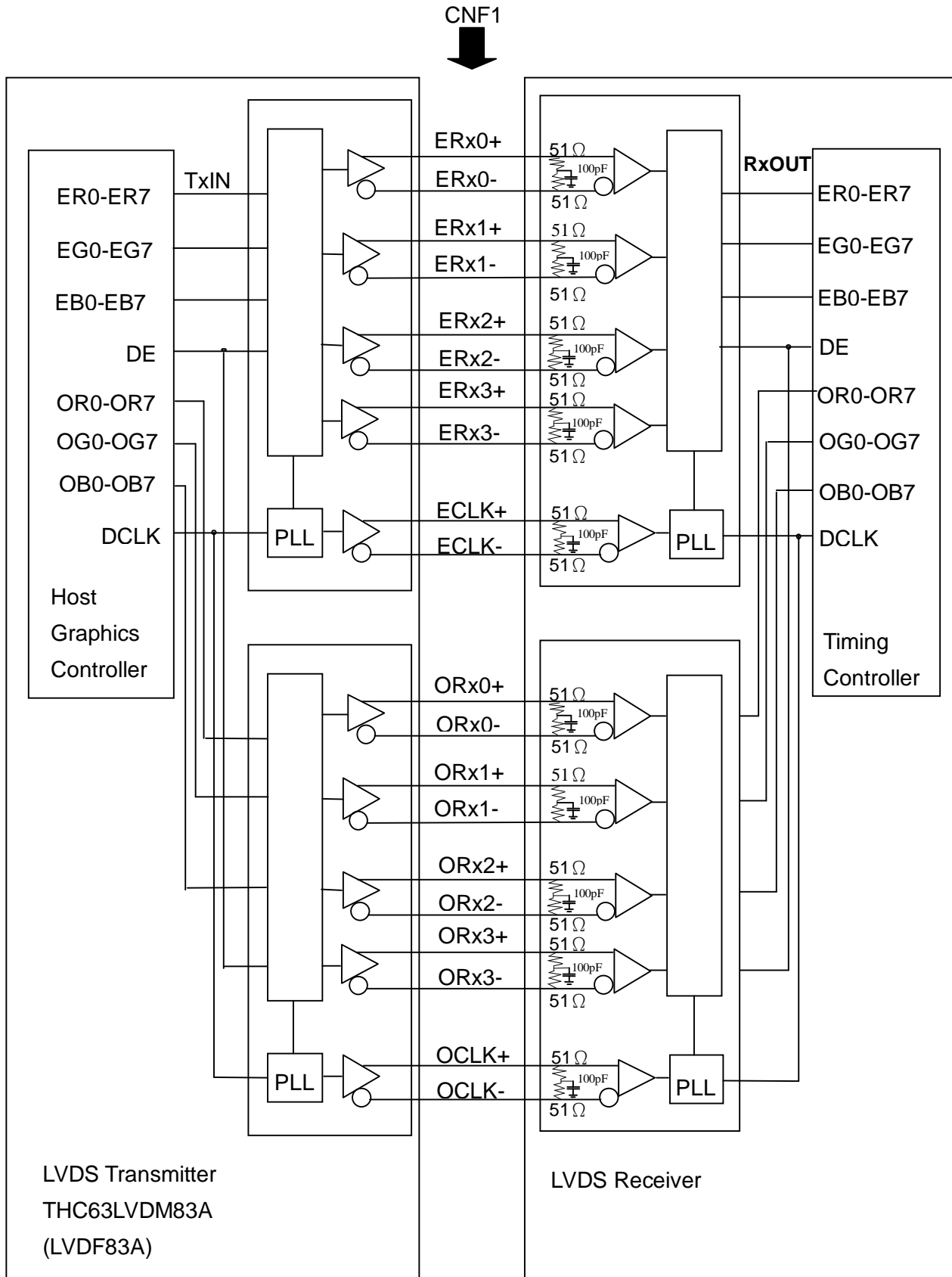
Note (1) Floating of any control signal is not allowed.

CN27: 7151-E08N (E&T) or equivalent

Pin No.	Symbol	Description
1	Control Signal	Board to Board
2		Board to Board
3		Board to Board
4		Board to Board
5		Board to Board
6		Board to Board
7		Board to Board
8		Board to Board

Note (1) Floating of any control signal is not allowed.

5.4 BLOCK DIAGRAM OF INTERFACE



ER0~ER7 : Even pixel R data

EG0~EG7 : Even pixel G data

EB0~EB7 : Even pixel B data

OR0~OR7 : Odd pixel R data

OG0~OG7 : Odd pixel G data

OB0~OB7 : Odd pixel B data

DE : Data enable signal

DCLK : Data clock signal

- Notes:
- (1) The system must have the transmitter to drive the module.
 - (2) LVDS cable impedance shall be 50 ohms per signal line or about 100 ohms per twist-pair line when it is used differentially.
 - (3) Two pixel data send into the module for every clock cycle. The first pixel of the frame is even pixel and the second pixel is odd pixel.

5.5 LVDS INTERFACE

	SIGNAL	TRANSMITTER THC63LVDM83A		INTERFACE CONNECTOR		RECEIVER THC63LVDF84A		TFT CONTROL INPUT
		PIN	INPUT	Host	TFT-LCD	PIN	OUTPUT	
24bit	R0	51	TxIN0	TA OUT0+	Rx 0+	27	Rx OUT0	R0
	R1	52	TxIN1			29	Rx OUT1	R1
	R2	54	TxIN2			30	Rx OUT2	R2
	R3	55	TxIN3			32	Rx OUT3	R3
	R4	56	TxIN4	TA OUT0-	Rx 0-	33	Rx OUT4	R4
	R5	3	TxIN6			35	Rx OUT6	R5
	G0	4	TxIN7			37	Rx OUT7	G0
	G1	6	TxIN8			38	Rx OUT8	G1
	G2	7	TxIN9	TA OUT1+	Rx 1+	39	Rx OUT9	G2
	G3	11	TxIN12			43	Rx OUT12	G3
	G4	12	TxIN13			45	Rx OUT13	G4
	G5	14	TxIN14			46	Rx OUT14	G5
	B0	15	TxIN15	TA OUT1-	Rx 1-	47	Rx OUT15	B0
	B1	19	TxIN18			51	Rx OUT18	B1
	B2	20	TxIN19			53	Rx OUT19	B2
	B3	22	TxIN20			54	Rx OUT20	B3
	B4	23	TxIN21	TA OUT2+	Rx 2+	55	Rx OUT21	B4
	B5	24	TxIN22			1	Rx OUT22	B5
	DE	30	TxIN26			6	Rx OUT26	DE
	R6	50	TxIN27			7	Rx OUT27	R6
	R7	2	TxIN5	TA OUT2-	Rx 2-	34	Rx OUT5	R7
	G6	8	TxIN10			41	Rx OUT10	G6
	G7	10	TxIN11			42	Rx OUT11	G7
	B6	16	TxIN16			49	Rx OUT16	B6
	B7	18	TxIN17	TA OUT3+	Rx 3+	50	Rx OUT17	B7
	RSVD 1	25	TxIN23			2	Rx OUT23	Not connect
	RSVD 2	27	TxIN24			3	Rx OUT24	Not connect
	RSVD 3	28	TxIN25			5	Rx OUT25	Not connect
	DCLK	31	TxCLK IN	TxCLK OUT+ TxCLK OUT-	RxCLK IN+ RxCLK IN-	26	RxCLK OUT	DCLK

R0~R7: Pixel R Data (7; MSB, 0; LSB)

G0~G7: Pixel G Data (7; MSB, 0; LSB)

B0~B7: Pixel B Data (7; MSB, 0; LSB)

DE : Data enable signal

DCLK : Data clock signal

Notes: (1) RSVD (reserved) pins on the transmitter shall be "H" or "L".

5.7 COLOR DATA INPUT ASSIGNMENT

The brightness of each primary color (red, green and blue) is based on the 8-bit gray scale data input for the color. The higher the binary input, the brighter the color. The table below provides the assignment of the color versus data input.

Color		Data Signal																							
		Red								Green								Blue							
		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
	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
	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
	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
	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
	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	Red (0) / Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (2)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Red (253)	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (254)	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 (255)	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	Green (0) / Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Green (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Green (253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
	Green (254)	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 (255)	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	Blue (0) / Dark	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 (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Blue (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue (253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	Blue (254)	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 (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

Note (1) 0: Low Level Voltage, 1: High Level Voltage

6. INTERFACE TIMING

6.1 INPUT SIGNAL TIMING SPECIFICATIONS

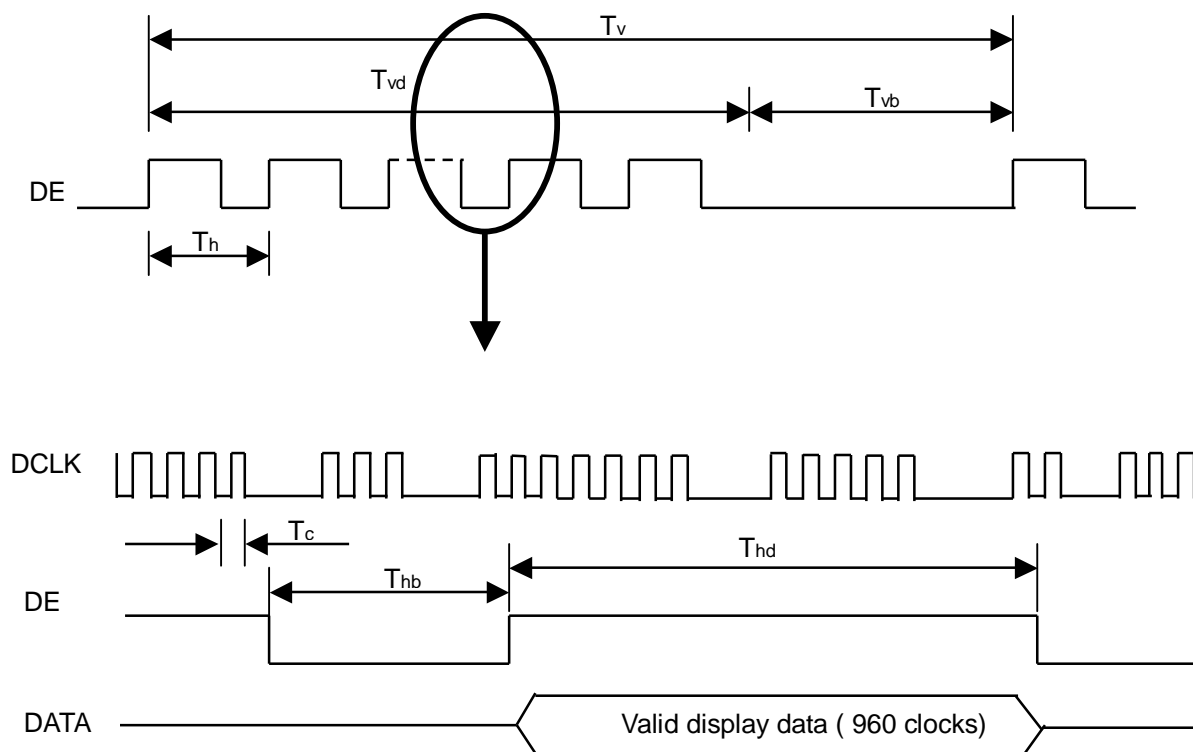
The input signal timing specifications are shown as the following table and timing diagram.

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
LVDS Receiver Clock	Frequency	$1/T_c$	60	74	80	MHz	-
	Input cycle to cycle jitter	Trcl	-	-	200	ps	-
LVDS Receiver Data	Setup Time	Tlvsu	600	-	-	ps	
	Hold Time	Tlvhd	600	-	-	ps	
Vertical Active Display Term	Frame Rate	Fr5	47	50	53	Hz	(1)
		Fr6	57	60	63	Hz	(2)
	Total	Tv	1115	1125	1139	Th	$T_v = T_{vd} + T_{vb}$
	Display	Tvd	1080	1080	1080	Th	-
	Blank	Tvb	35	45	59	Th	-
Horizontal Active Display Term	Total	Th	2100	2200	2300	Tc	$T_h = T_{hd} + T_{hb}$
	Display	Thd	1920	1920	1920	Tc	-
	Blank	Thb	180	280	380	Tc	-

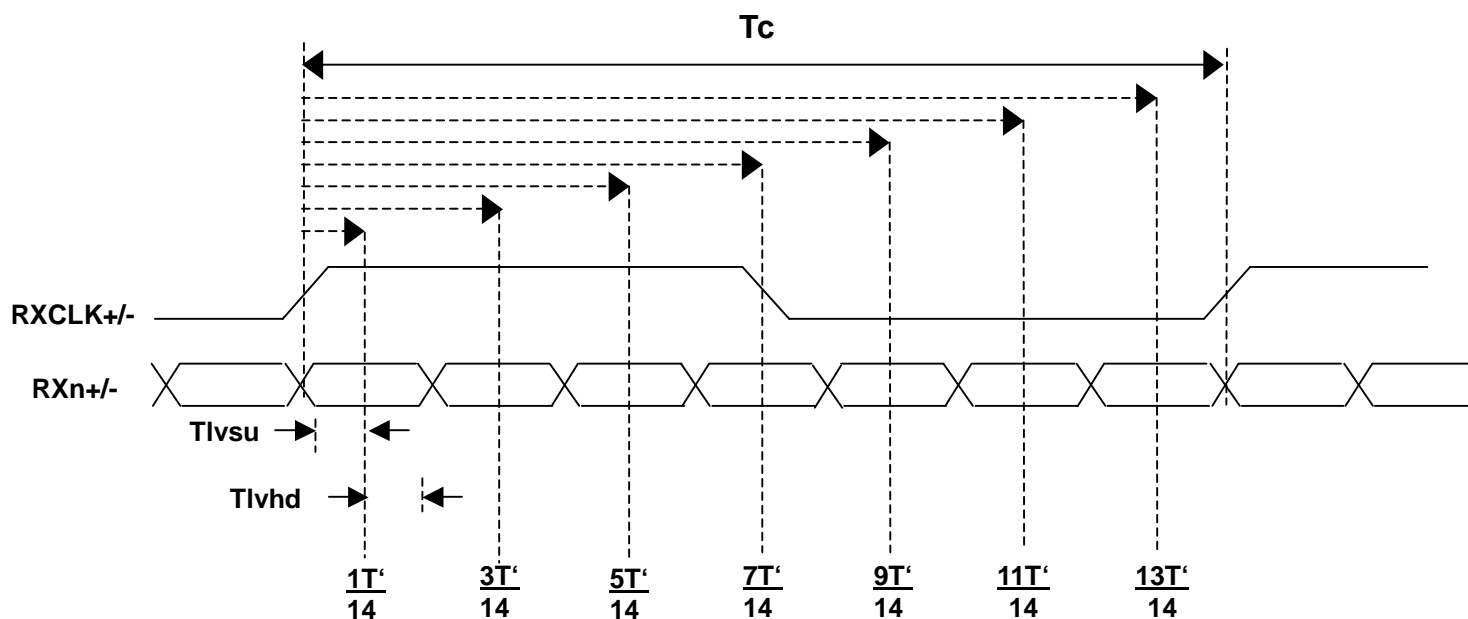
Note (1) (ODSEL) = (H). Please refer to 5.1 for detail information.

(2) (ODSEL) = (L). Please refer to 5.1 for detail information.

INPUT SIGNAL TIMING DIAGRAM

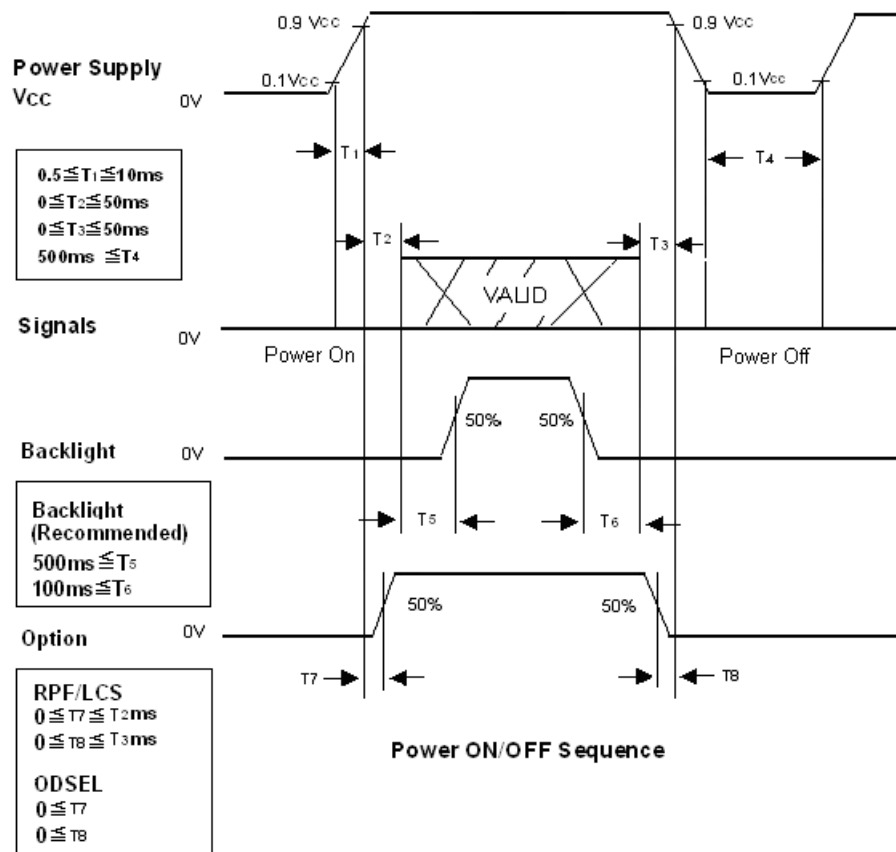


LVDS INPUT INTERFACE TIMING DIAGRAM



6.2 POWER ON/OFF SEQUENCE

To prevent a latch-up or DC operation of LCD module, the power on/off sequence should follow the diagram below.



Note.

- (1) The supply voltage of the external system for the module input should follow the definition of V_{CC}.
- (2) Apply the lamp voltage within the LCD operation range. When the backlight turns on before the LCD operation or the LCD turns off before the backlight turns off, the display may momentarily become abnormal screen. There is no reliability issue when the T5, T6 timing missing the range.
- (3) In case of VCC is in off level, please keep the level of input signals on the low or high impedance.
- (4) T4 should be measured after the module has been fully discharged between power off and on period.
- (5) Interface signal shall not be kept at high impedance when the power is on.

7. OPTICAL CHARACTERISTICS

7.1 TEST CONDITIONS

Item	Symbol	Value	Unit
Ambient Temperature	Ta	25±2	°C
Ambient Humidity	Ha	50±10	%RH
Supply Voltage	V _{CC}	12V	V
Input Signal	According to typical value in "3. ELECTRICAL CHARACTERISTICS"		
Lamp Current	I _L	6.0±0.5	mA
Oscillating Frequency (Inverter)	F _W	47±2	KHz
Vertical Frame Rate	Fr	60	Hz

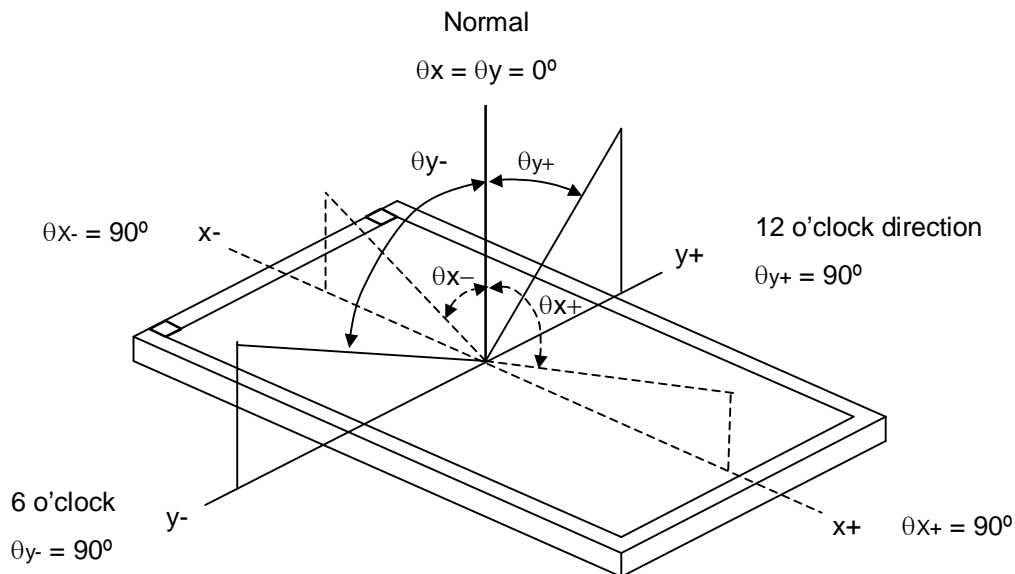
7.2 OPTICAL SPECIFICATIONS

The relative measurement methods of optical characteristics are shown in 7.2. The following items should be measured under the test conditions described in 7.1 and stable environment shown in Note (6).

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio		CR	$\theta_x=0^\circ, \theta_Y=0^\circ$ Viewing Normal Angle		(1500)	-	-	Note (2)
Response Time		Gray to gray		-	6.5		ms	Note (3)
Center Luminance of White		L _C			(500)	-	cd/m ²	Note (4)
White Variation		δW		-	-	1.3	-	Note (7)
Cross Talk		CT		-	-	4	%	Note (5)
Color Chromaticity	Red	R _x		Typ.- 0.03	(0.641)	Typ.+ 0.03	-	Note (6)
		R _y			(0.331)		-	
	Green	G _x			(0.275)		-	
		G _y			(0.589)		-	
	Blue	B _x			(0.143)		-	
		B _y			(0.068)		-	
	White	W _x			0.280		-	
		W _y			0.285		-	
	Color Gamut				(72)		-	
Viewing Angle	Horizontal	θ _{x+}	CR≥20	80	88	-	Deg.	Note (1)
		θ _{x-}		80	88	-		
	Vertical	θ _{y+}		80	88	-		
		θ _{y-}		80	88	-		

Note (1) Definition of Viewing Angle (θ_x, θ_y):

Viewing angles are measured by Eldim EZ-Contrast 160R



Note (2) Definition of Contrast Ratio (CR):

The contrast ratio can be calculated by the following expression.

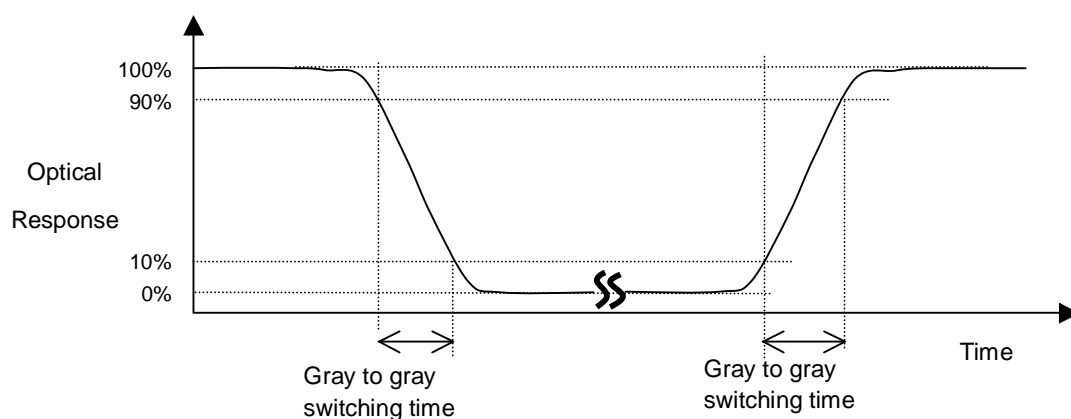
$$\text{Contrast Ratio (CR)} = L_{255} / L_0$$

L255: Luminance of gray level 255

L 0: Luminance of gray level 0

CR = CR (5), where CR (X) is corresponding to the Contrast Ratio of the point X at the figure in Note (7)

Note (3) Definition of Gray to Gray Switching Time :



The driving signal means the signal of gray level 0, 63, 127, 191, and 255.

Gray to gray average time means the average switching time of gray level 0, 63, 127, 191, 255 to each other.

Note (4) Definition of Luminance of White (L_C):

Measure the luminance of gray level 255 at center point.

$L_C = L(5)$, where $L(x)$ is corresponding to the luminance of the point X at the figure in Note (7).

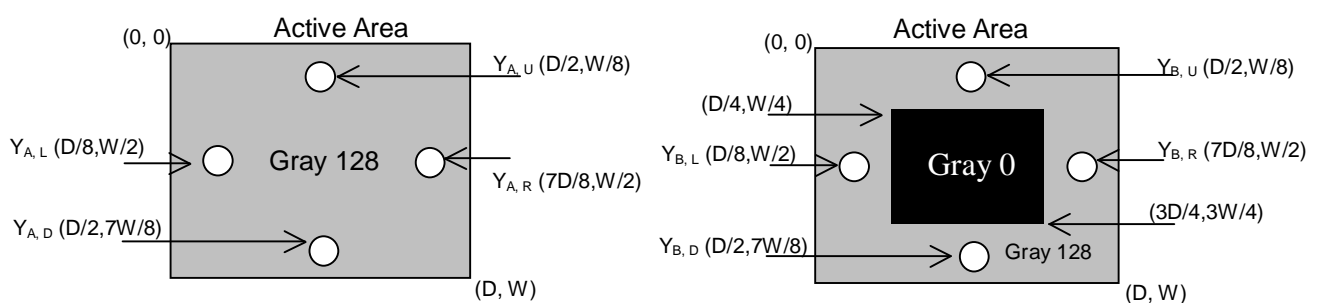
Note (5) Definition of Cross Talk (CT):

$$CT = |Y_B - Y_A| / Y_A \times 100 (\%)$$

Where:

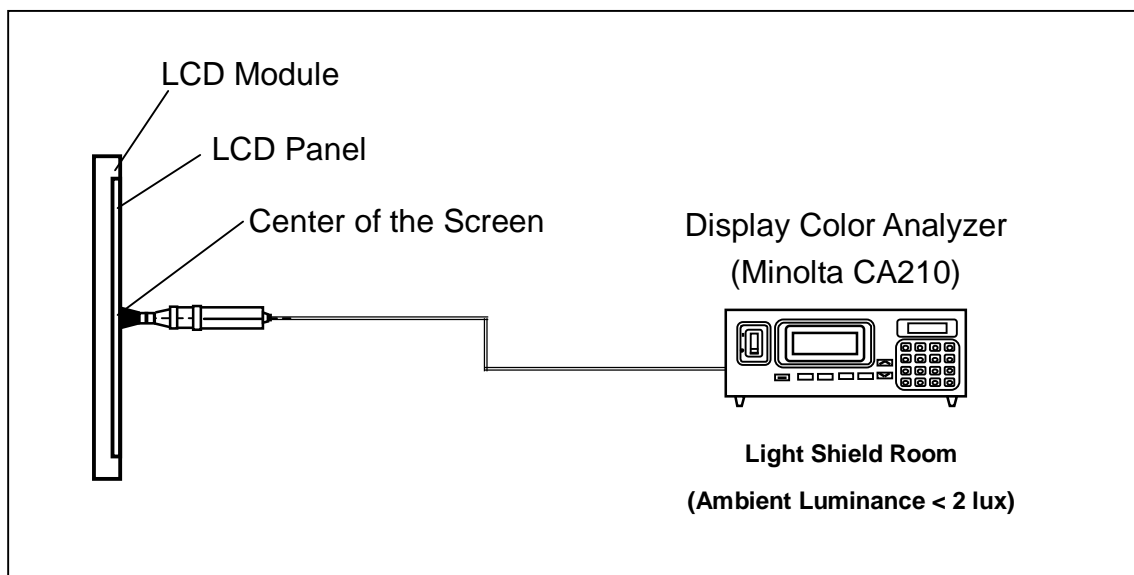
Y_A = Luminance of measured location without gray level 0 pattern (cd/m^2)

Y_B = Luminance of measured location with gray level 0 pattern (cd/m^2)



Note (6) Measurement Setup:

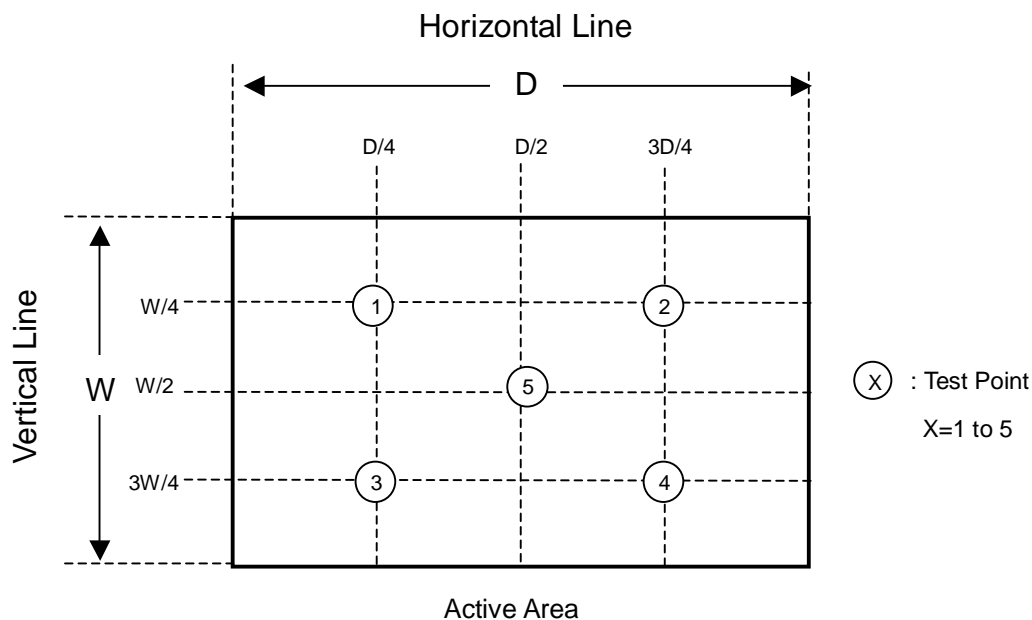
The LCD module should be stabilized at given temperature for 1 hour to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting backlight for 1 hour in a windless room.



Note (7) Definition of White Variation (δW):

Measure the luminance of gray level 255 at 5 points

$$\delta W = \text{Maximum } [L(1), L(2), L(3), L(4), L(5)] / \text{Minimum } [L(1), L(2), L(3), L(4), L(5)]$$



8. PRECAUTIONS

8.1 ASSEMBLY AND HANDLING PRECAUTIONS

- (1) Do not apply rough force such as bending or twisting to the module during assembly.
- (2) It is recommended to assemble or to install a module into the user's system in clean working areas. The dust and oil may cause electrical short or worsen the polarizer.
- (3) Do not apply pressure or impulse to the module to prevent the damage of LCD panel and Backlight.
- (4) Always follow the correct power-on sequence when the LCD module is turned on. This can prevent the damage and latch-up of the CMOS LSI chips.
- (5) Do not plug in or pull out the I/F connector while the module is in operation.
- (6) Do not disassemble the module.
- (7) Use a soft dry cloth without chemicals for cleaning, because the surface of polarizer is very soft and easily scratched.
- (8) Moisture can easily penetrate into LCD module and may cause the damage during operation.
- (9) High temperature or humidity may deteriorate the performance of LCD module. Please store LCD modules in the specified storage conditions.
- (10) When ambient temperature is lower than 10°C, the display quality might be reduced. For example, the response time will become slow, and the starting voltage of CCFL will be higher than that of room temperature.

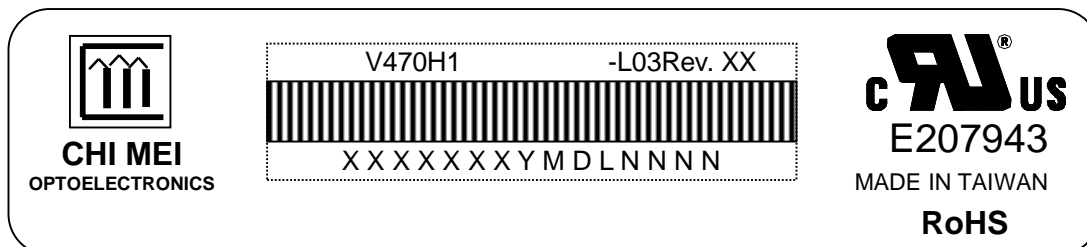
8.2 SAFETY PRECAUTIONS

- (1) The startup voltage of a Backlight is approximately 1000 Volts. It may cause an electrical shock while assembling with the inverter. Do not disassemble the module or insert anything into the Backlight unit.
- (2) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, skin or clothes, it has to be washed away thoroughly with soap.
- (3) After the module's end of life, it is not harmful in case of normal operation and storage.

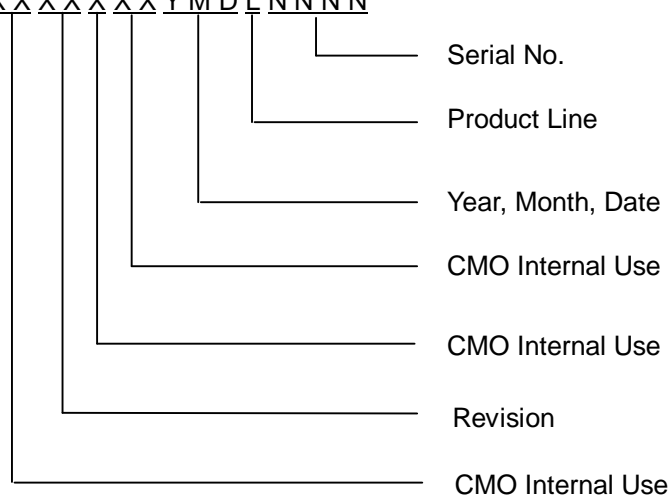
9. DEFINITION OF LABELS

9.1 CMO MODULE LABEL

The barcode nameplate is pasted on each module as illustration, and its definitions are as following explanation.



- (a) Model Name: V470H1-L03
- (b) Revision: Rev. XX, for example: A0, A1... B1, B2... or C1, C2...etc.
- (c) Serial ID: X X X X X X Y M D L N N N N



Serial ID includes the information as below:

- (a) Manufactured Date: Year: 0~9, for 2000~2009
Month: 1~9, A~C, for Jan. ~ Dec.
Day: 1~9, A~Y, for 1st to 31st, exclude I ,O, and U.
- (b) Revision Code: Cover all the change
- (c) Serial No.: Manufacturing sequence of product
- (d) Product Line: 1 -> Line1, 2 -> Line 2, ...etc.

11. MECHANICAL CHARACTERISTIC

