Product Information

ISSUE DATE : 00-11-18
MODEL   : LTM213U3-L02

<u>**NOTE : This product information is subject to change after 3 months of issuing date**</u>

PREPARED BY :   AMLCD Application Engineering Group

SAMSUNG ELECTRONICS CO., LTD.

SAMSUNG
ELECTRONICS

CONTENTS

SAMSUNG

ELECTRONICS

GENERAL DESCRIPTION

DESCRIPTION

LTM213U3-L01 is a color active matrix TFT(Thin Film Transistor) liquid crystal display(LCD) that uses amorphous silicon TFT as a switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 21.3" contains 1600 x 1200 pixels and can display up to 16.7 million colors with wide viewing angle of 80˚ of higher in all directions. 6 o'clock direction is the optimum viewing angle.

FEATURES

- High contrast ratio, High aperture structure
- CE(Coplanar Electrode) Mode
- Wide Viewing Angle
- High speed response
- UXGA(1600x1200 pixels) resolution
- Low power consumption
- 6 CCFTs(Cold Cathode Fluorescent Tube)
- DE Only Mode
- Open LDI(DS90CF388)

APPLICATIONS

- Workstation & High end Desktop monitors
- Display terminals for AV application products
- Monitors for Industrial machine

General Information

ITEM	SPECIFICATION	UNIT	NOTE
Display area	432(H) x324(V) (21.3 inch diagonal)	mm	
Driver element	a-si TFT active matrix		
Display colors	16.7M (True 8-bit)		
Number of pixel	1600 x 1200	pixel	
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.27(H) x 0.27(W)	mm	
Display Mode	Normally Black		
Surface treatment	Haze 25% , Hard - Coating (3H)		

SAMSUNG
ELECTRONICS
SAMSUNG TFT-LCD

Mechanical Information

ITEM		MIN.	TYP.	MAX.	NOTE
Module size	Horizontal (H)	-	483.0	-	mm
	Vertical (V)	-	373.2	-	mm
	Depth (D)	-	-	30	mm
Weight (W/O inverter)		-	-	(5,000)	g

1. ELECTRICAL ABSOLUTE RATINGS

1.1 TFT LCD MODULE

(Vss =GND= 0 V)

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Power Supply Voltage	V_{DD}	Vss-0.5	(6.0)	V	(1)

NOTE (1) Within Ta ($25 \pm 2\ ^{O}C$)

1.2 BACK-LIGHT UNIT

Ta = $25 \pm 2\ ^{O}C$

ITEM	SYMBOL	MIN.	MAX.	UNIT.	NOTE
Lamp current	I_L	(3.0)	(7.0)	mArms	(1)
Lamp frequency	f_L	(30)	(60)	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.

SAMSUNG
ELECTRONICS
SAMSUNG TFT-LCD

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 (4).
Measuring equipment : TOPCON BM-5A, BM-7
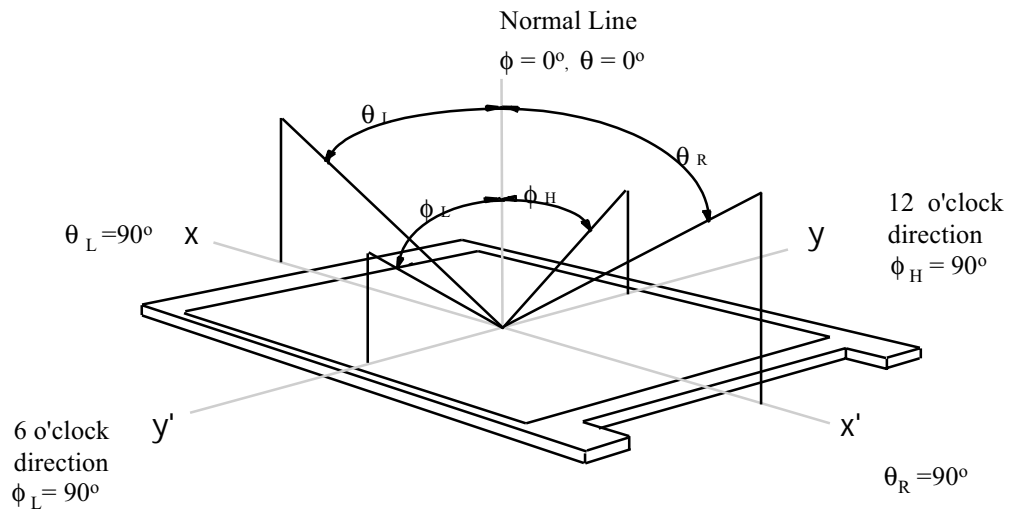   PHOTO RESEARCH PR650

* Ta = 25 ± 2ºC , V_{DD} = 5.0V, fv= 60Hz, f_{DCLK}=81MHz, I_L = 6.5 mArms

ITEM		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
Contrast Ratio (Center of screen)		CR		(300)	-	-		(1), (2), (4)
Response Time at Ta	Rising	T_R		-	(30)	(40)	msec	(1), (3)
	Falling	T_F		-	(30)	(40)		
Luminance of White (Center of screen)		Y_L	$\phi = 0$, $\theta = 0$ Normal Viewing Angle	(200)	-	-	cd/m^2	(1), (4)
Color Chromaticity (CIE)	Red	R_X		-	0.612	-		(1), (4)
		R_Y		-	0.345	-		
	Green	G_X		-	0.317	-		
		G_Y		-	0.554	-		
	Blue	B_X		-	0.148	-		
		B_Y		-	0.137	-		
	White	W_X		-	(0.314)	-		
		W_Y		-	(0.346)	-		
Viewing Angle	Hor.	θ_L	CR $\geq$ 10	-	80	-	Degrees	
		θ_R		-	80	-		
	Ver.	ϕ_H		-	80	-		
		ϕ_L		-	80	-		

SAMSUNG
ELECTRONICS
SAMSUNG TFT-LCD

Note 1) Definition of Viewing Angle : Viewing angle range (10≤ CR)

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

θ_L

θ_R

ϕ_L ϕ_H

$\theta_L = 90^o$ x

y

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

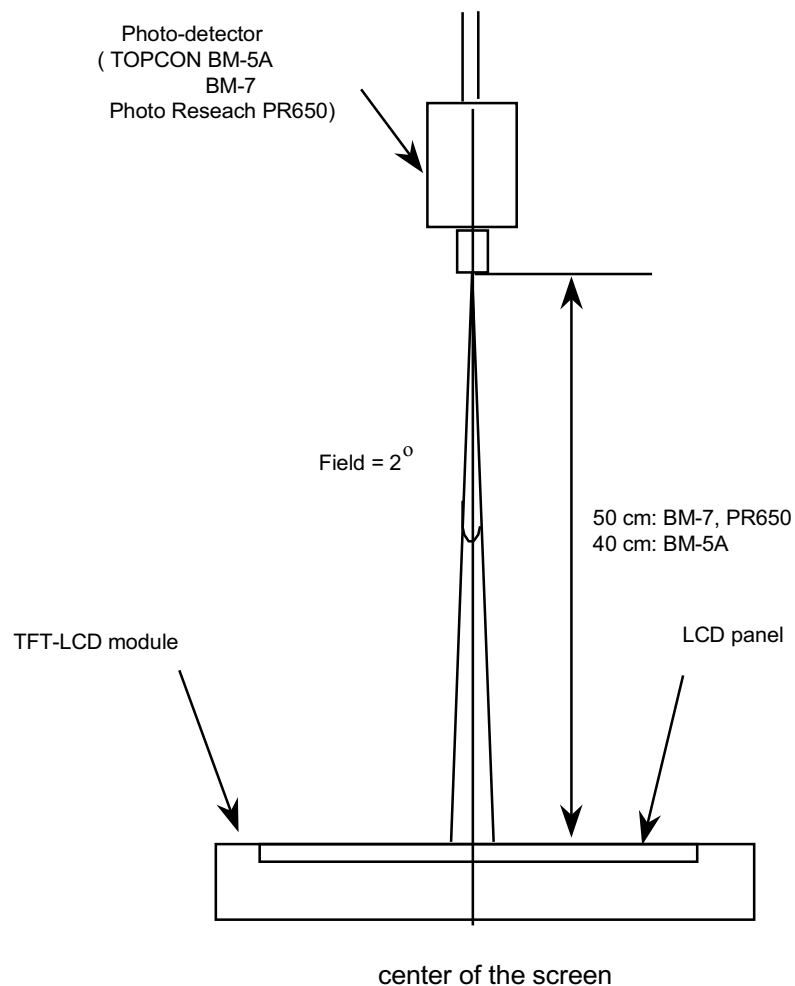6 o'clock direction
$\phi_L = 90^o$ y'

x'

$\theta_R = 90^o$

Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax) ,gray min (Gmin) at the center of the screen

$$CR \ = \ \frac{\text{Luminance with all pixels white (Gmax)}}{\text{Luminance with all pixels black (Gmin)}}$$

Note 3) Definition of Response time : Sum of T_R , T_F

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

Optical Response

T_R T_F

100%
90%

10%
0%

Time

SAMSUNG

ELECTRONICS
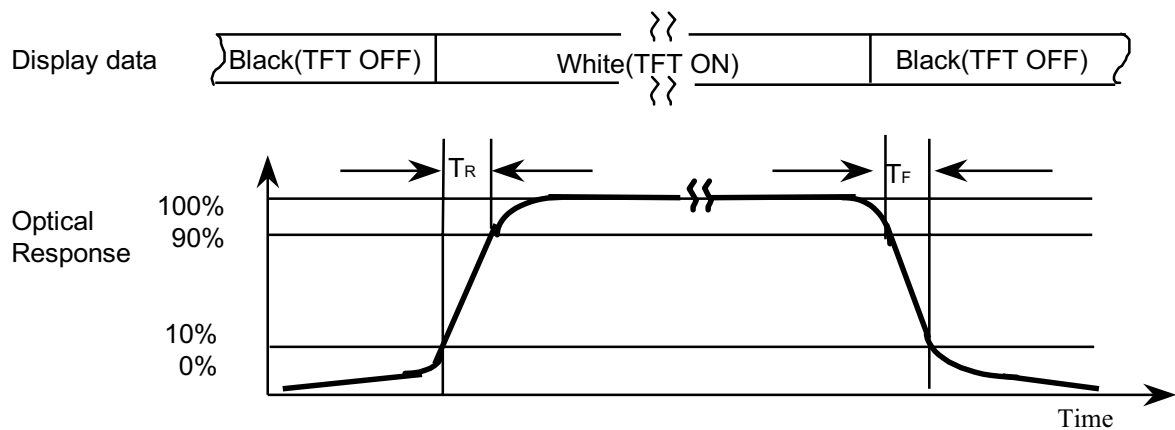
Note 4) After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement
should be executed. Measurement should be executed in a stable, windless, and dark room.
30 min after lighting the back-light. This should be measured in the center of screen.
Each lamp current : 6.5mA (Refer to the note(1) in the page 10 for more information.)
Environment condition : Ta = 25°C $\pm$ 2 ^{o}C

Photo-detector
(TOPCON BM-5A
BM-7
Photo Reseach PR650)

Field = 2°

50 cm: BM-7, PR650
40 cm: BM-5A

TFT-LCD module

LCD panel

center of the screen

Optical characteristics measurement setup

SAMSUNG
ELECTRONICS
SAMSUNG TFT-LCD

3. ELECTRICAL CHARACTERISTICS

3.1 TFT LCD MODULE

Ta= 25 ± 2 °C

ITEM		SYMBOL	MIN	TYP	MAX	UNIT	NOTE
Voltage of Power Supply		V_{DD}	4.5	5.0	5.5	V	
Current of Power Supply	Black	I_{DD}	-	(1100)	-	mA	(1)(3)*a
	Mosaic		-	(1600)	-	mA	(1)(3)*b
	2line vertical		-	(2100)	(2300)	mA	(1)(3)*c
Vsync Frequency		fv	-	60	-	Hz	
Hsync Frequency		fH	-	75	-	kHz	
Main Frequency		fDCLK	-	81	-	MHz	(2)
Rush Current		Irush	-	-	(6.0)	A	(4)

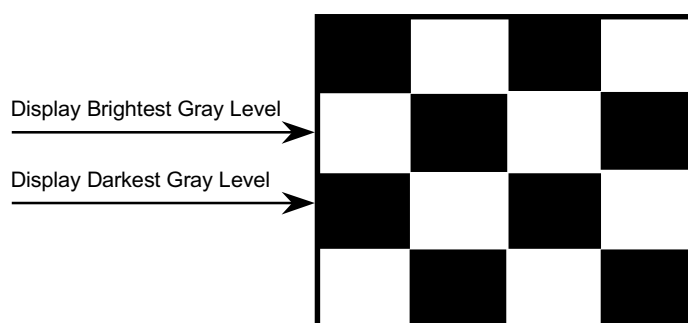Note (1) fv=60Hz, fDCLK =81MHZ, V_{DD} = 5.0V, DC Current.

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

(3) Power dissipation check pattern(LCD Module only)

*a) Black Pattern   *b) Mosaic Pattern

VIEW AREA

Display Brightest Gray Level

Display Darkest Gray Level

SAMSUNG
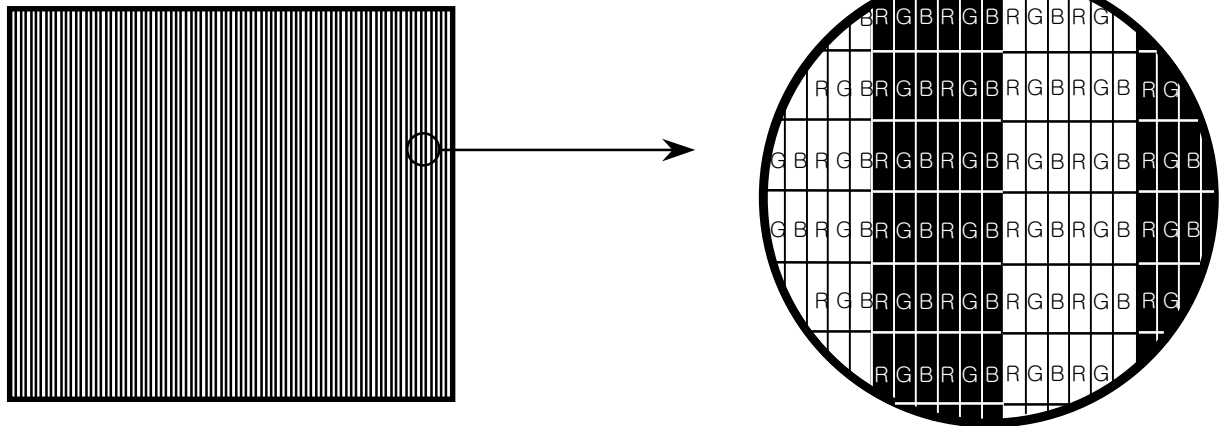ELECTRONICS
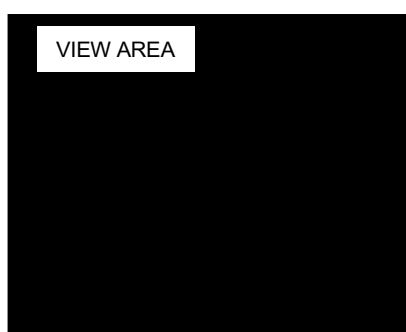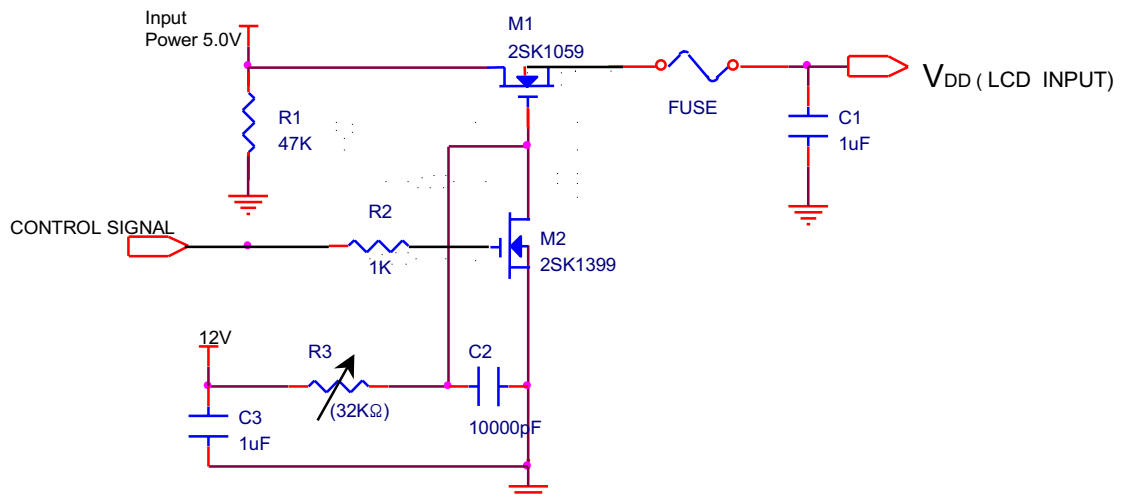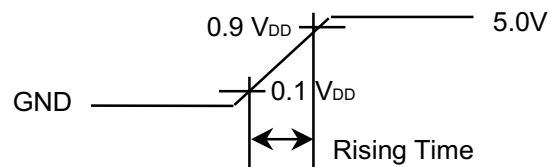
*c) 2line Vertical stripe pattern

(4) Measurement Conditions

Note : Control Signal : High(+5.0V) -->Low(Ground)

All Signal lines to panel except for power 5.0V : Ground

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

SAMSUNG ELECTRONICS

SAMSUNG TFT-LCD

3.2 BACK - LIGHT UNIT

The back-light system is an edge-lighting type with 6 CCFTs(Cold Cathode Fluorescent Tube). The characteristics of each lamp is shown in the following tables.

Ta=25±2°C

ITEM	SYMBOL	MIN	TYP	MAX	UNIT	NOTE
Lamp Current	I_L	(6.2)	(6.5)	(6.8)	mA $_{rms}$	(1)
Lamp Voltage	V_L	-	(860)	-	Vrms	
Lamp Frequency	f_L	(30)	-	(60)	kHz	(2)
Operating Life Time	H_r	(TBD)	-	-	Hour	(3) (25 °C) (0 °C)
Startup Voltage	V_S	-	-	(1300)(25 °C) (1800) (0 °C)	Vrms	(4)

Note) The method of measurement's inverter should be used PWM(Pulse Width Modulation). The waveform of the inverter output voltage must be area symmetric and the design of the inverter must have specifications for the modularized lamp.
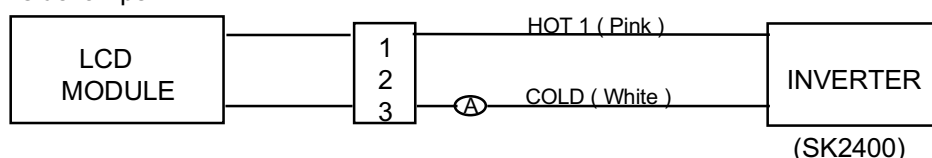
The performance of the back-light, for example life time or brightness, is much influenced by the characteristics of the DC-AC inverter for the lamp. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter. 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 in the same condition as it is installed in your instrument.

Note (1) 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.

* side lamps

LCD MODULE — | 1 2 3 | — HOT 1 (Pink) — INVERTER (SK2400)
(A) COLD (White)

* center lamp

LCD MODULE — | 1 2 4 | — HOT 1 (Pink) — INVERTER (SK2400)
(A) COLD (White)
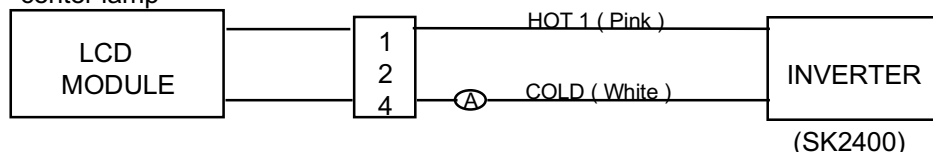
(2) Lamp frequency may produce interference with horizontal synchronous frequency and this may cause line flow on the display. Therefore lamp frequency shall be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

(3) Life time (Hr) of a lamp is defined as the time in which it continues to operate under the condition of Ta=25±2°C and I_L = 6.5mArms for each lamp until the brightness becomes 50% or lower than it's original value.

(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.

SAMSUNG
ELECTRONICS

4. BLOCK DIAGRAM

4.1 TFT LCD MODULE

4.2 BACK- LIGHT UNIT

SAMSUNG

ELECTRONICS

SAMSUNG TFT-LCD

5. INPUT TERMINAL PIN ASSIGNMENT

5.1. Input Signal (Connector : JAE F1-WE31P-HF)
(Mating Connector :JAE F1-WE31S-HF)
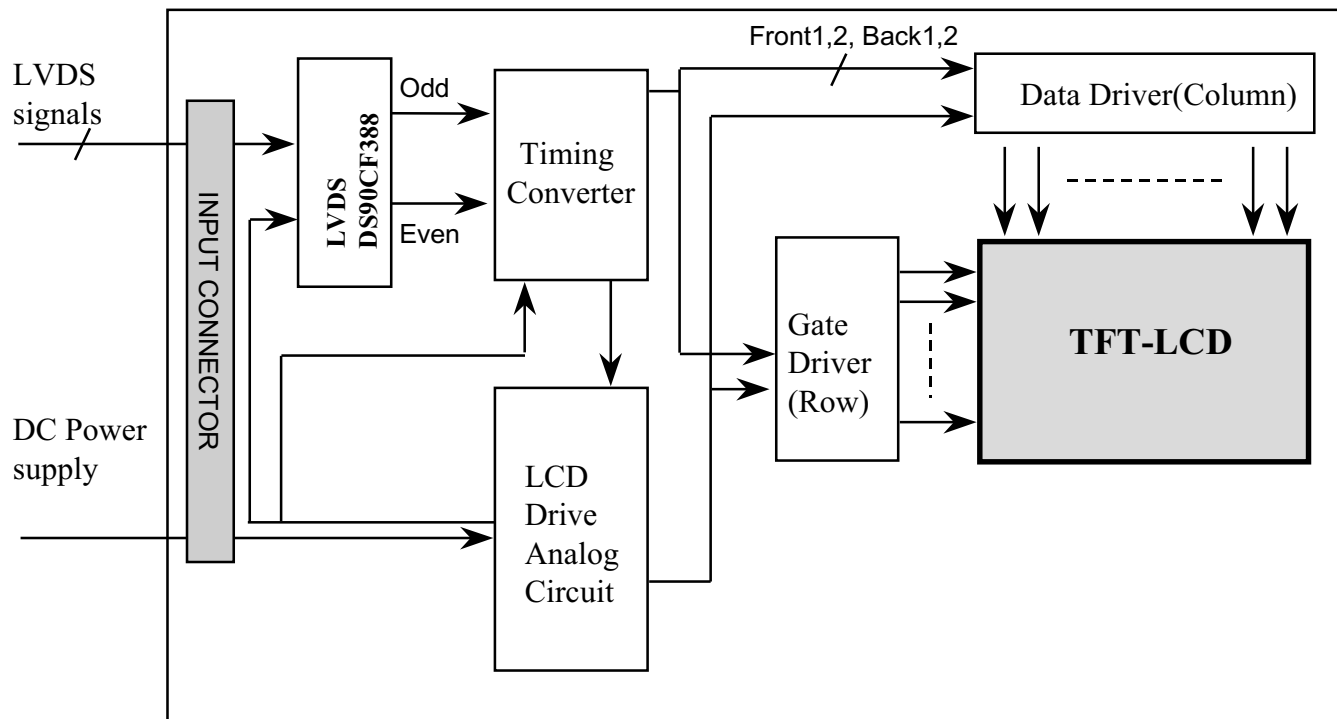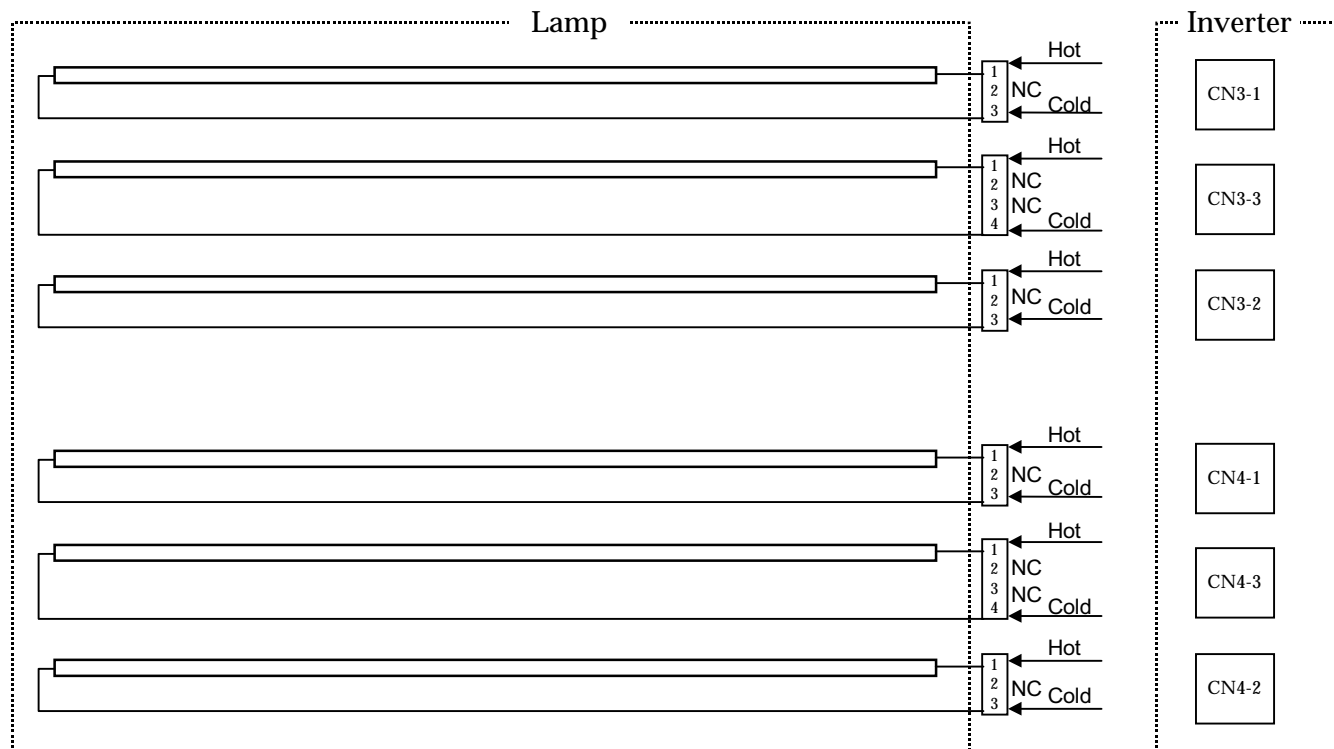
387 No.	Tx Signal	JAE31P No.	388 No.	Rx Signal	Remark
		31 (Reserved)		Reserved	Service Port
		30 (Reserved)		Reserved	Service Port
		29 (Reserved)		Reserved	Service Port
		28 (Reserved)		Reserved	Service Port
		27 (Reserved)		Reserved	Service Port
28	TxOut7+	26	79	RxOut7+	Twisted Pair
29	TxOut7-	25	80	RxOut7-	
		24 (GND)			Twisted Pair
		23 (GND)			
31	TxOut6+	22	82	RxOut6+	Twisted Pair
32	TxOut6-	21	83	RxOut6-	
33	TxOut5+	20	84	RxOut5+	Twisted Pair
34	TxOut5-	19	85	RxOut5-	
36	TxOut4+	18	86	RxOut4+	Twisted Pair
37	TxOut4-	17	87	RxOut4-	
		16 (GND)			Twisted Pair
		15 (GND)			
38	TxOut3+	14	89	RxOut3+	Twisted Pair
39	TxOut3-	13	90	RxOut3-	
41	TxOutCLK+	12	91	RxOutCLK+	Twisted Pair
42	TxOutCLK-	11	92	RxOutCLK-	
		10 (GND)			Twisted Pair
		9 (GND)			
44	TxOut2+	8	94	RxOut2+	Twisted Pair
45	TxOut2-	7	95	RxOut2-	
46	TxOut1+	6	96	RxOut1+	Twisted Pair
47	TxOut1-	5	97	RxOut1-	
49	TxOut0+	4	98	RxOut0+	Twisted Pair
50	TxOut0-	3	99	RxOut0-	
		2 (GND)			Twisted Pair
		1 (GND)			

SAMSUNG
ELECTRONICS
SAMSUNG TFT-LCD

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

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

5.3 BACK - LIGHT UNIT

PIN No.	INPUT [ch1] , [ch2]	Color	Function
3-1-1	HOT	Pink	High Voltage
3-1-2	N.C.	-	-
3-1-3	Cold	White	Ground
3-2-1	HOT	Pink	High Voltage
3-2-2	N.C.	-	-
3-2-3	Cold	White	Ground
3-3-1	HOT	Pink	High Voltage
3-3-2	N.C.	-	-
3-3-3			
3-3-4	Cold	White	Ground
4-1-1	HOT	Pink	High Voltage
4-1-2	N.C.	-	-
4-1-3	Cold	White	Ground
4-2-1	HOT	Pink	High Voltage
4-2-2	N.C.	-	-
4-2-3	Cold	White	Ground
4-3-1	HOT	Pink	High Voltage
4-3-2	N.C.	-	-
4-3-3			
4-3-4	Cold	White	Ground
Connector Part No.	JST BHR-03VS-1, JST BHR-04VS-1		

SAMSUNG
ELECTRONICS

5.4 Input Signal,Basic Display Colors and Gray Scale of Each Colors

COLOR	DISPLAY	DATA SIGNAL RED								GREEN								BLUE								GRAY SCALE LEVEL
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7	
BASIC COLOR	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	R0
	DARK	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R1
	↑	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R252
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R253
	LIGHT	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R254
	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	R255
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	G0
	DARK	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G1
	↑	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G252
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G253
	LIGHT	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G254
	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	G255
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	B0
	DARK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	B1
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	B2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B252
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	B253
	LIGHT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	B254
	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	B255

Note) ▸ Definition of Gray :

  Rn : Red Gray, Gn : Green Gray, Bn : Blue Gray (n = Gray level)

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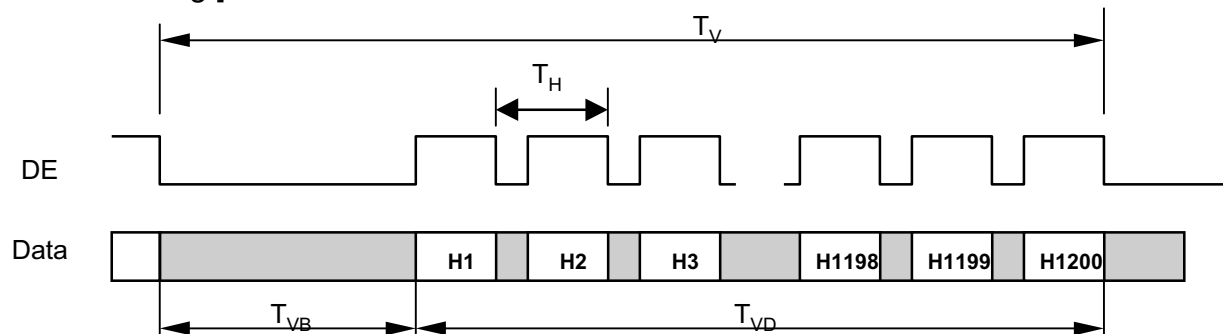
SAMSUNG

ELECTRONICS

6. INTERFACE TIMING

6.1 Timing Parameters and diagram of Interface signal (DE Only Mode)

Item		Symbol	Min	Typ	Max	Unit
Clock Frequency		1/Tc	60	81	82	MHz
Horizontal	Total Period	T_H	900	1080	1090	Pixels
	Active Period	T_{HD}	800	800	800	Pixels
	Blank Period	T_{HB}	100	280	290	Pixels
Vertical	Total Period	T_V	1208	-	1250	Lines
	Active Period	T_{VD}	1200	1200	1200	Lines
	Blank Period	T_{VB}	8	-	50	Lines

[Horizontal Timing]
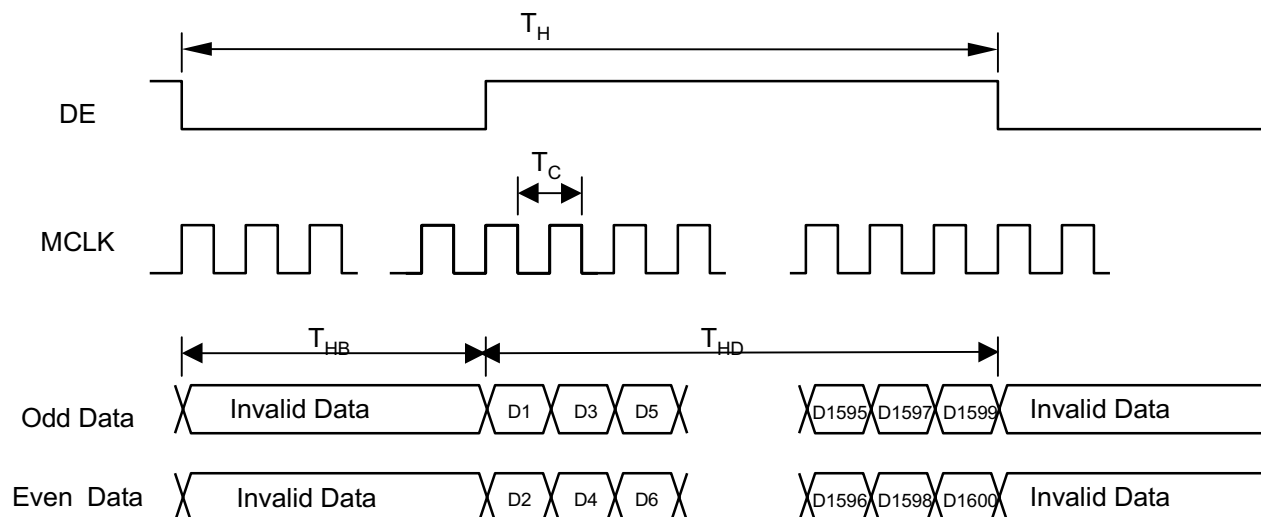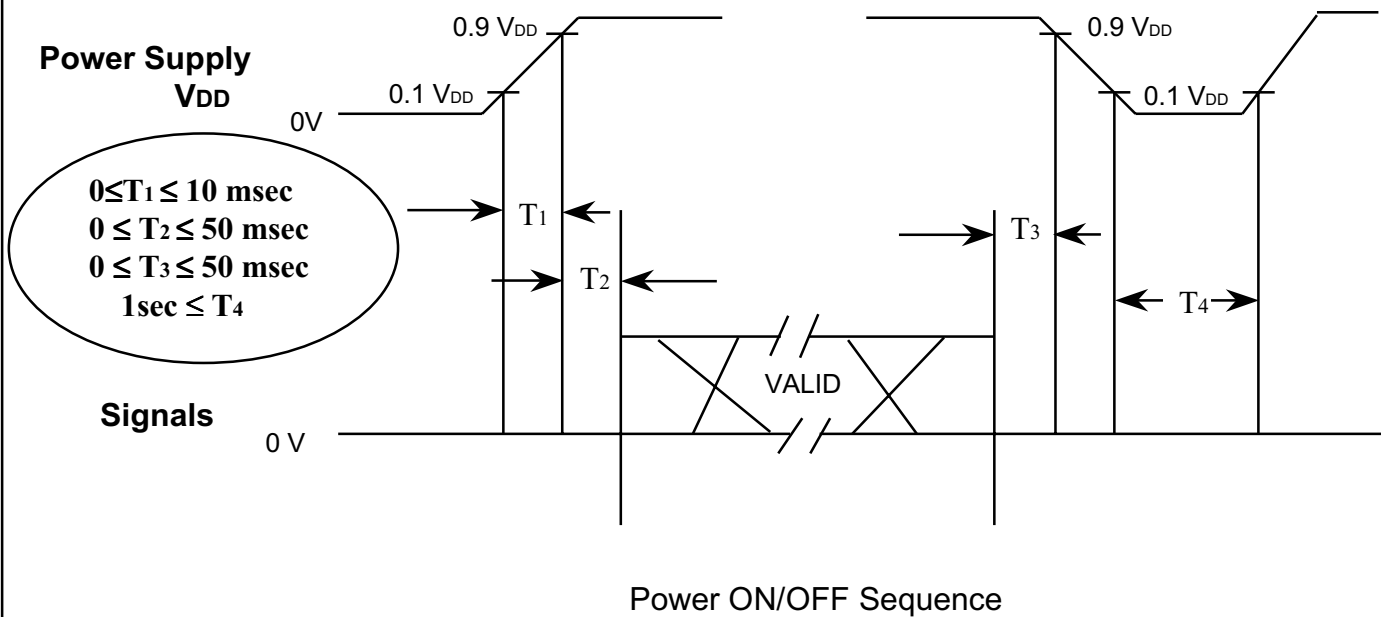

[Vertical Timing]

SAMSUNG
ELECTRONICS
SAMSUNG TFT-LCD

6.2 Power ON/OFF Sequence

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

Power Supply
V_DD

0.9 V_DD

0.1 V_DD

0V

0.9 V_DD

0.1 V_DD

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

T_1

T_2

T_3

T_4

VALID

Signals

0 V

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 V_DD.

(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 turns off, the
display may momentarily become white.

(3) In case of V_DD = off level, please keep the level of input signals on the low or keep
a 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. OUTLINE DIMENSION

SAMSUNG
ELECTRONICS
SAMSUNG TFT-LCD

8. GENERAL PRECAUTIONS

8.1 Handling

(a) When the module is assembled, It should be attached to the system firmly
    using every mounting holes. 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 permanent damage to the polarizer due to chemical reaction.

(g) 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, legs or clothes, it must be washed away thoroughly
    with soap.

(h) Protect the module from static , it 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 back side.

(m) Protection film for polarizer on the module shall be slowly peeled off just before use so
     that the electrostatic charge can be minimized.

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

8.2 Storage

(a) Do not leave the module in high temperature, and 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 shall be stored in a dark place. It is prohibited to apply sunlight or fluorescent
    light during the store.

8.3 Operation

 (a) Do not connect,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 shall 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 shall be 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 may require higher
      startup voltage(Vs).

8.4 Others

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

(b) Avoid condensation of water. It 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, so on)
    Otherwise the module may be damaged.

(d) If the module displays the same pattern continuously for a long period of time,it can be
    the situation when the image "sticks" to the screen.

(e) This module has its circuitry PCB's on the rear side and should be handled carefully in
    order not to be stressed.

SAMSUNG
ELECTRONICS
SAMSUNG TFT-LCD