



ELECTRONICS

Product Information

Issued Date : June 17, 2002

Model : LTS180S3-HF1

Note : This Product information is subject to change without any notice.

PREPARED BY : AMLCD Application Engineering Group 1

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Revision History

Date	Rev. No.	Page	Summary
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General Description

* Description

LTS180S3-HF1 is a transmissive type 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 module, a driver circuit and a back-light unit. The resolution of 1.8" contains 128 x 160 pixels and can display up to 65K colors.

* Features

- Transmissive type and back-light with three LEDs are available.
- Visible in outdoor & back-light off condition with slight reflectivity.
- TN(Twisted Nematic) mode.
- Line inversion mode.
- 16bit CPU interface.
- Full, Still, Sleep, Stand-by mode are available.
- Low Power consumption.

* Applications

- Display terminals for cellular phone.

* General information

Item	Specification	Unit	Note
Display area	28.032(H) x 35.04(V)	mm	-
Driver element	a-Si TFT active matrix	-	-
Display colors	65K	colors	-
Number of pixels	128(H) x 160(V)	pixel	-
Pixel arrangement	RGB vertical stripe	-	-
Pixel pitch	0.219(H) x 0.219(V)	mm	-
Display mode	Normally White	-	-
Viewing direction	12	o'clock	-
Surface Treatment	Glare Type 1B	-	-

* Mechanical information

Item	Min.	Typ.	Max.	Unit	Note	
Module size	Horizontal(H)	33.8	34.0	34.2	mm	-
	Vertical(V)	46.5	46.7	46.9	mm	(1)
	Depth(D)	2.8	3.0	3.2	mm	(1)
Weight	-	-	11	g	-	

Note (1) Without FPC

Refer to the Outline Dimension in the page 26 for further information.

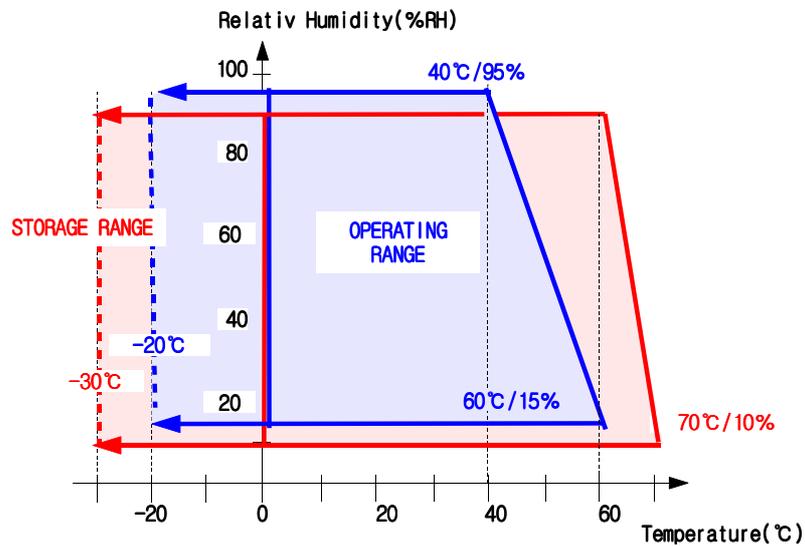
1. Absolute Maximum Ratings

1.1 Absolute Ratings of Environment

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T _{STG}	-30	70	°C	(1)
Operating temperature (Ambient temperature)	T _{OPR}	-20	60	°C	(1),(2)

Note (1) 95 % RH Max. (40 °C ≥ Ta)

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



- (2) In case of below 0° , the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one.
Level of retardation depends on temperature, because of LC's characteristics.

1.2 Electrical Absolute Ratings

(1) TFT-LCD Module

(Ta = 25 ± 2°C, V_{ss}=GND=0)

Item	Symbol	Min.	Max.	Unit	Note
Logic supply voltage	V _{CC}	-0.3	4.6	V	-
DC/DC supply voltage	V _{Cl}	-0.3	4.6	V	-

(2) Back-Light Unit

(Ta = 25 ± 2°C)

Item	Symbol	Min.	Max.	Unit.	Note
Current	I _B	-	25	mA	(1)

Note (1) Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded.

Functional operation should be restricted to the conditions described under normal operating conditions.

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: LCD-7200, BM-5A, BM-7, PR-650, EZ-Contrast

($T_a = 25 \pm 2^\circ\text{C}$, $V_{CC} = V_{CI} = 2.8\text{V}$, $I_B = 15\text{mA}$)

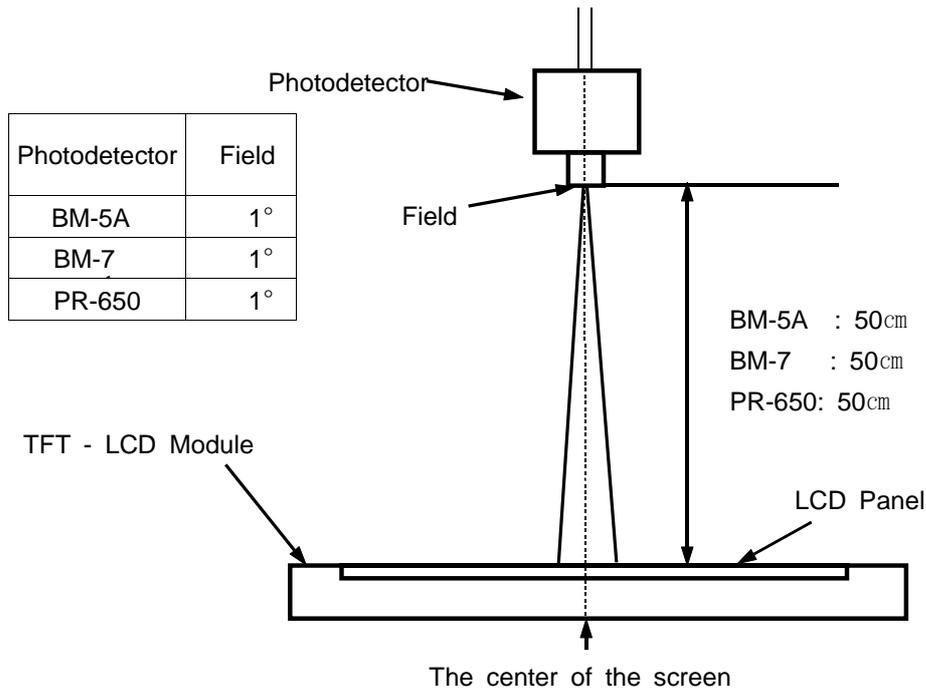
Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note		
Reflectance	Rf	B/L Off	(0.5)	(1.0)	-	%	(2) LCD-7200		
Contrast ratio (Center point)	C/R	NOTE (1)	(100)	(150)	-	-	(3) BM-5A		
Luminance of white (Center point)	YL		(100)	(150)	-	cd/m2	(4) BM-5A		
Response time	Rising:Tr Falling:Tf		Tr+Tf	$\phi = 0$ $\theta = 0$	-	(20)	(40)	msec	(5) BM-7
Color chromaticity (CIE 1931)	White	Wx	Normal Viewing Angle	B/L On	TBD	(0.322)	TBD	-	(6) PR-650
		Wy			TBD	(0.345)	TBD		
	Red	Rx			TBD	(0.568)	TBD		
		Ry			TBD	(0.356)	TBD		
	Green	Gx			TBD	(0.346)	TBD		
		Gy			TBD	(0.526)	TBD		
	Blue	Bx			TBD	(0.149)	TBD		
		By			TBD	(0.159)	TBD		
Viewing angle	Hor.	θ_L	$C/R \geq 10$ B/L On	TBD	(40)	-	Degrees	(7) Ez-Contrast	
		θ_R		TBD	(40)	-			
	Ver.	ϕ_H		TBD	(40)	-			
		ϕ_L		TBD	(15)	-			

Note (1) Test Equipment Setup

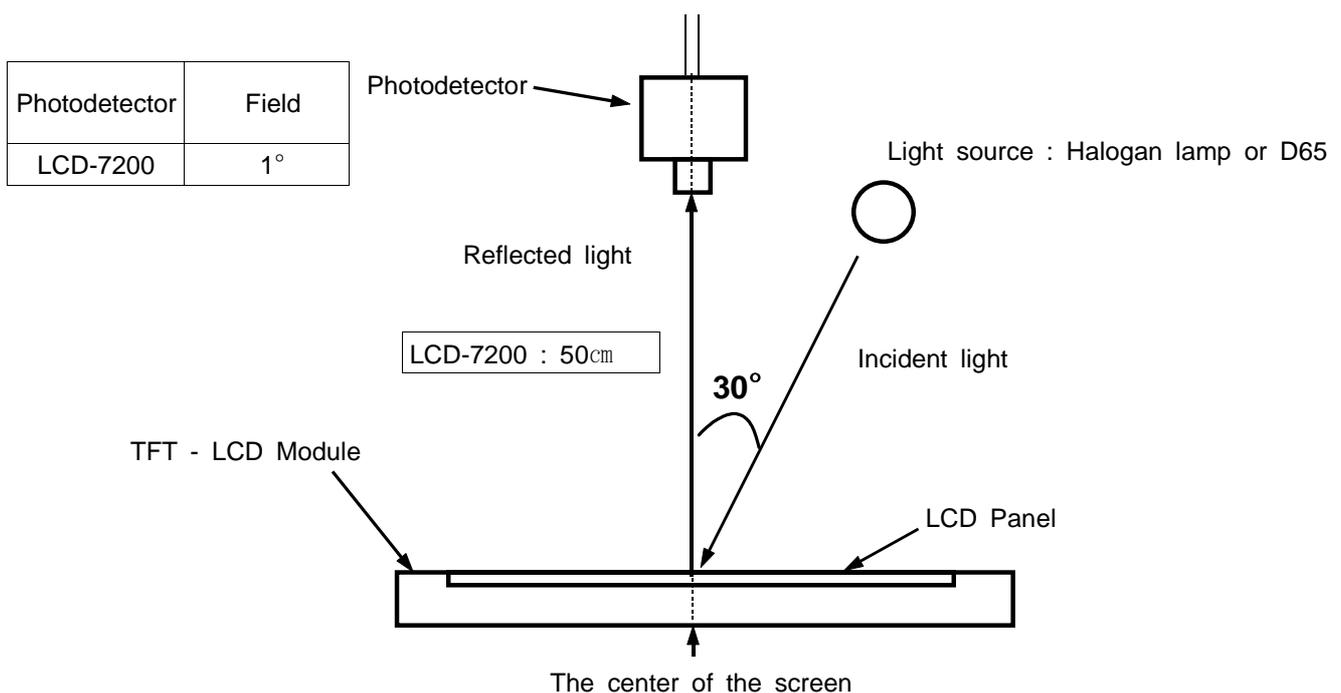
After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the back-light. This should be measured in the center of screen.

Environment condition : $T_a = 25 \pm 2 \text{ }^\circ\text{C}$

- Back-Light On condition



- Back-Light Off condition



Note (2) Definition of Reflectance : The reflectance is relative quantity to the standard white BaSO₄ or MgO plate that the reflectance of the standard white plate is the 100%.

$$\text{Reflectance} = \frac{\frac{\text{Light intensity of the reflected light on LCD}}{\text{Input intensity of the reflected light on BaSO}_4 \text{ plate}}}{\frac{\text{Output intensity of the reflected light on BaSO}_4 \text{ plate}}{\text{Input intensity of the reflected light on BaSO}_4 \text{ plate}}} \times 100\%$$

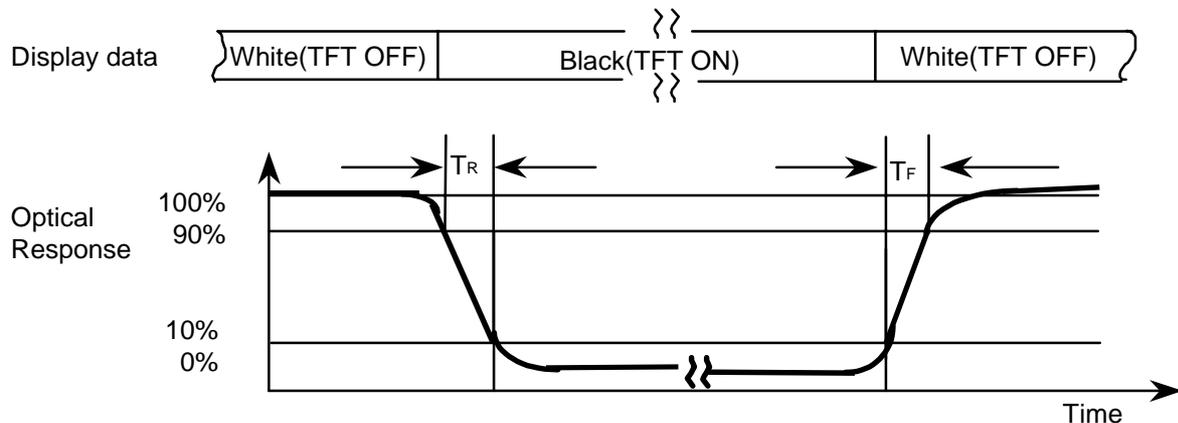
Note (3) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin) at the center point

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

* Gmax : Luminance with all pixels white
 * Gmin : Luminance with all pixels black

Note (4) Definition of Luminance of White : Luminance of white at the center point

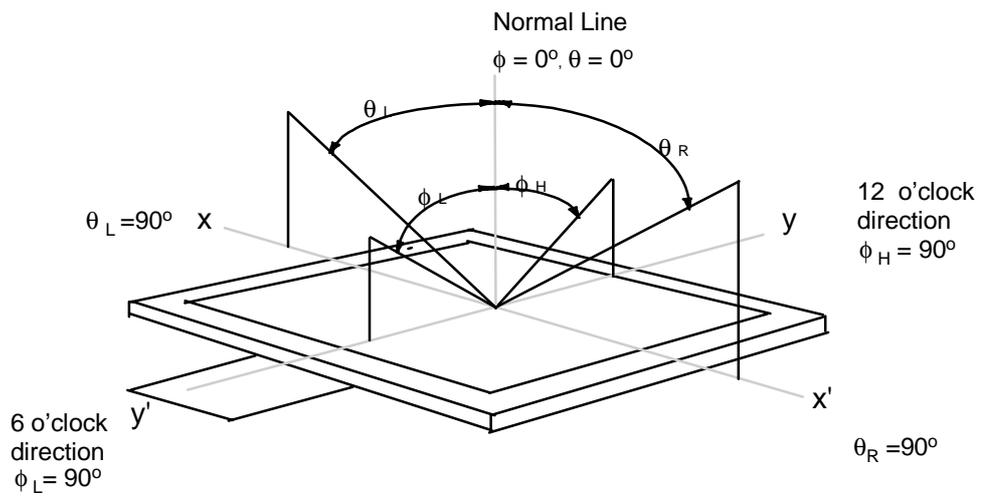
Note (5) Definition of Response time : Sum of Tr ,Tf



Note (6) Definition of Color Chromaticity (CIE 1931)

Color coordinate of white & red, green, blue at center point.

Note (7) Definition of Viewing Angle : Viewing angle range ($CR \geq 2$)



3. Electrical Characteristics

3.1 TFT-LCD Module

(Ta = 25 ± 2°C)

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Logic supply voltage	V _{CC}	1.8	2.8	3.3	V	-
DC/DC supply voltage	V _{CI}	2.5	2.8	3.3	V	-
Current Dissipation	Stand-by	(I _{CC} +I _{CI}) _{STB}	-	-	TBD	(1)
	Sleep	(I _{CC} +I _{CI}) _{SLP}	-	-	TBD	(2)
	Still	(I _{CC} +I _{CI}) _S	-	-	(4.5)	(3),(5)
	Full	(I _{CC} +I _{CI}) _F	-	-	(5.5)	(4),(5)
Internal frequency	f _{Vsync}	-	60	-	Hz	-
Frame rate	R _{frame}	-	-	fvsync	Frame	-

* To prevent a latch-up or DC operation of the LCD module, the power on/off sequence should be as the Chapter 8. TFT-LCD Driver IC Control Algorithms

Note (1) V_{CC} = V_{CI} = 2.8V, Stand-by mode & No input signals

(2) V_{CC} = V_{CI} = 2.8V, Sleep mode & No input signals

(3) V_{CC} = V_{CI} = 2.8V, Internal Mode & No input signals

(4) V_{CC} = V_{CI} = 2.8V, f_{Vsync} = 60Hz, R_{frame} = 15Frame

(5) Dissipation current check pattern

► Black Pattern



3.2 Back-Light unit

The back-light system is an edge-lighting type with three white LED(Light Emitting Diode)s.

(Ta=25 ± 2°C)

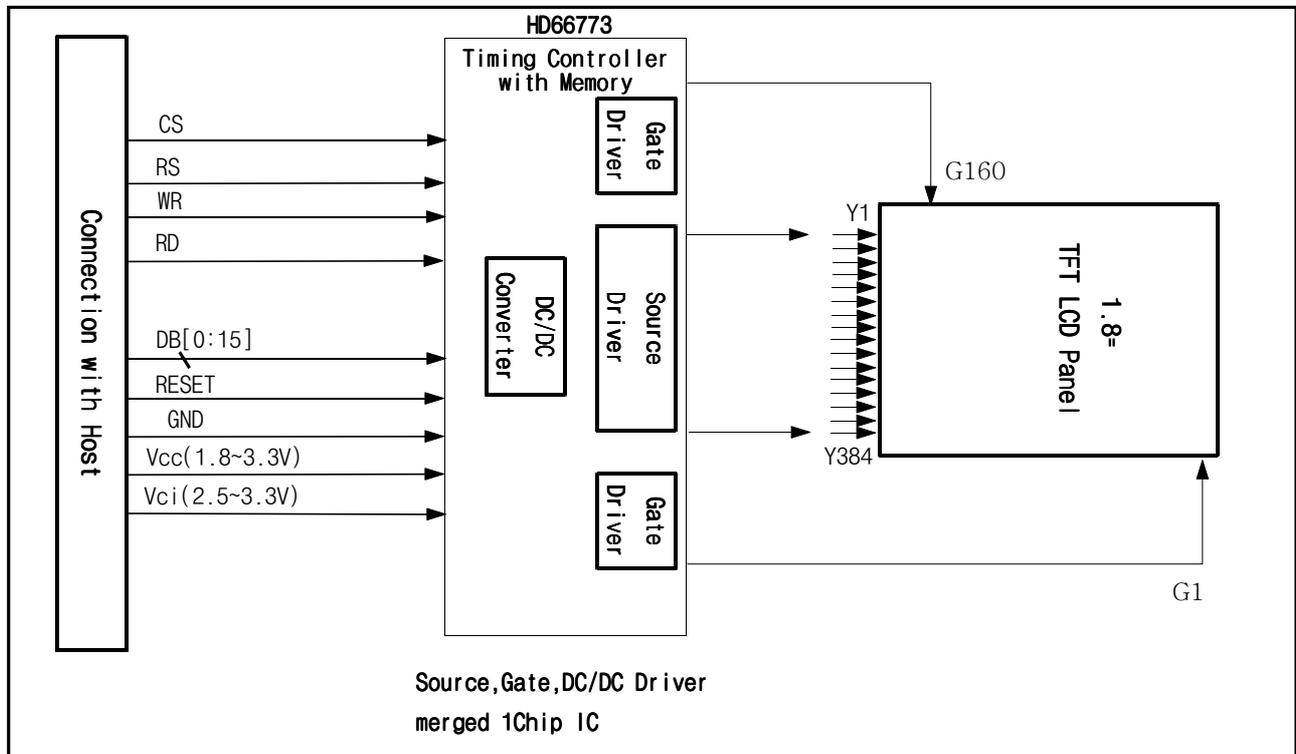
Item	Symbol	Min.	Typ.	Max.	Unit	Note
Current	I _B	-	15	20	mA	(1)
Power Consumption	P _{BL}	120	150	180	mW	(2)

Note (1) Three LEDs serial type.

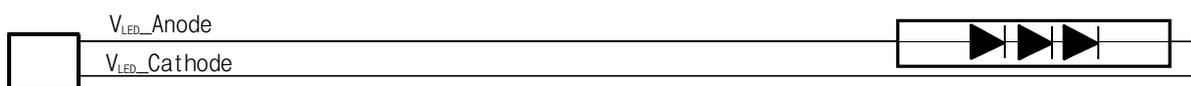
(2) Where $I_B = 15\text{mA}$, $V_B = P_{BL} / I_B$

4. Block Diagram

4.1 TFT-LCD Module (Interface System Structure)



4.2 Back-light Unit



5. Input Terminal Pin Assignment

5.1 Input Signal & Power (Connector : 27Pin FPC Hot-Bar type)

Pin No	Symbol	Description	Remark
1	NC	No Connection	-
2	GND	Power Ground	-
3	GND	Power Ground	-
4	CS	Chip Selesct	Input
5	RS	Command(L) / Data(H)	Input
6	WR	Write	Input
7	RD	Read(VCC)	Input
8	D0	Data 0	Input
9	D1	Data 1	Input
10	D2	Data 2	Input
11	D3	Data 3	Input
12	D4	Data 4	Input
13	D5	Data 5	Input
14	D6	Data 6	Input
15	D7	Data 7	Input
16	D8	Data 8	Input
17	D9	Data 9	Input
18	D10	Data 10	Input
19	D11	Data 11	Input
20	D12	Data 12	Input
21	D13	Data 13	Input
22	D14	Data 14	Input
23	D15	Data 15	Input
24	RESET	Data 16	Input
25	VCC	Logic Power	Input
26	VCI	DC/DC converter power	Input
27	NC	No Connection	

5.2 Back-Light Unit (Connector : 2Pin FPC Solder type)

Pin No.	Symbol	Fucntion
1	Anode	LED Input Terminal
2	Cathode	GND

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

COLOR	DISPLAY	DATA SIGNAL															GRAY SCALE LEVEL	
		RED					GREEN					BLUE						
		R0	R1	R2	R3	R4	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3		B4
BASIC COLOR	BLACK	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	1	1	1	1	1	-
	GREEN	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	-
	CYAN	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	-
	RED	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	-
	MAGENTA	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	-
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	-
	WHITE	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	R0
	DARK ↑	1	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	R2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R28
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	LIGHT ↓	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	R29
		0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	R30
	RED	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	R31
GRAY SCALE OF GREEN	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G0
	DARK ↑	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	G1
		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	G2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G60
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	LIGHT ↓	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	G61
		0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	G62
	GREEN	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	G63
GRAY SCALE OF BLUE	BLACK	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	1	0	0	0	0	B1
		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	B2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B28
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	LIGHT ↓	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	B29
		0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	B30
	BLUE	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	B31

Note) Definition of Gray :

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

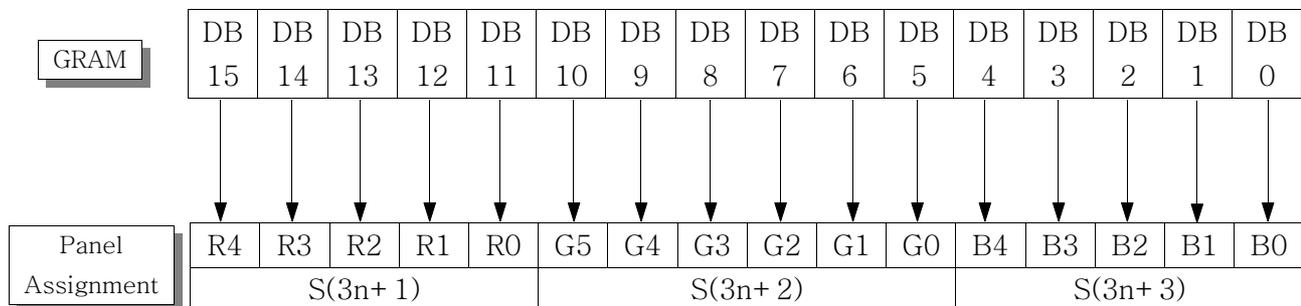
Input Signal : 0 = Low level voltage, 1 = High level voltage

6. Interface Specifications

6.1 Register Selection

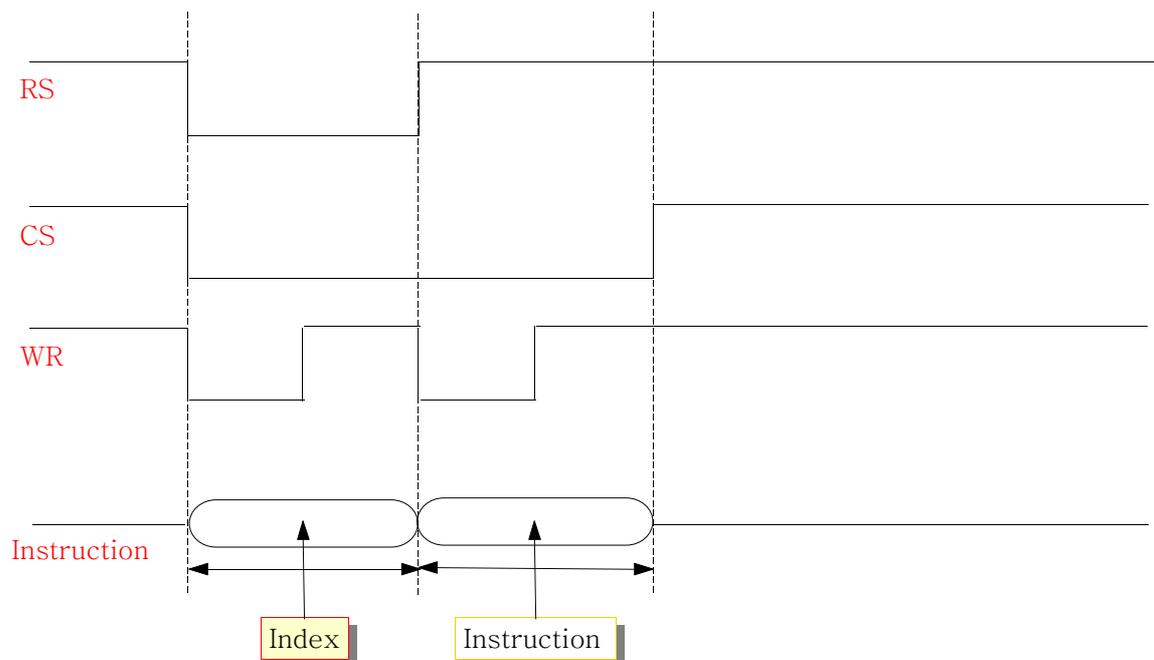
WR	RD	RS	Operation
0	1	0	Write of index
1	0	0	Read of internal status
0	1	1	Write to control register
1	0	1	Read from the GRAM

6.2 Data Format for 16bit CPU Interface

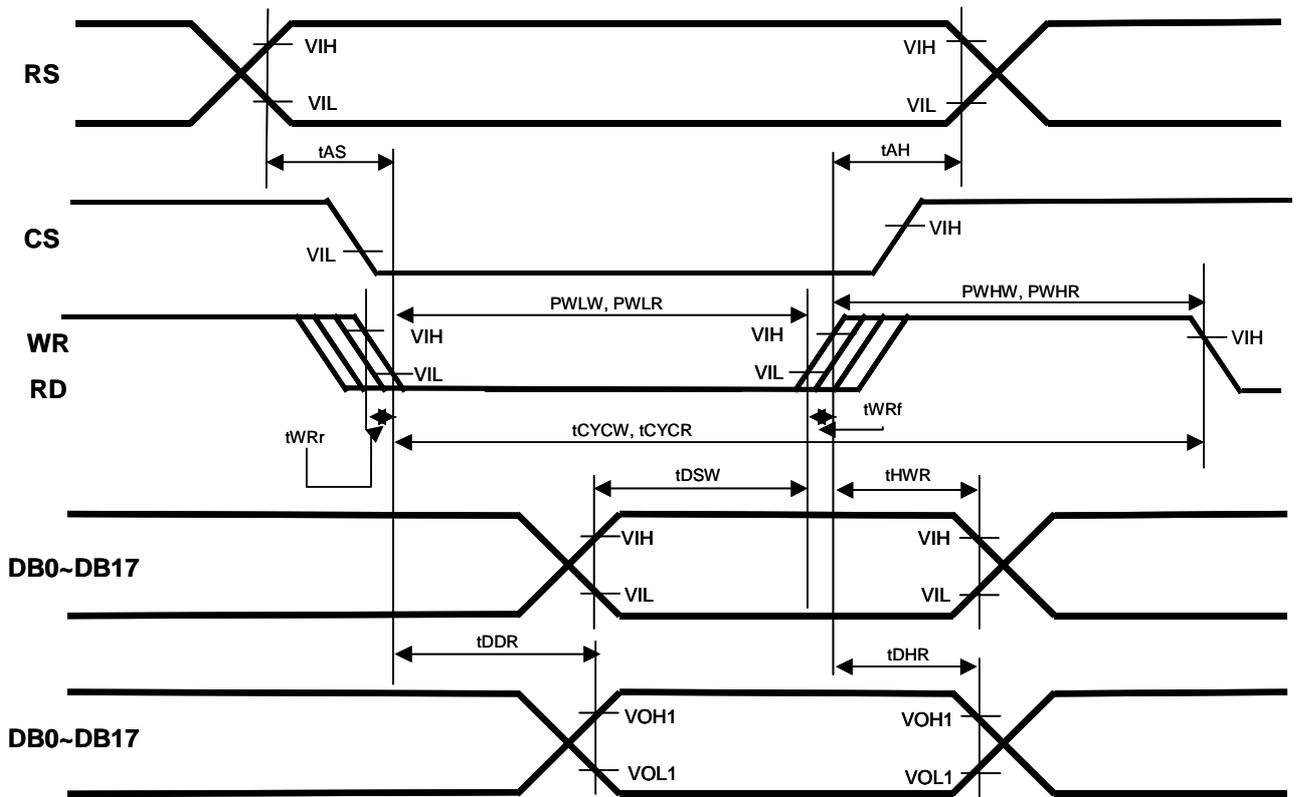


6.3 16bit CPU Interface Timing

1) Input Signal Timing



1) Input Signal Timing



6.4 DC Characteristics

($T_a = -30$ to $+70^\circ\text{C}$, $V_{CC} = 1.8$ to 3.3V , $\text{GND} = 0\text{V}$)

Item	Symbol	Min.	Typ.	Max.	Unit
High level input voltage	V_{IH}	$0.8V_{CC}$	-	V_{CC}	V
Low level input voltage	V_{IL}	0	-	$0.2V_{CC}$	

6.5 AC Characteristics

($T_a = -30$ to $+70^\circ\text{C}$, $V_{CC} = 1.8$ to 2.4V , $\text{GND} = 0\text{V}$)

1) setup 1 : $V_{CC} = 1.8 \sim 2.4\text{v}$ HWM=0

Item	Symbol	Min	Typ	Max	unit
E_RD cycle time	t_{CYCW}	600	-	-	ns
	t_{CYCR}	800	-	-	ns
E_RD pulse width low	PW_{LW}	90	-	-	ns
	PW_{LR}	350	-	-	ns
E_RD pulse width high	PW_{HW}	300	-	-	ns
	PW_{HR}	400			
Pulse rise/fall time	$t_{\text{WRr}, \text{WRf}}$	-	-	25	ns
Chip select setup time	t_{AS}	10	-	-	ns
Chip select hold time	t_{AH}	5	-	-	ns
DB setup time	t_{DSW}	60	-	-	ns
DB hold time	t_{HWR}	15	-	-	ns
DB output setup time	t_{DDR}	-	-	200	ns
DB output hold time	t_{DHR}	5	-	-	ns

2)setup 2 : $V_{CC} = 1.8 \sim 2.4\text{v}$ HWM=1

Item	Symbol	Min	Typ	Max	unit
E_RD cycle time	t_{CYCW}	200	-	-	ns
	t_{CYCR}	800	-	-	ns
E_RD pulse width low	PW_{LW}	90	-	-	ns
	PW_{LR}	350	-	-	ns
E_RD pulse width high	PW_{HW}	90	-	-	ns
	PW_{HR}	400			
Pulse rise/fall time	$t_{\text{WRr}, \text{WRf}}$	-	-	25	ns
Chip select setup time	t_{AS}	10	-	-	ns
Chip select hold time	t_{AH}	5	-	-	ns
DB setup time	t_{DSW}	60	-	-	ns
DB hold time	t_{HWR}	15	-	-	ns
DB output setup time	t_{DDR}	-	-	200	ns
DB output hold time	t_{DHR}	5	-	-	ns

3)setup 3 : Vcc = 2.4 ~ 3.3v HWM=0

Item	Symbol	Min	Typ	Max	unit
E_RD cycle time	t _{CYCW}	200	-	-	ns
	t _{CYCR}	300	-	-	ns
E_RD pulse width low	PW _{LW}	40	-	-	ns
	PW _{LR}	150	-	-	ns
E_RD pulse width high	PW _{HW}	100	-	-	ns
	PW _{HR}	100			
Pulse rise/fall time	t _{WRr,WRf}	-	-	25	ns
Chip select setup time	t _{AS}	10	-	-	ns
Chip select hold time	t _{AH}	2	-	-	ns
DB setup time	t _{DSW}	60	-	-	ns
DB hold time	t _{HWR}	2	-	-	ns
DB output setup time	t _{DDR}	-	-	100	ns
DB output hold time	t _{DHR}	5	-	-	ns

4)setup 4 : Vcc = 2.4 ~ 3.3v HWM=1

Item	Symbol	Min	Typ	Max	unit
E_RD cycle time	t _{CYCW}	100	-	-	ns
	t _{CYCR}	300	-	-	ns
E_RD pulse width low	PW _{LW}	40	-	-	ns
	PW _{LR}	150	-	-	ns
E_RD pulse width high	PW _{HW}	40	-	-	ns
	PW _{HR}	100			
Pulse rise/fall time	t _{WRr,WRf}	-	-	25	ns
Chip select setup time	t _{AS}	10	-	-	ns
Chip select hold time	t _{AH}	2	-	-	ns
DB setup time	t _{DSW}	60	-	-	ns
DB hold time	t _{HWR}	2	-	-	ns
DB output setup time	t _{DDR}	-	-	100	ns
DB output hold time	t _{DHR}	5	-	-	ns

7. Reset

If the /RESET input becomes L or the reset command is input, the each register to its default value. These default values are listed in the table below.

Register		Default	Remark
Start Oscillation	R00	0000H	
Driver output control	R01	0114H	
LCD-driving-waveform	R02	0700H	
Power control 1	R03	0214H	
Power control 2	R04	8000H	
Entry mode	R05	0230H	
Display control	R07	0104H	
Frame cycle control	R0B	0000H	
Power control 3	R0C	0000H	
Power control 4	R0D	0502H	
Power control 5	R0E	0000H	
Gate scan control	R0F	0000H	
Vertical scroll control	R11	0000H	
1st screen driving position	R14	5C00H	
2nd screen driving position	R15	9F5DH	
Horizontal RAM address position	R16	7F00H	
Vertical RAM address position	R17	9F00H	
RAM data mask	R20	0000H	
RAM data address set	R21	0000H	
RAM data read/write	R22	0000H	
γ Control 1	R30	0000H	
γ Control 2	R31	0000H	
γ Control 3	R32	0000H	
γ Control 4	R33	0000H	
γ Control 5	R34	0000H	
γ Control 6	R35	0000H	
γ Control 7	R36	0000H	
γ Control 8	R37	0000H	
γ Control 9	R3A	0000H	
γ Control 10	R3B	0000H	

8. TFT-LCD Driver IC Control Algorithms

8.1 Sub function

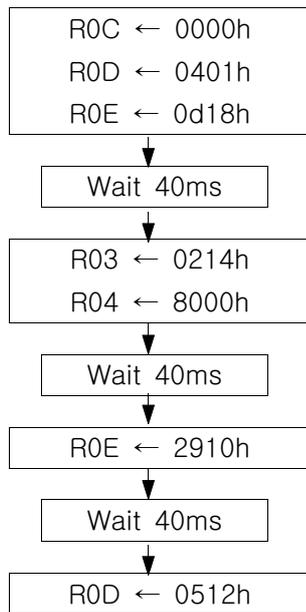
■ Initializing Function 1

R01 ← 0115h
R02 ← 0700h
R05 ← 0230h
R06 ← 0000h
R07 ← 0104h
R0B ← 0000h

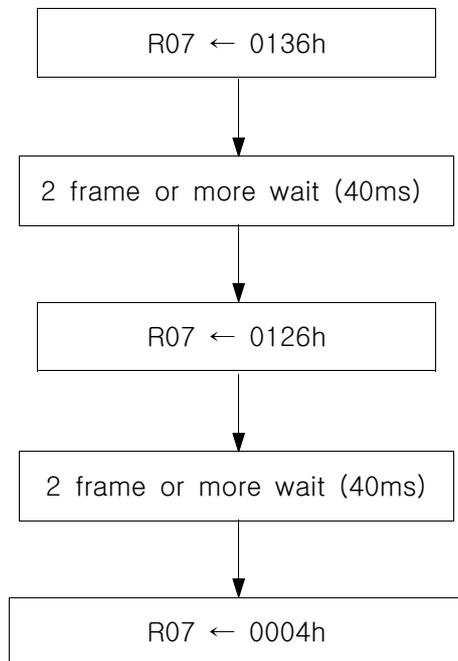
■ Initializing Function 2

R21 ← 0100h
R30 ← 0000h
R31 ← 0000h
R32 ← 0000h
R33 ← 0000h
R34 ← 0000h
R35 ← 0707h
R36 ← 0707h
R37 ← 0000h
R0F ← 0000h
R11 ← 0000h
R14 ← 5C00h
R15 ← A05Dh
R16 ← 7F00h
R17 ← A000h
R3A ← 0000h
R3B ← 0000h

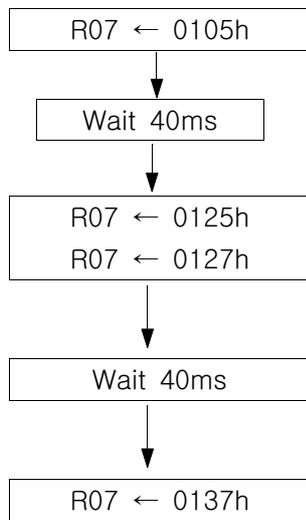
■ Power Setting Function



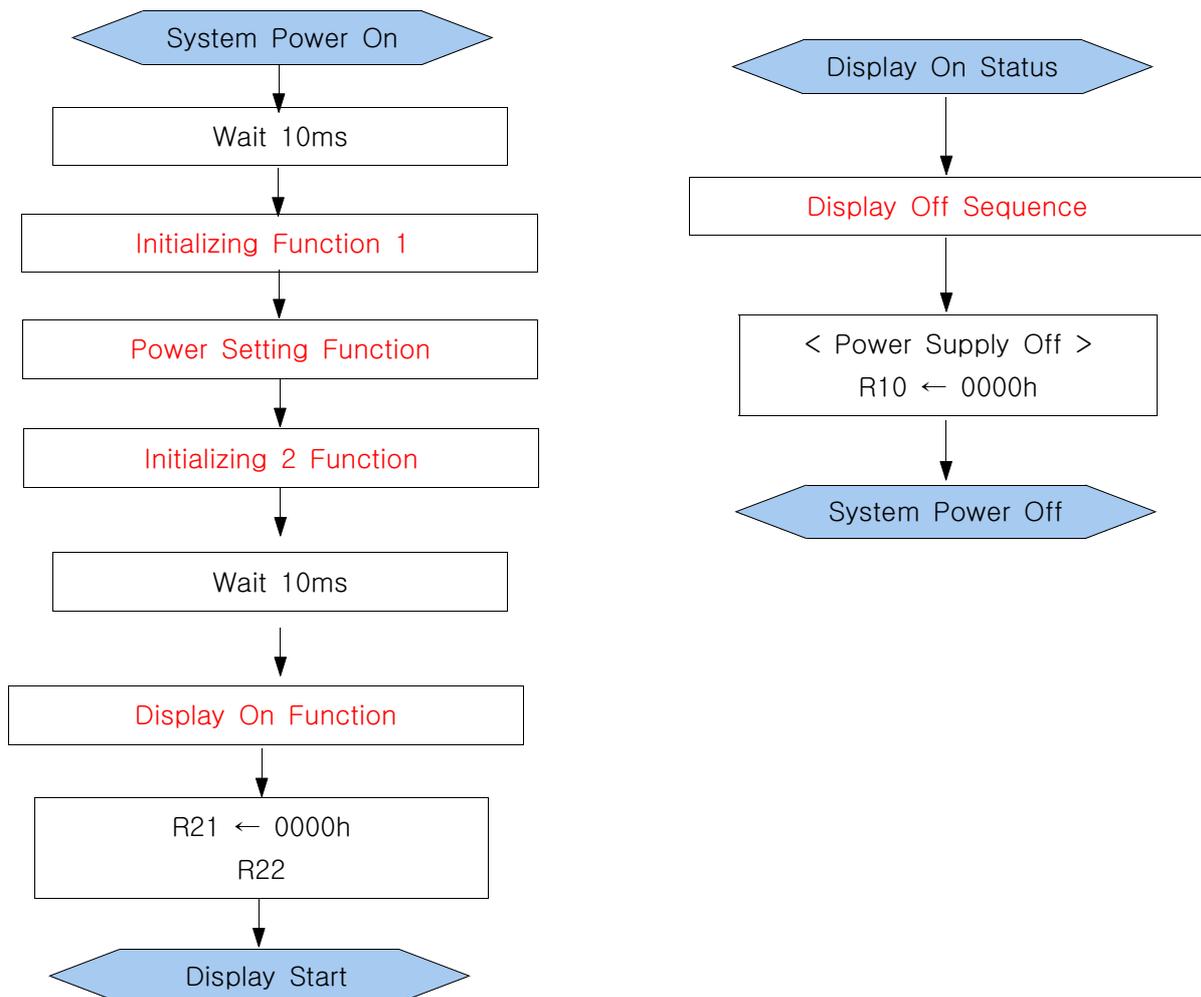
■ Display Off Function



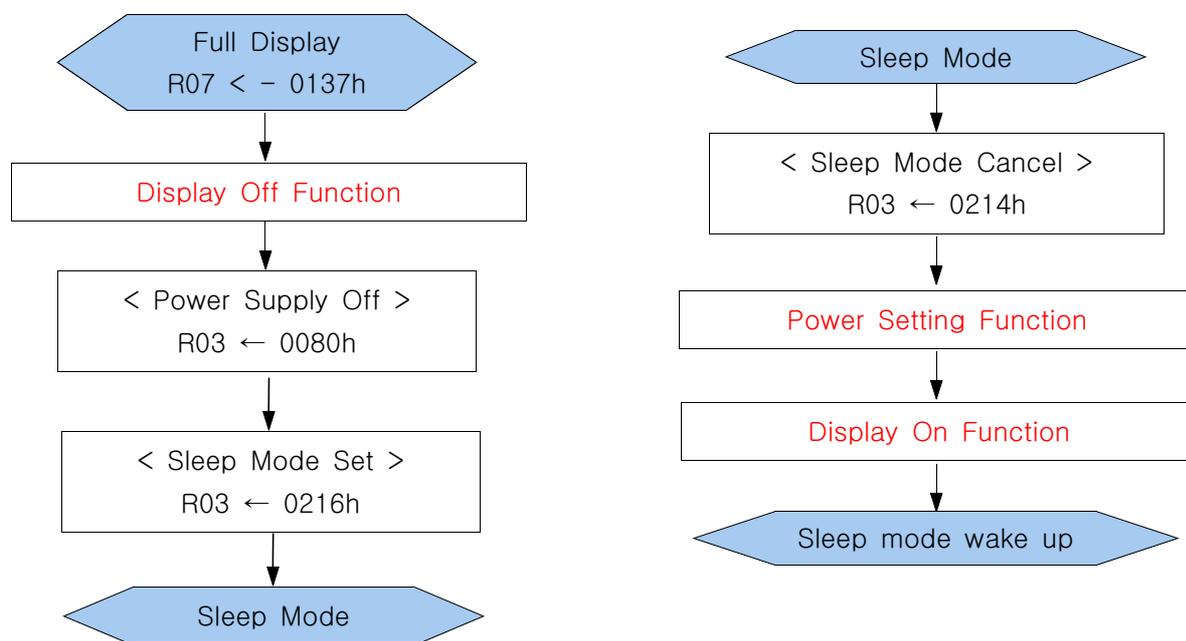
■ Display On Function



8.2 Power On/Off Sequence



8.3 Sleep Mode/ Wake up Sequence [Oscillator is ON]



Note (1) During sleep mode, GRAM data and instructions are retained.

Note (2) In the sleep mode, the system must stop sending CPU I/F signals.

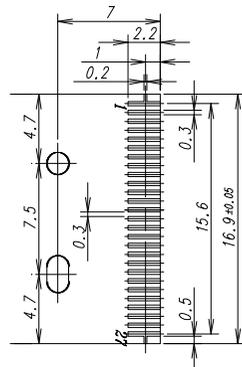
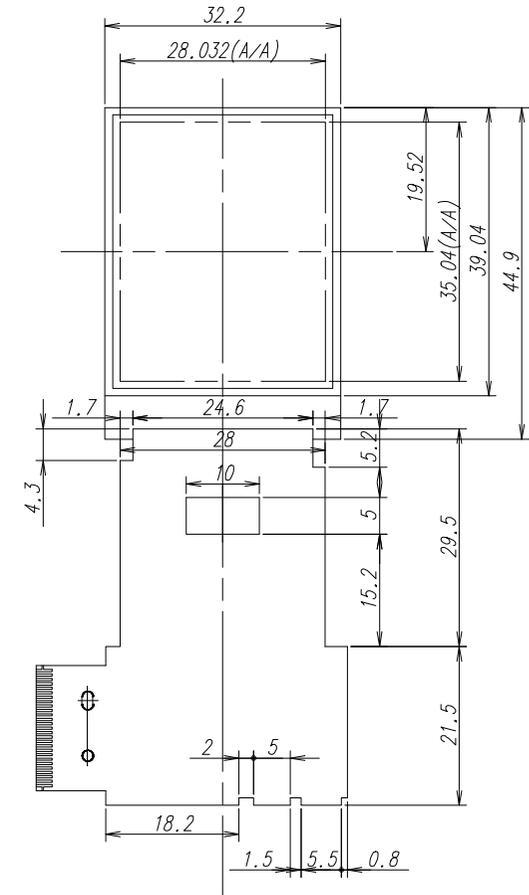
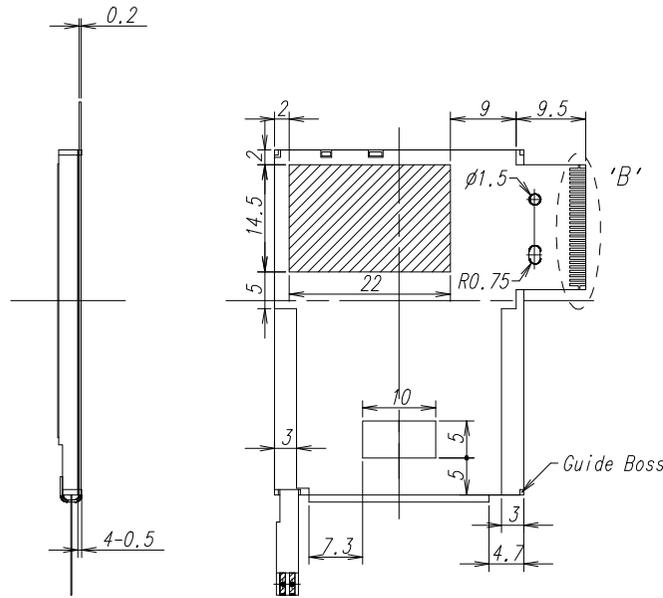
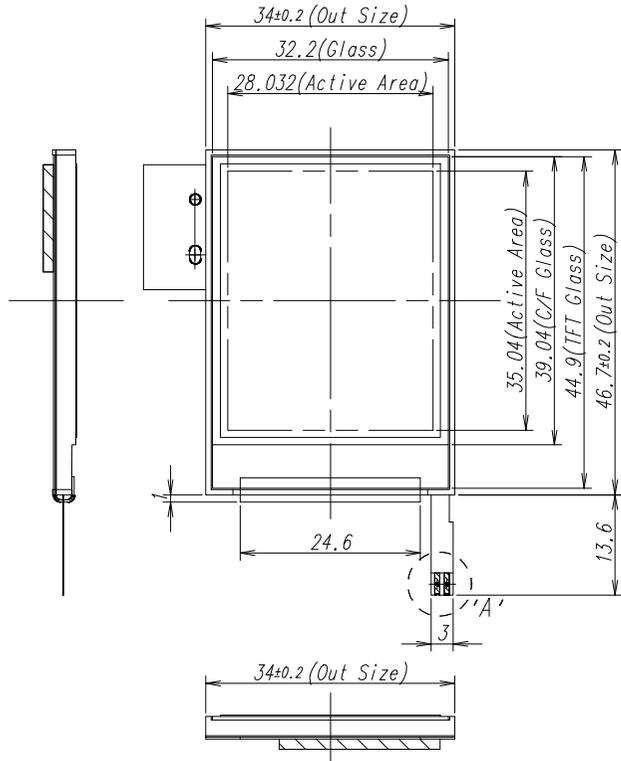
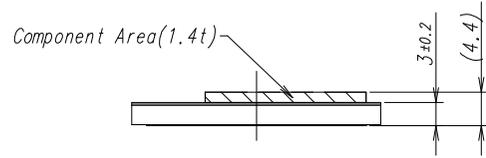
8.4 Stand by Mode/ Wake up Sequence [Oscillator is OFF]



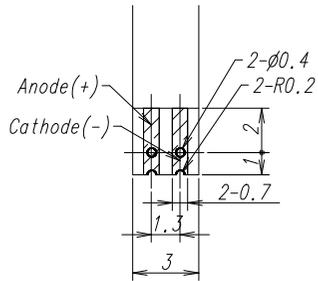
9. Outline Dimension

See the next page.

NO	PART NAME	CODE NO	SPECIFICATION	Q'TY	SPEC NO	REMARK



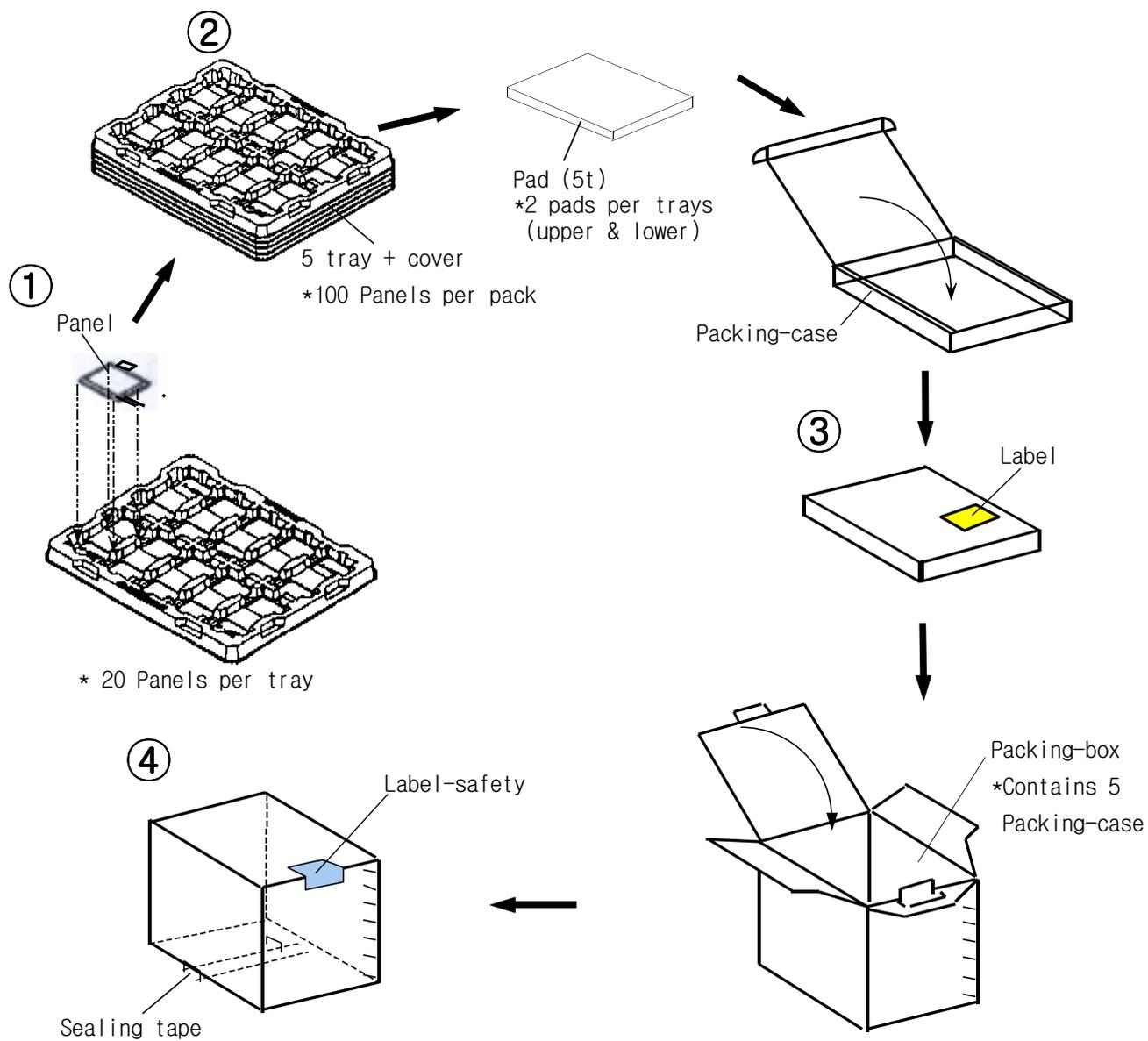
Detail 'B' (S=3/1)



Detail 'A' (S=3/1)

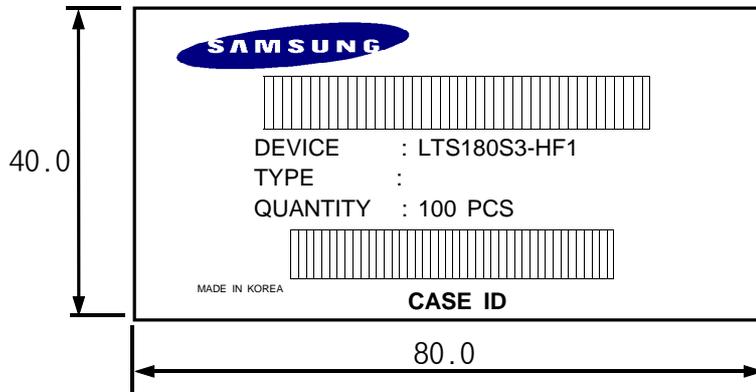
GENERAL TOLERANCE				REV		DATE							
STEP	LEVEL 1	LEVEL 2	LEVEL 3	UNIT	mm	DRA'N BY	DES'D BY	CHK'D BY	APP'D BY	MODEL NAME	LTS180S3-HF1		
0 < X ≤ 4	±0.05	±0.1	±0.2	SCALE	1/1	K.D.LEE		I.S.LEE		PART/SHEET NAME	Out Dimension	SHEET	1/1
4 < X ≤ 16	±0.08	±0.15	±0.3	TOLERANCE		02.04.10		02.04.10				VER.	09
16 < X ≤ 64	±0.12	±0.25	±0.5	SAMSUNG ELECTRONICS								CODE NO.	
64 < X ≤ 256	±0.25	±0.4	±0.8									SPEC. NO	

10. Packing



11. Marking & Others

Packing case attach



CASE ID : V 00 00 00001



12. General Precautions

12.1 Handling

- (a) When the module is assembled, it should be attached to the system firmly. Be careful not to twist and bend the module.
- (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 back-light unit.
- (c) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a B 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) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (l) Pins of I/F connector shall not be touched directly with bare hands.

12.2 Storage

- (a) Do not leave the panel in high temperature, and high humidity for a long time. It is highly recommended to store the module with temperature from 0 to 35° C 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.

12.3 Operation

- (a) Do not connect, disconnect the module in the "Power On" condition.
- (b) Power supply should always be turned on/off by the chapter 8 TFT-LCD Driver IC Operation Algorithms.

12.4 Others

- (a) The Liquid crystal is deteriorated by ultraviolet, do not leave it in direct sunlight and strong ultraviolet ray for many hours.
- (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, and so on)
Otherwise the panel may be damaged.
- (d) If the panel 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 panel has its circuitry FPC on the bottom side and should be handled carefully in order not to be stressed.