Product Information

ISSUE DATE   : 2002-06-26

MODEL   : LTM190U1-L02

Samsung Electronics Co . , LTD.

<u>Contents</u>

General Description

* Description

LTM190U1-L02 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 19.0" contains 1600 x 1200 pixels and can display up to 256 gray colors with wide viewing angle of 85° or higher in all directions. (Vertical viewing angle : 170° , Horizontal viewing angle : 170°)

* Features

- High contrast ratio, high aperture structure
- PVA (Patterned Vertical Alignment) mode
- Wide viewing angle
- High speed response
- UXGA(1600 x 1200 pixels) resolution
- Low power consumption
- 2 triple CCFTs (Cold Cathode Fluorescent Tube)
- DE only mode
- LVDS(Low Voltage Differential Signaling) Interface

* Applications

Workstation & desktop monitors
Display terminals for industrial and medical application products
Desktop Publishing(DTP) Monitors

* General information

Items	Specification	Unit	Note
Display area	386.4(H) * 289.8(V) (19.0")	mm	
Driver element	a-Si TFT Active matrix		
Display colors	256	gray colors	
Number of pixels	1,600 * 1,200	pixel	
Pixel arrangement	Vertical Stripe		
Pixel pitch	0.2415(H) × 0.2415(V)	mm	
Display mode	Normally Black		
Surface treatment	Haze 25% , Hard-Coating (3H)		

* Mechanical information

Item		Min.	Typ.	Max.	Note
Module size	Horizontal(H)	414.5	415.0	415.5	mm
	Vertical(V)	325.5	326.0	326.5	mm
	Depth(D)	-	-	26.5	mm
Weight		-	-	3,100	g

1. Absolute Maximum Ratings

1.1 Absolute ratings of environment

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T_{STG}	-20	65	℃	(1)
Operating temperature (Ambient temperature)	T_{OPR}	0	50	℃	(1)
Shock (non - operating)	Snop	-	50	G	(2),(4)
Vibration (non - operating)	Vnop	-	1.5	G	(3),(4)

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

　　　　90 % RH Max. (40 °C ≥ Ta)

　　　　Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C) No condensation.

(2) 11ms, sine wave, one time for ±X, ±Y, ±Z axis

(3) 10-300 Hz, Sweep rate 10min, 30min for X,Y,Z axis

(4) At vibration and shock test, the fixture which holds the module to be tested has to be hard and rigid enough so that the module would neither be twisted nor bent by the fixture.

| Doc . No | PI001_LTM190U1-L02 | Page | 4 / 23 |
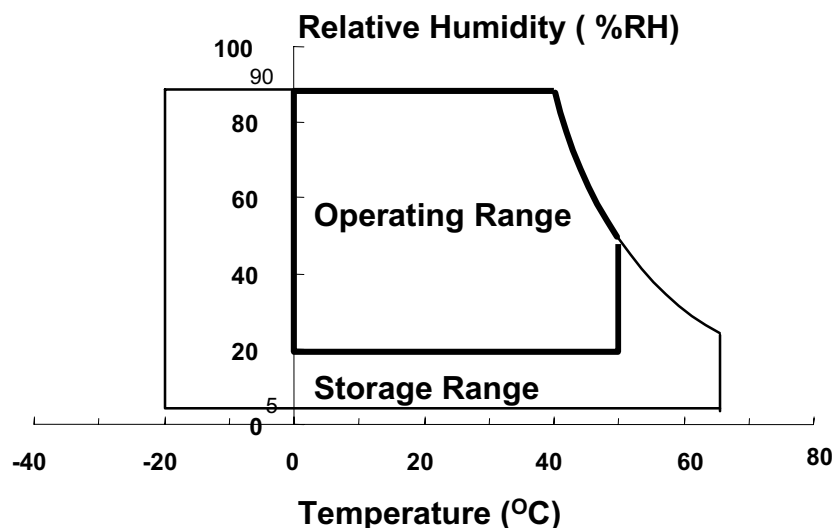
1.2 ELECTRICAL   ABSOLUTE   RATINGS

(1) TFT LCD Module   (Vss = GND = 0 V)

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	VDD	Vss-0.5	6.5	V	(1)

NOTE (1)   Within Ta (25 ± 2 °C)

(2) BACK-LIGHT UNIT   (Ta = 25 ± 2°C)

Item	Symbol	Min.	Max.	Unit.	Note
Lamp Current	IL	2.0	7.0	mArms	(1),(2)
Lamp Frequency	fL	30	80	kHz	(1)

NOTE (1)   Permanent   damage to the device may occur if maximum values are exceeded.
Functional operation should be restricted to the conditions described under Normal
Operating Conditions.
   (2)   Specified values are for a single lamp (Refer to the Note (1) in the page 11 for
further information).

2. Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (1).

Measuring equipment : TOPCON BM-5A , BM-7, PHOTO RESEARCH PR650

Eldim EZ-Contrast

(Inverter Freq. : 54kHz)   * Ta = 25 ± 2°C,   VDD=5V,   fv= 60Hz,   fDCLK=54MHz,   IL = (5.5)mArms

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R	Normal f = 0 q = 0 Viewing Angle	(650)	(700)	-		(3) BM-5A
Response Time	Rising	Tr		-	15	20	msec	(4)
	Falling	Tf		-	10	15		BM-7
Luminance of White (Center of screen)		YL		(600)	(700)	-	cd/m2	(5) BM-5A
Color Chromaticity (CIE 1931)	White	Wx		TYP -0.03	(0.310)	TYP -0.03		(6) PR650
		Wy			(0.330)			
Viewing Angle	Hor.	θ L	CR≥10	80	85	-	Degrees	(7) BM-5A
		θ R		80	85	-		
	Ver.	φ H		80	85	-		
		φ L		80	85	-		
Brightness Uniformity (9 points)		Buni		-	-	(15)	%	(8) BM-5A
Crosstalk		CT		-	-	5.0	%	(9) BM-5A

Note 1) Test Equipment Setup

   Measurement should be executed in a stable, windless, and dark room
   after lighting the back-light for 30 min to stabilize at a given temperature.
   This should be measured at the center of screen.

 Single lamp current : (5.5)mA (Refer to the note(1) in the page 11 for more information.)
 Environment condition : Ta = 25 ± 2 °C

Photodetector	Field
BM-5A	2°
BM-7	2°
PR650	1°

Photodetector

Field

BM-5A : 40㎝
BM-7 : 50㎝
PR650 : 50㎝

TFT - LCD Module

LCD Panel

The center of the screen
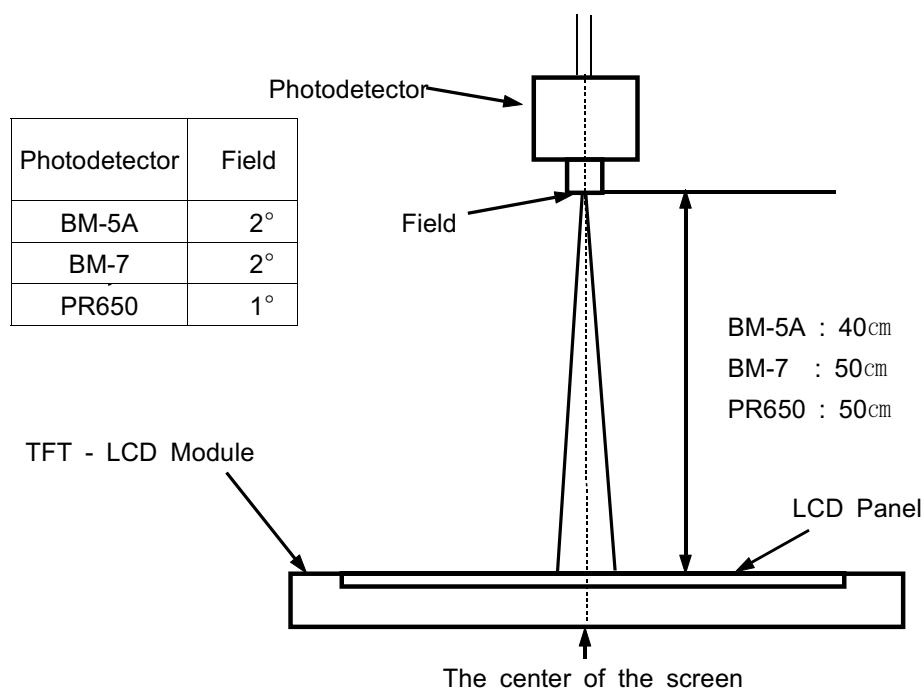
Optical Measuring Equipment Setup

Note 2) Definition of test point

(160)   (800)   (1440)   ◯ : test point

9   8   7   (120)

6   5   4   (600)

3   2   1   (1080)
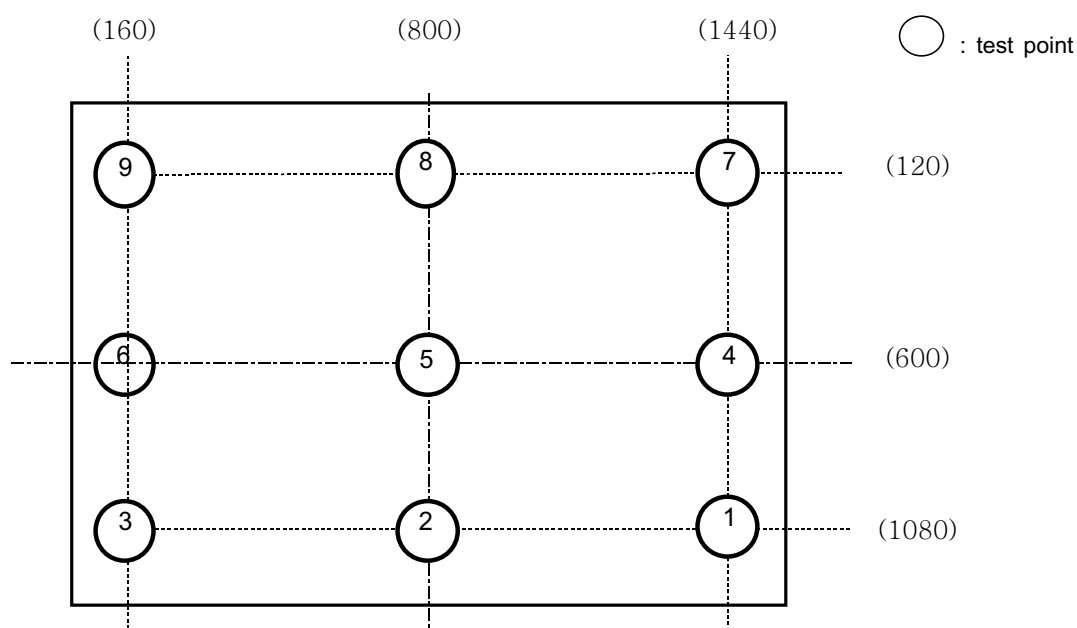
Note 3) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin) at the center point⑤ of the panel

$$CR = \frac{G\max}{G\min}$$

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

Note 4) Definition of Response time : Sum of Tr ,Tf

Display data   Black(TFT OFF)   White(TFT ON)   Black(TFT OFF)

Optical Response   100% 90% T_R T_F 10% 0%   Time
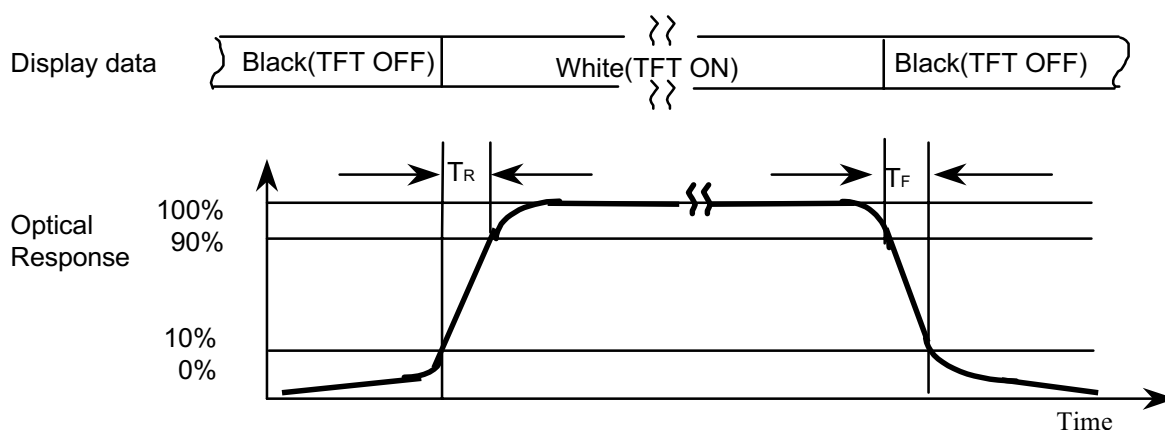
Note 5) Definition of Luminance of White : Luminance of white at center point⑤.

Note 6) Definition of Color Chromaticity (CIE 1931)

Color coordinate of Red , Green , Blue & White at center point⑤.

Note 7) Definition of Viewing Angle : Viewing angle range (CR≥ 10)

Normal Line
$\phi = 0^o, \theta = 0^o$

θ_L θ_R

ϕ_L ϕ_H

$\theta_L = 90^o$ x

12 O'clock direction
$\phi_H = 90^o$

y

6 O'clock y' direction
$\phi_L = 90^o$

x'

$\theta_R = 90^o$
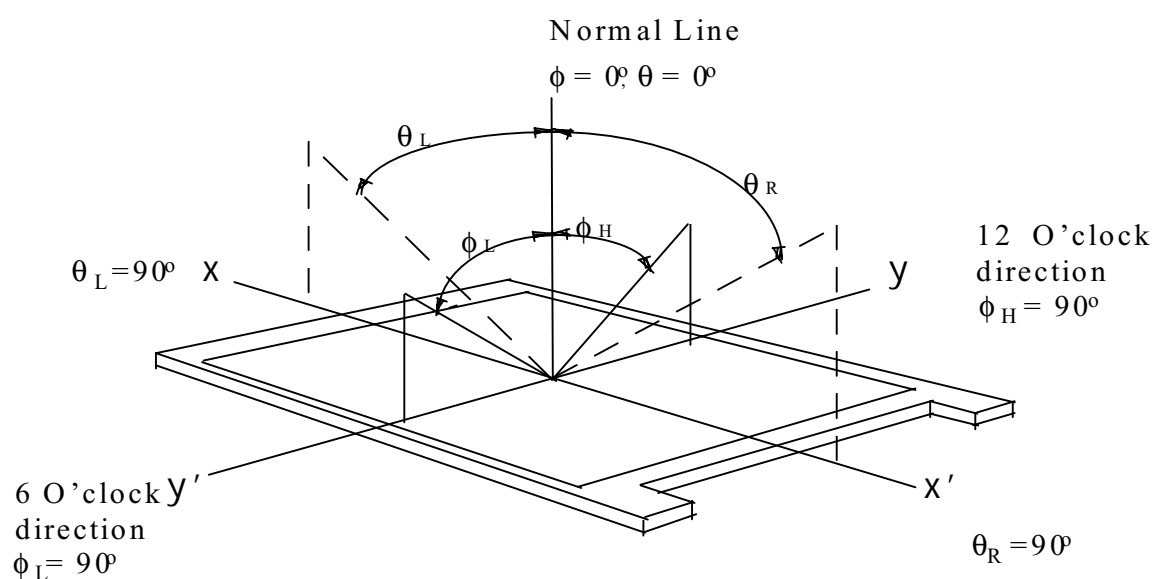
Note 8) Definition of 9 points brightness uniformity

$$Buni = 100 * \frac{(B\max - B\min)}{B\max}$$

  Bmax : Maximum brightness
  Bmin : Minimum brightness

Note 9) Definition of Crosstalk Test Method (Refer to the VESA STD)
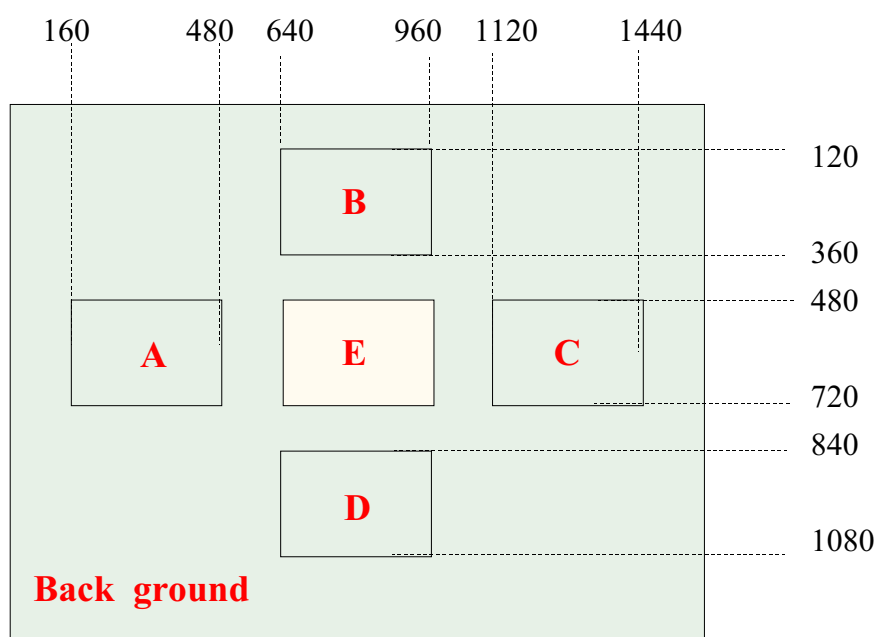
Procedure

  Step (1) Determine background and foreground gray levels (colors) to select the worst case
        shadowing pattern
            (Ex Background : 50% gray white pattern , Foreground : Pure white pattern)
  Step (2) Determine the worst shadowing box (between Box A,B,C,D & E) using the same
        condition at Step (1) gray levels (colors)
  Step (3) Determine test most shadowing position of selected box at Step (2)
  Step (4) Check the brightness of selected position of Step (3) with selected box(at Step (2))
        & without selected box (at Step (2))

$$CT = \frac{|L\max - L\min|}{L\min} * 100\%$$

    Lmax : the larger Brightness value of selected position
    Lmin : the smaller brightness value of selected position

3. Electrical Characteristics

3.1 TFT LCD MODULE

Ta = 25°C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	4.5	5.0	5.5	V	(1)
Interface type		LVDS	DS90CF387		DS90CF388	Pair	
Current of Power Supply	(a)Black	P_{DD}	-	4.3	5.1	Watt	(2),(3)
	(b)Mosaic		-	5.3	6.0	Watt	
	(c)2 Line Vertical		-	6.3	7.6	Watt	
Vsync Frequency		f_V	58	60	60	Hz	
Hsync Frequency		f_H	70	75	75	kHz	
Main Frequency		f_{DCLK}	62	81	-	MHz	
Rush Current		I_{RUSH}	-	1.3	2.0	A	(4)

Note   (1) f_V=60Hz, f_{DCLK} =81MHz, V_{DD} = 5.0V, DC Current.

(2)   Main pixel clock frequency is the value which is measured at the input of LVDS transmitter.

(3)   Power dissipation check pattern(LCD Module only)
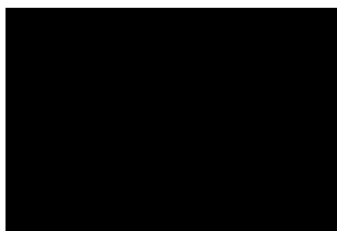
a)Black Pattern   b)Mosaic Pattern
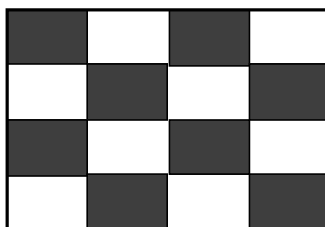
c)2 Line Vertical
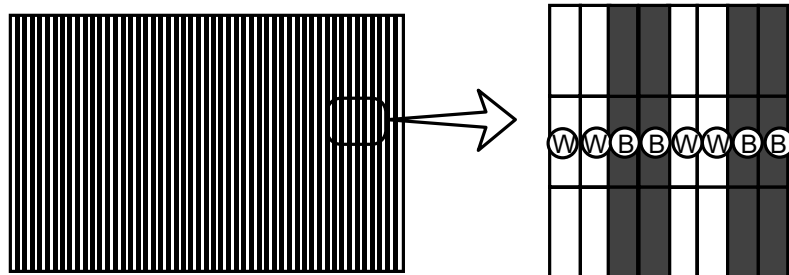
(4) Measurement Conditions
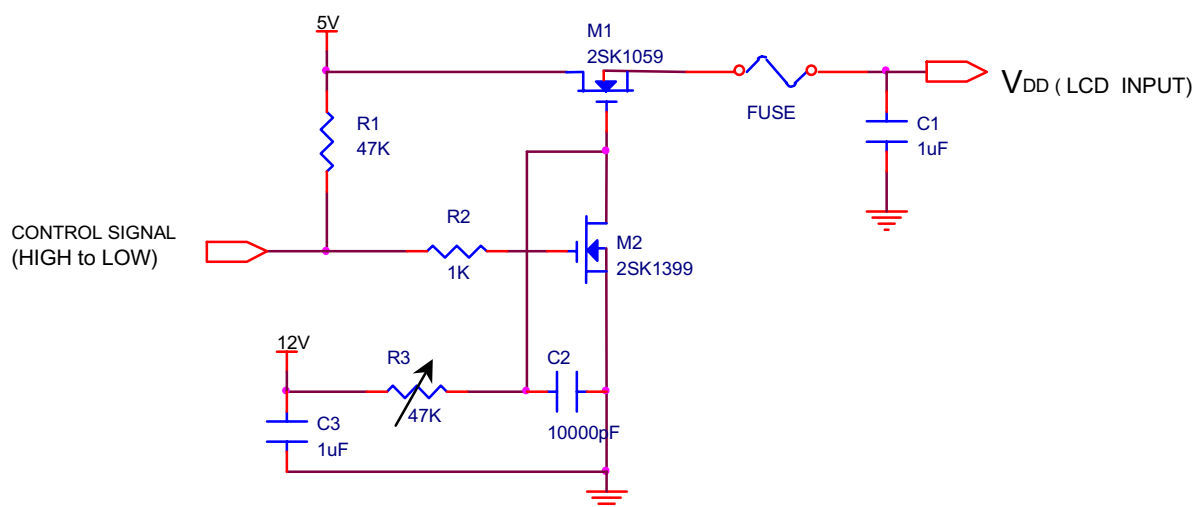
Note : Control Signal : High(+5V) -->Low(Ground)

All Signal lines to panel except for power 5V : Ground

The rising time of supplied voltage is controlled to 470us by R3 and C2 value.

3.2 BACK-LIGHT UNIT

The back-light system is an edge - lighting type with 2 triple CCFTs (Cold Cathode Fluorescent Tube). The characteristics of two triple lamps are shown in the following tables.

Ta=25 ± 2°C

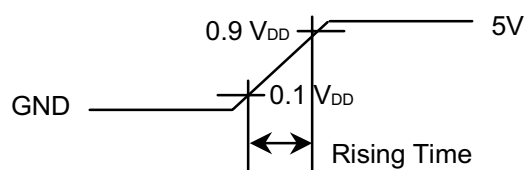| Item	Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current	IL	4.5	(5.5)	(5.5)	mArms	(1)
Lamp Voltage	VL	-	830	-	Vrms	
Lamp Frequency	fL	30	-	60	kHz	(2)
Operating Life Time	Hr	20000	30000	-	Hour	(3)
		1000	-	-		
Startup Voltage	Vs	-	-	0℃: 1760	Vrms	(4)
				25℃:1260		

Note) The inverter must have a symmetric out voltage waveform and be designed on the basis of the modularized lamp.

   The performance of the back-light, for example life time or brightness, is much influenced by the characteristics of the DC-AC inverter for the lamp. So all parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.

   When you design or order the inverter, please make sure that a poor lighting caused by the mismatch of the back-light and the inverter(miss lighting, flicker, etc.) never occur. When you confirm it, the module should be operated on the same condition as it is installed in your instrument.

Note (1) Dual lamp current is measured with current meter for high frequency as shown below.
        Refer to the block diagram of the back-light unit in the next page for more information.
        Specified values are for a single lamp.

* side lamps

```
┌──────────┐       ┌───┐          HOT 1 ( Pink )       ┌──────────┐
│   LCD    │───────│ 1 │──────────────────────────────│          │
│  MODULE  │       │ 2 │                                │ INVERTER │
│          │───────│ 3 │──(A)──── COLD ( White )────────│          │
└──────────┘       └───┘                                └──────────┘
                                                          (SK2400)
```

* center lamp

```
┌──────────┐       ┌───┐          HOT 1 ( Pink )       ┌──────────┐
│   LCD    │───────│ 1 │──────────────────────────────│          │
│  MODULE  │       │ 2 │                                │ INVERTER │
│          │───────│ 4 │──(A)──── COLD ( White )────────│          │
└──────────┘       └───┘                                └──────────┘
                                                          (SK2400)
```
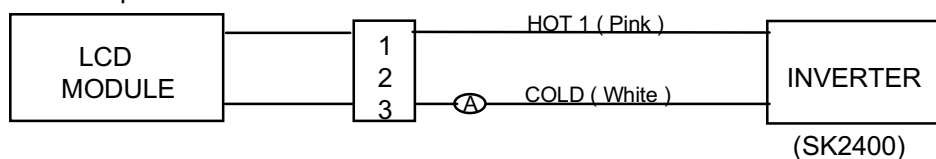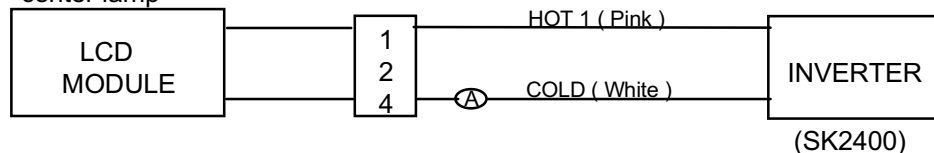
   (2) Lamp frequency, which may produce interference with horizontal synchronous frequency which may cause line flow on the display. Therefore lamp frequency should be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

   (3) Lifetime(Hr) of a lamp is defined as the time in which it continues to operate under the condition of Ta = 25± 2℃ and IL = 6.5mA until the brightness becomes 50% or lower than its original value.

   (4) If an inverter has shutdown function, it should keep its output for over 1 second even if the lamp connector is open. Otherwise the lamps may not be turned on.

4. Block Diagram

4.1 TFT LCD MODULE
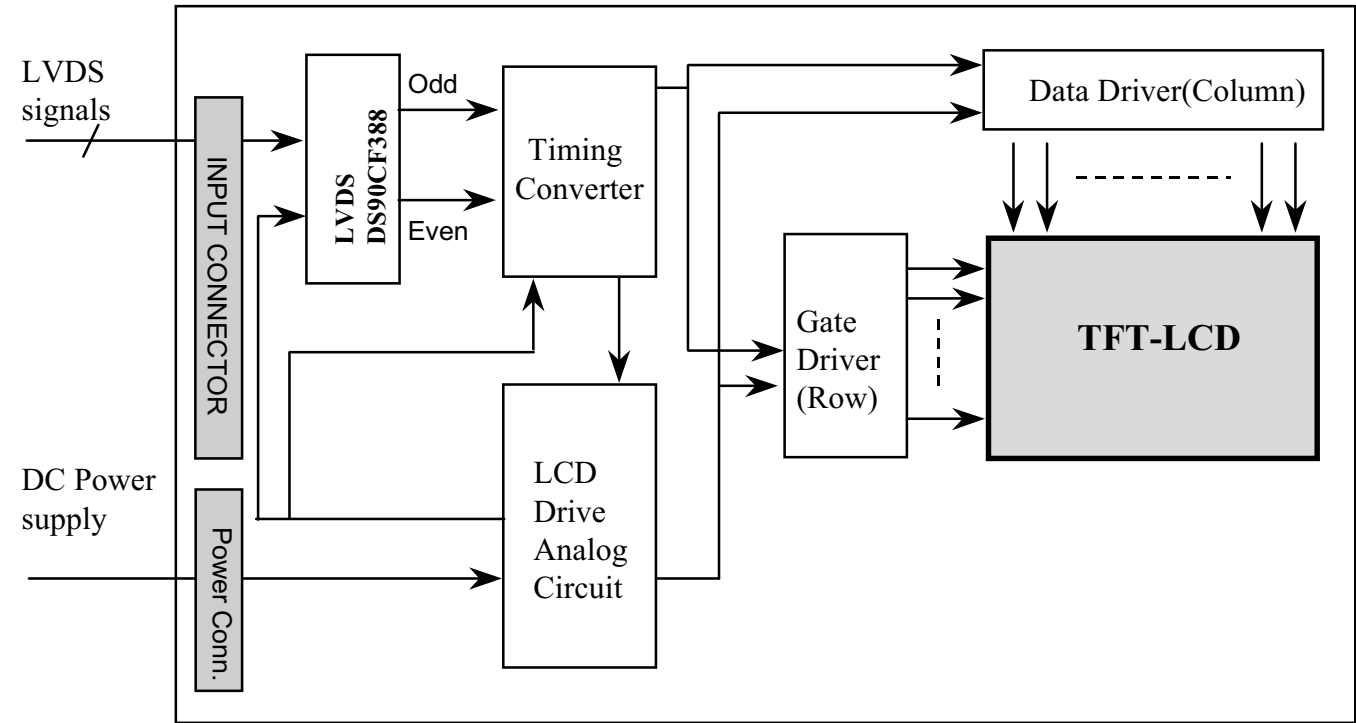
4.2 BACK-LIGHT UNIT

Connector: JST BHR-03VS-1 / JST BHR-04VS-1
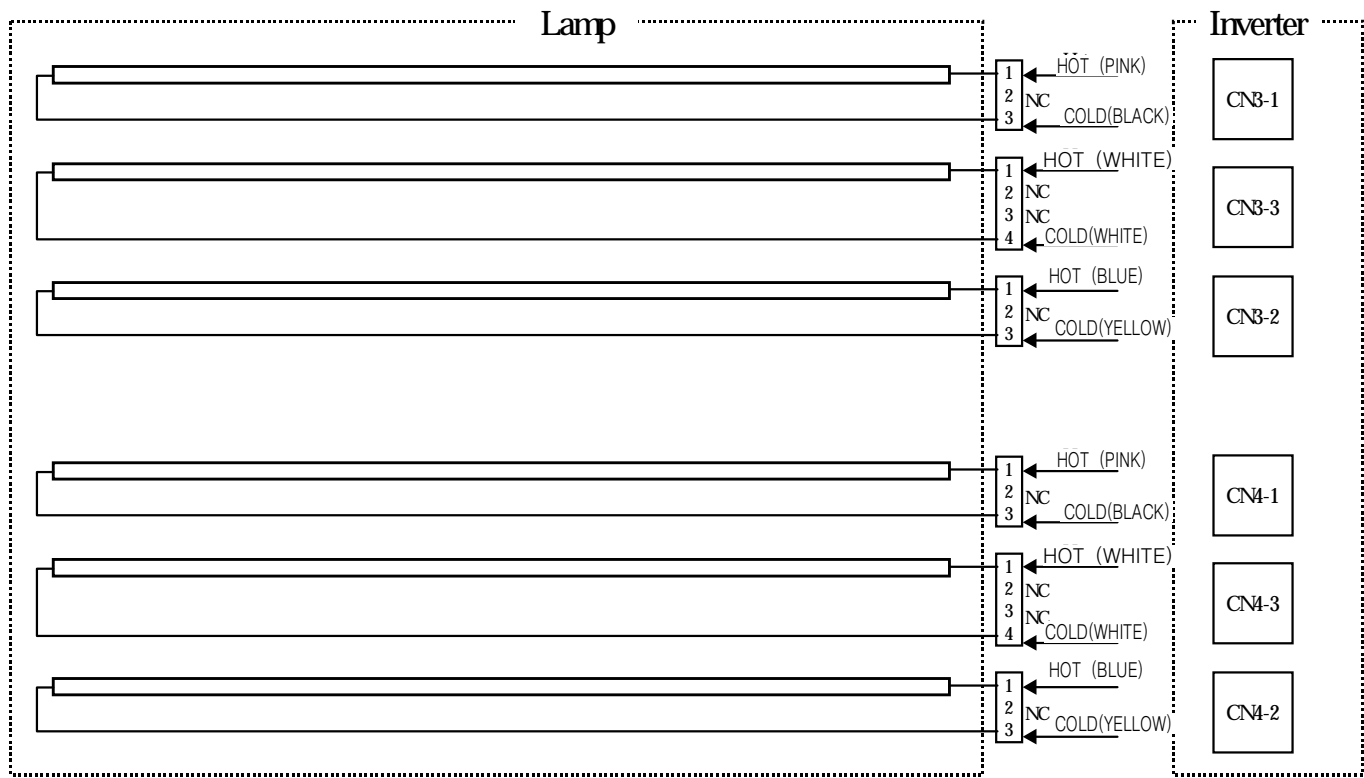
5. Input Terminal Pin Assignment

5.1. Input Signal & Power (Connector : JAE F1-WE31P-HF)

Pin No	Symbol	Function
1	GND	Ground
2		
3	A0M	Negative LVDS differential data output
4	A0P	Positive LVDS differential data output
5	A1M	Negative LVDS differential data output
6	A1P	Positive LVDS differential data output
7	A2M	Negative LVDS differential data output
8	A2P	Positive LVDS differential data output
9	GND	Ground
10		
11	CLKM	Negative LVDS differential clock output
12	CLKP	Positive LVDS differential clock output
13	A3M	Negative LVDS differential data output
14	A3P	Positive LVDS differential data output
15	GND	Ground
16		
17	A4M	Negative LVDS differential data output
18	A4P	Positive LVDS differential data output
19	A5M	Negative LVDS differential data output
20	A5P	Positive LVDS differential data output
21	A6M	Negative LVDS differential data output
22	A6P	Positive LVDS differential data output
23	GND	Ground
24		
25	A7M	Negative LVDS differential data output
26	A7P	Positive LVDS differential data output
27	N.C	Reserved
28	N.C	Reserved
29	N.C	Reserved
30	N.C	Reserved
31	N.C	Reserved

5.2 Input Power (Connector : Molex 53261-1290)
           (Mating Connector : Molex 51021-1200)

Pin No	Symbol	Function
1		
2		
3	+5V	Module Input Vcc
4		
5		
6		
7		
8		
9	GND	Power Ground
10		
11		
12		

5.3 Table of Gray Scale

Color	Display	Data Signal							
	Black	G7	G6	G5	G4	G3	G2	G1	G0
Gray Scale	Dark Gray ↑	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	1
		0	0	0	0	0	0	1	0
		0	0	0	0	0	0	1	1
		0	0	0	0	0	1	0	0
		0	0	0	0	0	1	0	1
		0	0	0	0	0	1	1	0
		0	0	0	0	0	1	1	1
		0	0	0	0	1	0	0	0
		0	0	0	0	1	0	0	1
		0	0	0	0	1	0	1	0
		:	:	:	:	:	:	:	:
		:	:	:	:	:	:	:	:
		:	:	:	:	:	:	:	:
	↓	:	:	:	:	:	:	:	:
		1	1	1	1	0	1	0	1
		1	1	1	1	0	1	1	0
		1	1	1	1	0	1	1	1
		1	1	1	1	1	0	0	0
	Light Gray	1	1	1	1	1	0	0	1
		1	1	1	1	1	0	1	0
		1	1	1	1	1	0	1	1
		1	1	1	1	1	1	0	0
		1	1	1	1	1	1	0	1
		1	1	1	1	1	1	1	0
	White	1	1	1	1	1	1	1	1

Note)   Definition of Gray :

Gn : Bit of gray (n = 0~7)

Input Signal :   0 = Low level voltage,   1 = High level voltage

6. Interface Timing

6.1 Timing Parameters (DE only mode)

SIGNAL	ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Clock	Frequency	1/TC	62	81	82	MHz	(1),(2)
	Hgh Time	TCH	1.5	-	-	nsec	
	Low Time	TCL	1.5	-	-	nsec	
Data	Setup Time	TDS	2	-	-	nsec	
	Hold Time	TDH	2	-	-	nsec	
Data Enable	Setup Time	TES	2	-	-	nsec	
Frame Frequency	Cycle	TH	-	16.7	-	msec	
			1208	1250	1250	lines	
Vertical Active Disply Term	Display Period	TVD	1200	1200	1200	lines	
	Verticle Blank Period	TVB	8	-	50	lines	
One Line Scanning Time	Cycle	TH	900	1080	1090	clocks	2pixel/clock
Horizontal Active Display Term	Display Period	THD	800	800	800	clocks	
			1600	1600	1600	pixels	

Note (1) Test Point : TTL control signal and CLK at LVDS Tx input terminal in system

(2) Internal Vcc = 3.0V

* Interfacing timing check point

Doc . No	PI001_LTM190U1-L02	Page	17 / 23
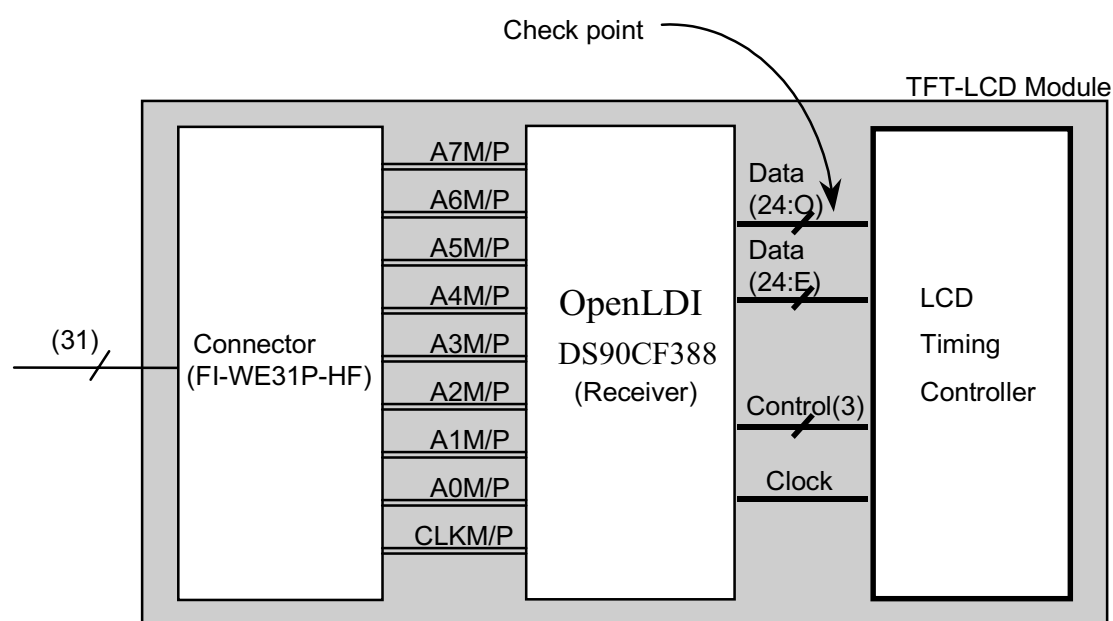
6.2 Timing diagrams of interface signal (DE only mode)

T_V

T_{VD}

T_{VB}

DE

T_H

DCLK

T_C

T_{HD}

DE

DATA
SIGNALS

Valid display data (640 clocks)

T_C

T_{CH}

T_{CL}

D_{CLK}

0.5 V_{CC}

T_{DS}

T_{DH}

DISPLAY
DATA

0.5 V_{CC}

T_{ES}

DE

0.5 V_{CC}
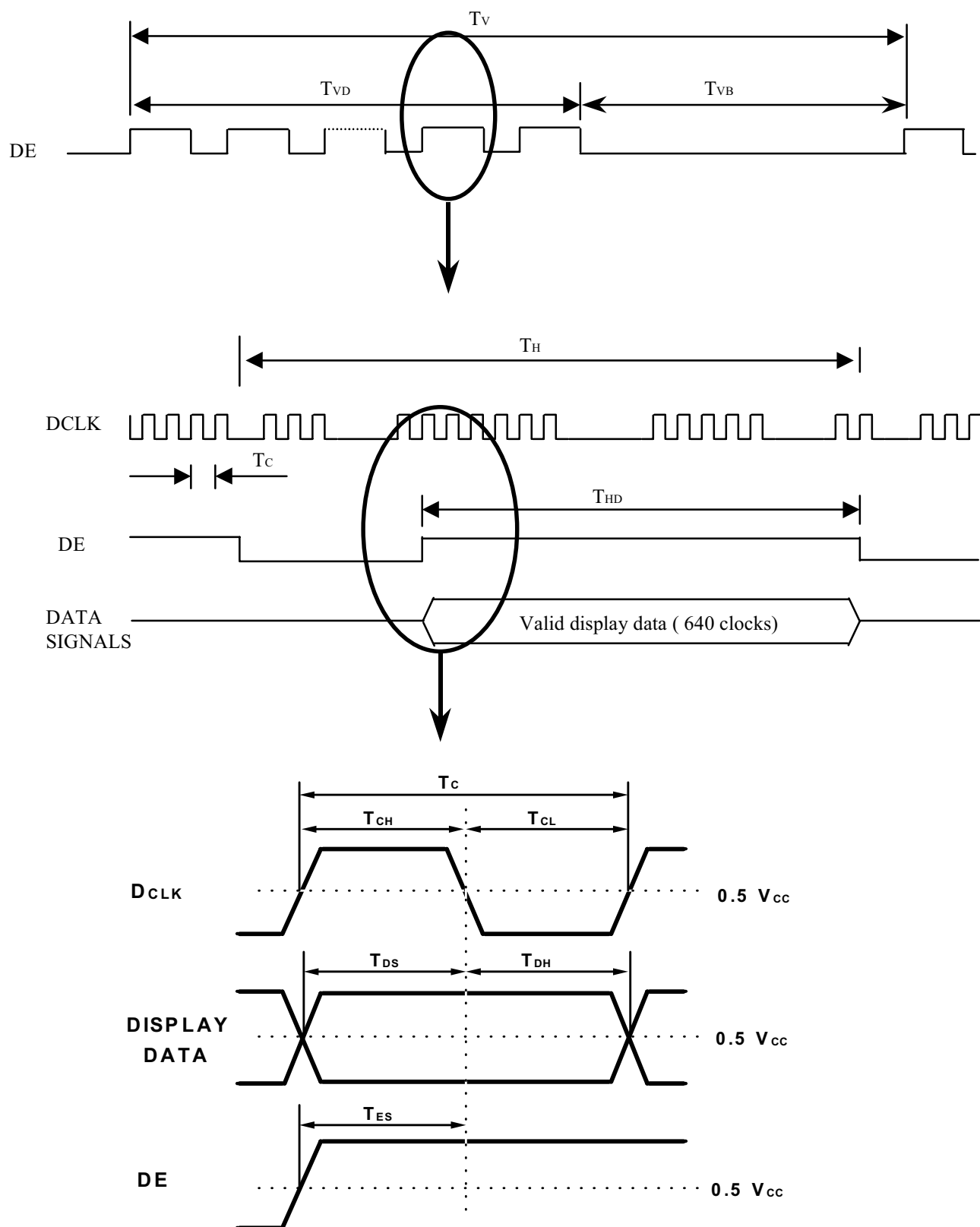
6.3 LVDS Interface

- LVDS Receiver : NS DS90CF388

HOST ← CABLE → LCD

Graphic Controller (A/D Converter)

LVDS TX (387)

LVDS Rx (388)

NOTE 1		PIN#	NOTE 2
B00	B00	10	R10
B01	B01	9	R11
B02	B02	8	R12
B03	B03	7	R13
B04	B04	6	R14
B05	B05	5	R15
B06	B06	4	R16
B07	B07	3	R17
G00	G00	2	G10
G01	G01	1	G11
G02	G02	100	G12
G03	G03	99	G13
G04	G04	96	G14
G05	G05	95	G15
G06	G06	94	G16
G07	G07	93	G17
R00	R00	92	B10
R01	R01	91	B11
R02	R02	90	B12
R03	R03	89	B13
R04	R04	88	B14
R05	R05	87	B15
R06	R06	86	B16
R07	R07	85	B17
	BE0	84	R20
	BE1	81	R21
	BE2	80	R22
	BE3	79	R23
	BE4	78	R24
	BE5	77	R25
	BE6	76	R26
	BE7	75	R27
	GE0	74	G20
	GE1	73	G21
	GE2	72	G22
	GE3	71	G23
	GE4	70	G24
	GE5	69	G25
	GE6	66	G26
	GE7	65	G27
	RE0	64	B20
	RE1	63	B21
	RE2	62	B22
	RE3	61	B23
	RE4	60	B24
	RE5	59	B25
	RE6	58	B26
	RE7	57	B27
Hsync	Hsync	54	Hsync
Vsync	Vsync	55	Vsync
DE	DE	56	DE
CLOCK	CLOCK	80	CLKIN

TX differential pairs:
A7P 28 — 79 A7P
A7M 29 — 80 A7M
A6P 31 — 82 A6P
A6M 32 — 83 A6M
A5P 33 — 84 A5P
A5M 34 — 85 A5M
A4P 36 — 86 A4P
A4M 37 — 87 A4M
A3P 38 — 89 A3P
A3M 39 — 90 A3M
CLKP 41 — 91 CLKP
CLKM 42 — 92 CLKM
A2P 44 — 94 A2P
A2M 45 — 95 A2M
A1P 46 — 96 A1P
A1M 47 — 97 A1M
A0P 49 — 98 A0P
A0M 50 — 99 A0M

LVDS Rx (388) outputs:

PIN#		NOTE 1
10	R10	R0_0
11	R11	R0_1
12	R12	R0_2
13	R13	R0_3
14	R14	R0_4
15	R15	R0_5
16	R16	R0_6
17	R17	R0_7
20	G10	G0_0
21	G11	G0_1
22	G12	G0_2
23	G13	G0_3
24	G14	G0_4
25	G15	G0_5
26	G16	G0_6
27	G17	G0_7
30	B10	B0_0
31	B11	B0_1
32	B12	B0_2
33	B13	B0_3
34	B14	B0_4
35	B15	B0_5
36	B16	B0_6
37	B17	B0_7
49	R20	RE_0
50	R21	RE_1
51	R22	RE_2
52	R23	RE_3
53	R24	RE_4
54	R25	RE_5
55	R26	RE_6
56	R27	RE_7
59	G20	GE_0
60	G21	GE_1
61	G22	GE_2
62	G23	GE_3
63	G24	GE_4
64	G25	GE_5
65	G26	GE_6
66	G27	GE_7
69	B20	BE_0
70	B21	BE_1
71	B22	BE_2
72	B23	BE_3
73	B24	BE_4
74	B25	BE_5
75	B26	BE_6
77	B27	BE_7
	Hsync	Hsync
	Vsync	Vsync
	DE	DE
	CLKOUT	MCLK

NOTE 1 : SIGNAL CONFIGURATION[Graphic Controller(A/D Converter) Output)

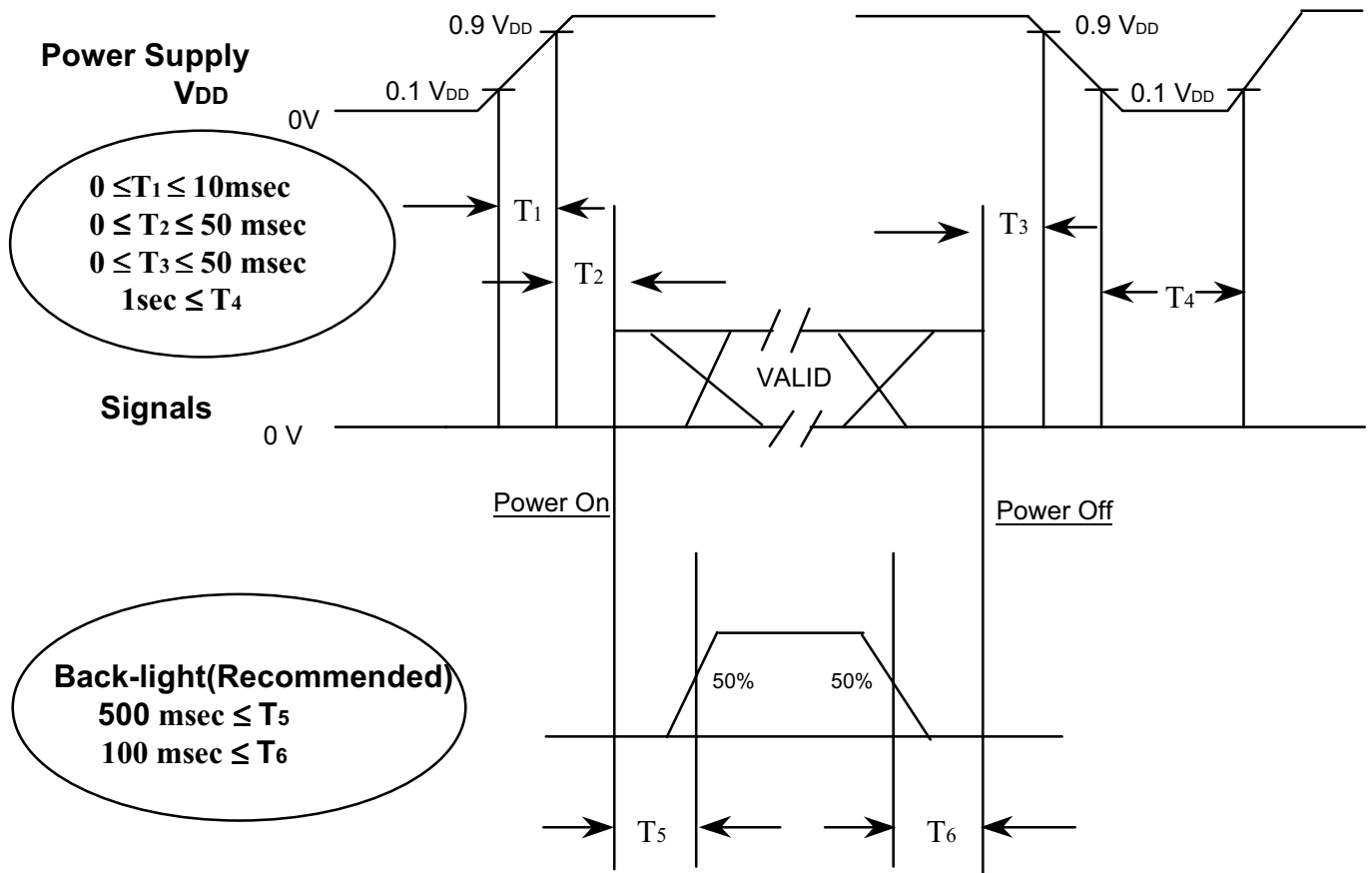ODD DATA(ROx, BOx, GOx : 1'st, 3'rd, 5'th .... data)

EVEN DATA(REx, GEx, BEx : 2'nd, 4'th, 6'th .... data)

NOTE 2 : Use FI-WE31P-HF JAE Connector on the TFT module side

Use Twisted Differential Cable(Impedence:50Ω)

Doc . No | PI001_LTM190U1-L02 | Page | 19 / 23

6.4 Power ON/OFF Sequence

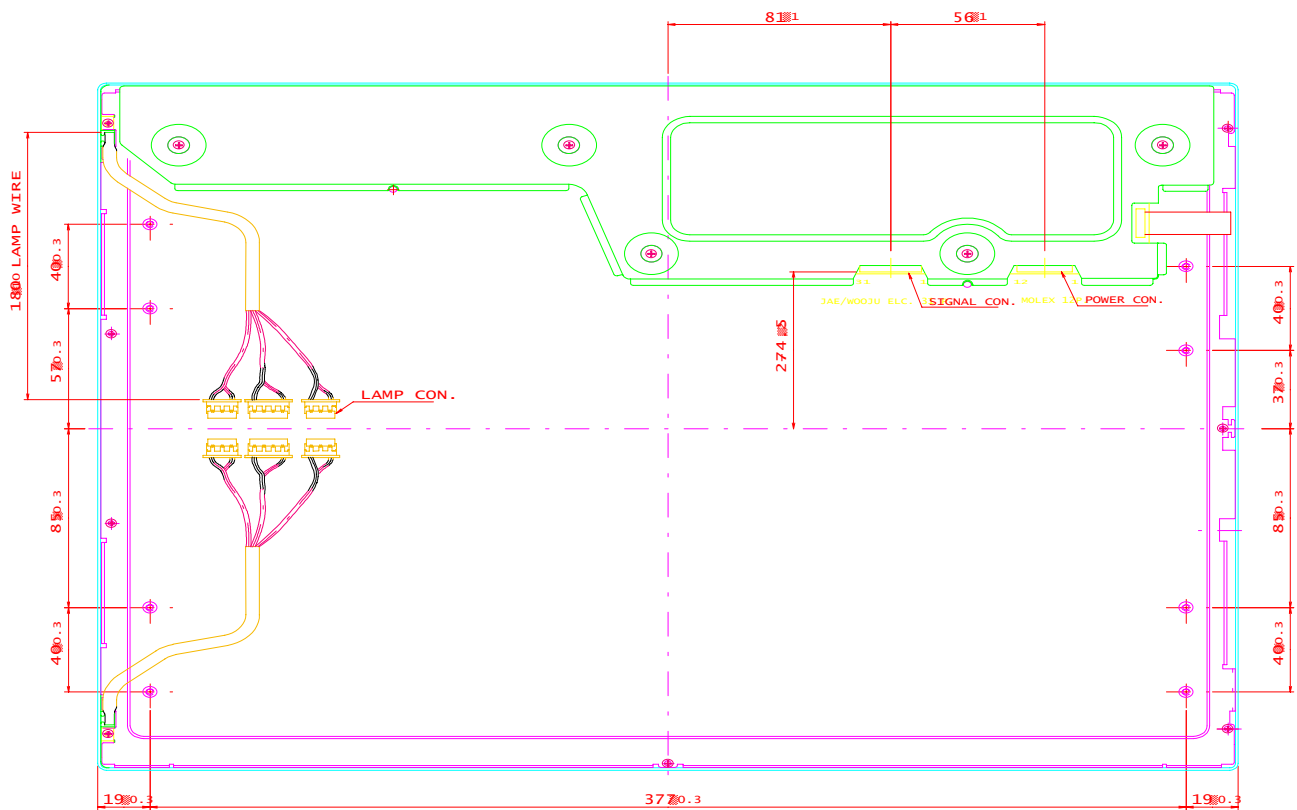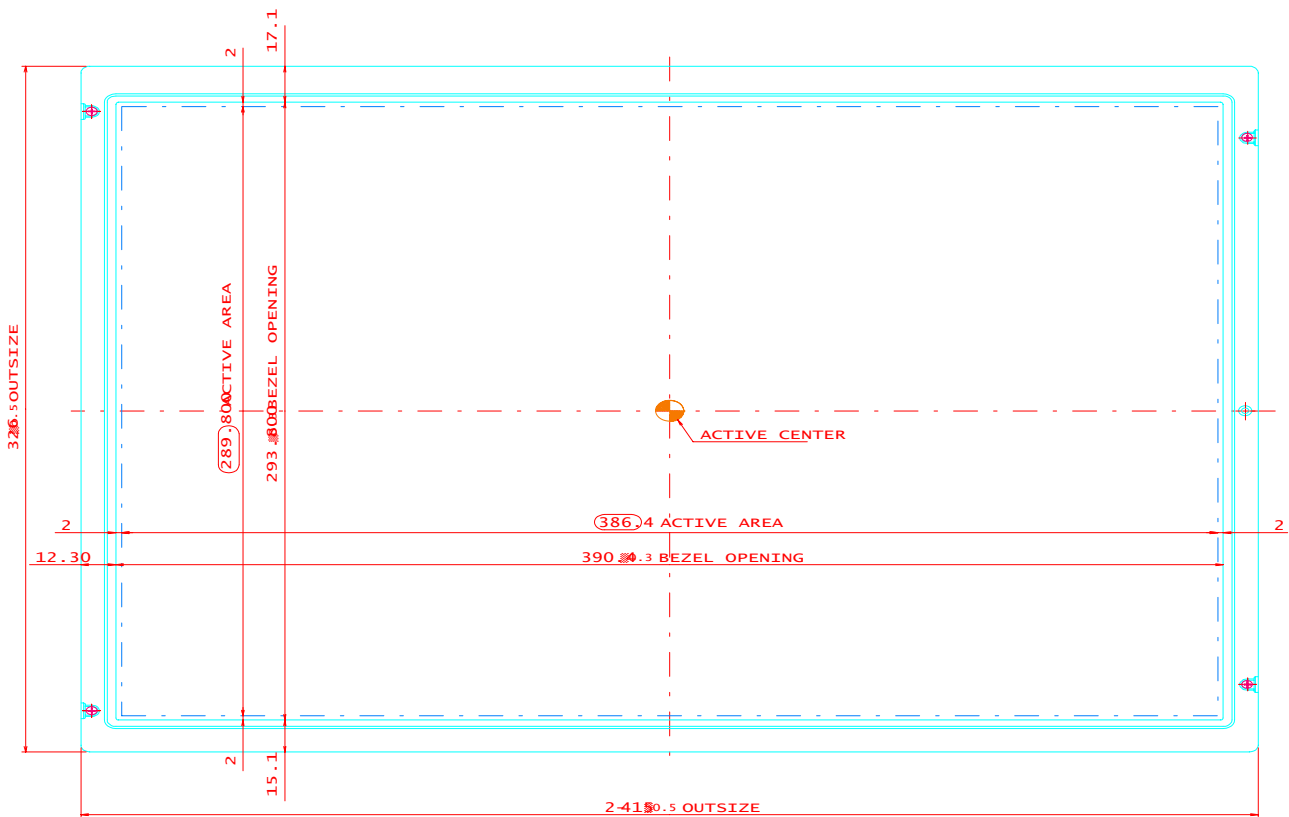: To prevent a latch-up or DC operation of the LCD module, the power on/off sequence should follow the diagram below.

Power Supply V_{DD}

$0 \le T_1 \le 10 msec$
$0 \le T_2 \le 50 msec$
$0 \le T_3 \le 50 msec$
$1sec \le T_4$

Signals

VALID

Power On   Power Off

Back-light(Recommended)
$500 msec \le T_5$
$100 msec \le T_6$

Power ON/OFF Sequence

NOTE.

(1) The supply voltage of the external system for the module input should be the same as the definition of VDD.

(2) Apply the lamp voltage within the LCD operation range. When the back-light turns on before the LCD operation or the LCD turns off before the back-light does, the display may momentarily show abnormal screen.

(3) In case of VDD = off level, please keep the level of input signals low or a high impedance.

(4) T4 should be measured after the module has been fully discharged between power off and on period.

(5) Interface signal should not be kept at high impedance when the power is on.

7. Outline Dimension

ACTIVE CENTER

326.5 OUTSIZE

17.1

289.800 ACTIVE AREA

293.800 BEZEL OPENING

386.4 ACTIVE AREA

390.4 BEZEL OPENING

12.30

15.1

2-416±0.5 OUTSIZE

81±1   56±1

180 LAMP WIRE

40±0.3

57±0.3

LAMP CON.

274±5

DAE/WOO33 ELC.   SIGNAL CON. MOLEX 1   POWER CON.

40±0.3

37±0.3

85±0.3

85±0.3

40±0.3

40±0.3

19±0.3   377±0.3   19±0.3

8. General Precautions

8.1 Handling

(a) When the module is assembled, it should be attached to the system firmly using every mounting hole. Be careful not to twist and bend the modules.

(b) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, this may cause improper operation or damage to the module and CCFT back-light.

(c) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a HB pencil lead.

(d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining and discoloration may occur.

(e) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.

(f) The desirable cleaners are water, IPA(Isopropyl Alcohol) or Hexane. Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might damage to the polarizer permanently due to chemical reaction.

(g) The liquid crystal material leaked from the panel should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.

(h) Protect the module from static which may cause damage to the CMOS Gate Array IC.

(i) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.

(j) Do not disassemble the module.

(k) Do not pull or fold the lamp wire.

(l) Do not adjust the variable resistor which is located on the module.

(m) Protection film of the polarizer on the module should be slowly peeled off just before use in order to minimize the electrostatic charge.

(n) Pins of I/F connector should not be touched directly with bare hands.

8.2 Storage

(a) Do not leave the module in high temperature, high humidity for a long time.
It is highly recommended to store the module with temperature from 0 to 35℃
and relative humidity of less than 70%.

(b) Do not store the TFT-LCD module in direct sunlight.

(c) The module should be stored in a dark place. It is prohibited to apply sunlight or
fluorescent light during the store.

8.3 Operation

(a) Do neither connect nor disconnect the module in the "Power On" condition.

(b) Power supply should always be turned on/off by the item 6.3
"Power on/off sequence"

(c) Module has high frequency circuits. Sufficient suppression to the
electromagnetic interference should be done by system manufacturers. Grounding
and shielding methods may be important to minimize the interference.

(d) The cable between the back-light connector and its inverter power supply should
have a minimized length and be connected directly . The longer cable between
the back-light and the inverter may cause lower luminance of lamp(CCFT) and
require higher startup voltage(Vs).

8.4 Others

(a) Ultra-violet ray filter is necessary for outdoor operation.

(b) Avoid condensation of water which may result in improper operation or disconnection
of electrode.

(c) Do not exceed the absolute maximum rating value. (the supply voltage variation,
input voltage variation, variation in part contents and environmental temperature,
and so on)
Otherwise the module may be damaged.

(d) If the module displays the same pattern continuously for a long period of time,
the situation when the image "Sticks" to the screen could happen.

(e) This module with its circuitry PCB's on the rear side should be handled
carefully in order to avoid the stress to the PCB.