

SAMSUNG

ELECTRONICS

Preliminary

TO :

DATE : Sep. 2006

SAMSUNG TFT-LCD

MODEL NO. : LMS350GF01-001

Approved by : _____

LCD DIVISION

Samsung Electronics Co., Ltd.

Revision History

Preliminary

Data	Rev. No.	Page	Summary
2006.08.31	000		

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General Description

* Description

LTV350QV-Fxx is a TMR(Transmissive with Micro Reflective) 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 a 3.5" contains 320RGBx240 dots and can display up to 16.7M colors.

* Features

- Transmissive with Micro Reflective type and back-light with six LED's are available.
- TN(Twist Nematic) mode.
- Line inversion mode with stripe type.
- 24bit RGB Interface + Serial Peripheral Interface(SPI)
- DE(Data Enable, Dotclk) mode, SYNC(Vsync, Hsync, Dotclk) mode
- Gate Driver IC embeded on Panel(Dual ASG)
- Low Power consumption.

* Applications

- Display terminals for P-CNS(Portable Car Navigation System), DSC(Digital Still Camera), PMP(Portable Multimedia Player), Voip(Voice Over Internet Protocol) Phone application products.

* General information

Items	Specification	Unit	Note
Display area	70.08(H) x 52.56(V)	mm	-
Driver element	a-Si TFT active matrix	-	-
Display colors	16.7M	colors	-
Number of pixels	320RGB(H) x 240(V)	dot	-
Pixel arrangement	stripe type	-	-
Pixel pitch	0.219(H) x 0.219(V)	mm	-
Display mode	Normally White	-	-
Viewing direction	6	o'clock	-

* Mechanical information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal(H)	TBD	TBD	TBD	mm	-
	Vertical(V)	TBD	TBD	TBD	mm	(1)
	Depth(D)	TBD	TBD	TBD	mm	(1)
Weight		-	43	48	g	-

Note (1) Not include FPC.

Refer to the Outline Dimension in the "9.Outline Dimension" for further information.

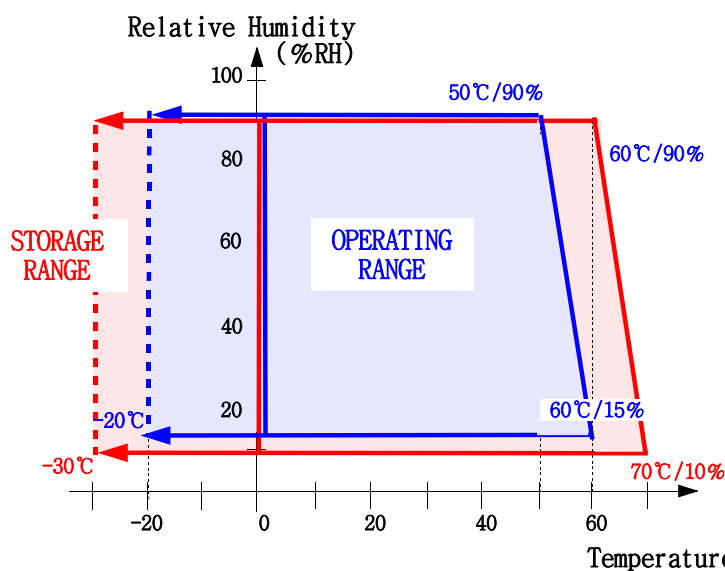
1. Absolute Maximum Ratings

1.1 Environment

ITEM	MIN	MAX	REMARK
Storage Temperature	-30℃	70℃	Note(1)
Operating Temperature	-20℃	60℃	Note(2)(3)

Note(1) 90%RH maximum humidity, 60℃ maximum wet-bulb temperature

- (2) When operated at a temperature lower than 0℃,
the LCD worked slowly and the screen appeared low-contrast images
due to the characteristics of LC(Liquid Crystal).
- (3) If any fixed pattern is displayed on LCD for minutes,
image-sticking phenomenon may occur.



Temperature & Humidity Graph at Absolute Environment

1.2 Electrical Absolute Ratings**(1) TFT-LCD Module**(Ta = 25°C, V_{ss}=GND=0)

Characteristics	Symbol	Min.	Max.	Unit	Note
Power supply voltage	V _{CC}	-0.5	3.6	V	-
I/O Power supply voltage	V _{ci}	-0.5	3.6	V	-
Input voltage	V _i	-0.5	V _{ci} + 0.5	V	-
Input current	I _i	±10		mA	-

(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-5000, BM-5A, BM-7, PR-650, EZ-Contrast

(Ta = 25 ± 2°C, V_{CC} = V_{CI} = 3.3V, I_B = 20mA)

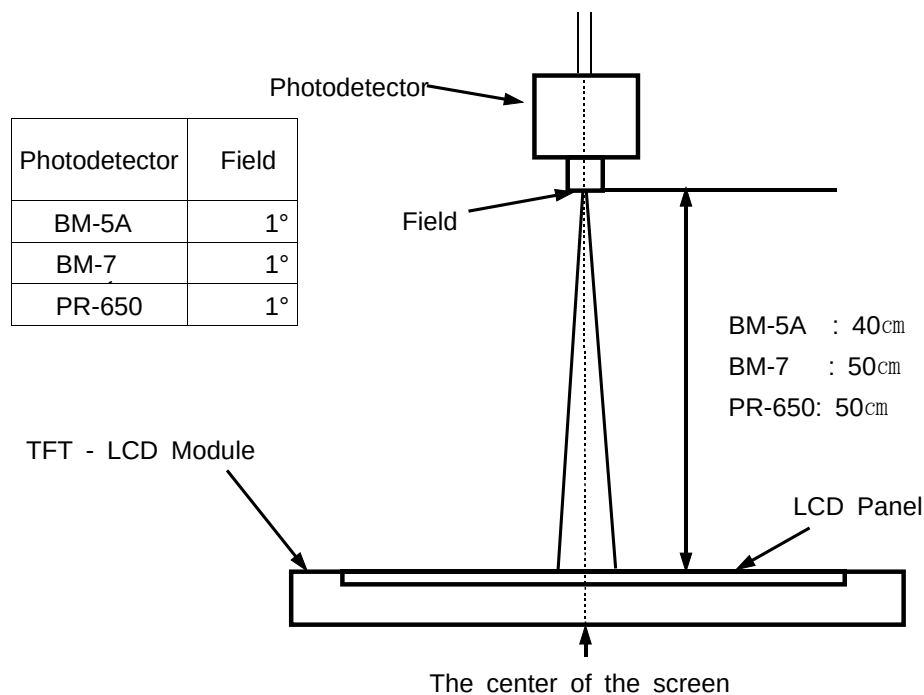
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast ratio (Center point)		C/R	NOTE (1)	-	300	-	-	(2) BM-5A
Luminance of white (Center point)		YL		-	350	-	cd/m ²	(3) BM-5A
Uniformity		-		80	-	-	%	(4) BM-7
Response time	Rising:Tr	Tr+Tf	$\phi = 0$ $\theta = 0$ Normal Viewing Angle	-	250	-	msec	(5) BM-7
	Falling:Tf							
Color chromaticity (CIE 1931)	White	Wx	B/L On		T.B.D		-	(6) PR-650
		Wy			T.B.D			
	Red	Rx			T.B.D			
		Ry			T.B.D			
	Green	Gx			T.B.D			
		Gy			T.B.D			
	Blue	Bx			T.B.D			
		By			T.B.D			
Viewing angle	Hor.	θ L	C/R≥10 B/L On		60		Degrees	(7) Ez-Contrast
		θ R			60			
	Ver.	ϕ H			50			
		ϕ L			55			

Note (1) Test Equipment Setup

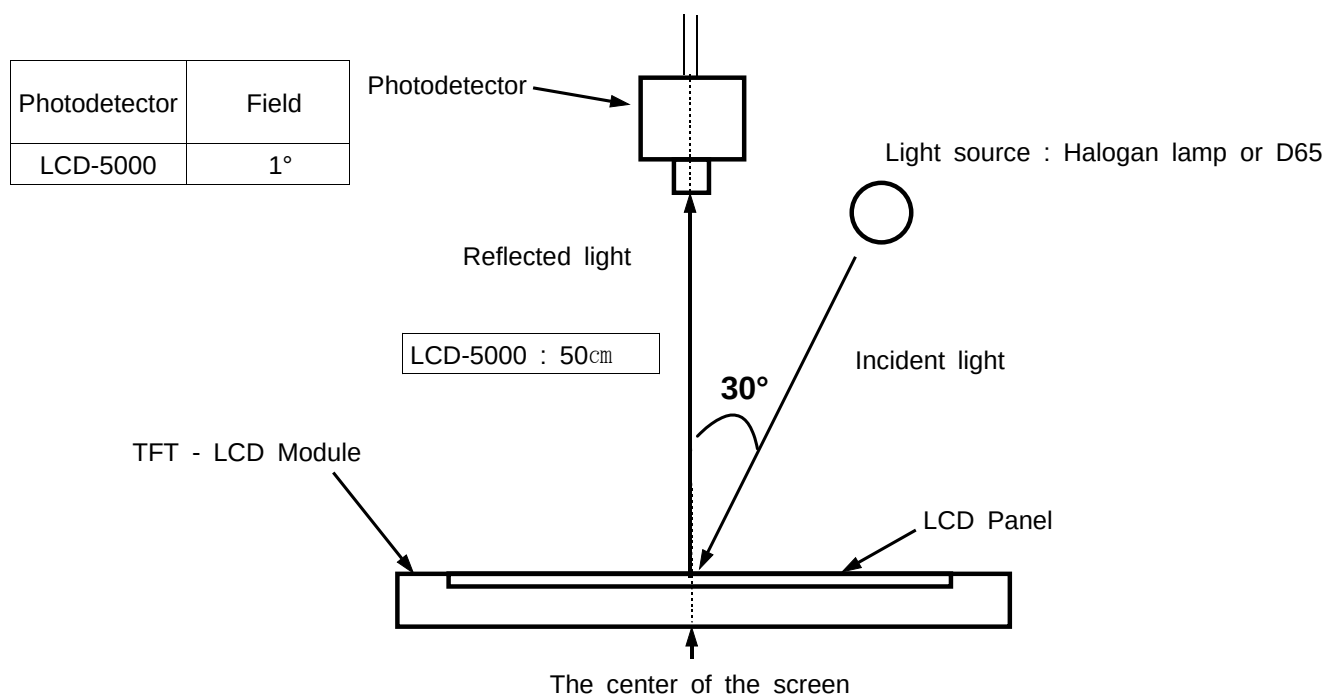
After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the back-light. This should be measured in the center of screen.

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

Back-Light On condition



Back-Light Off condition



Optical Measuring Equipment Setup

Note (2) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin) at the center point

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

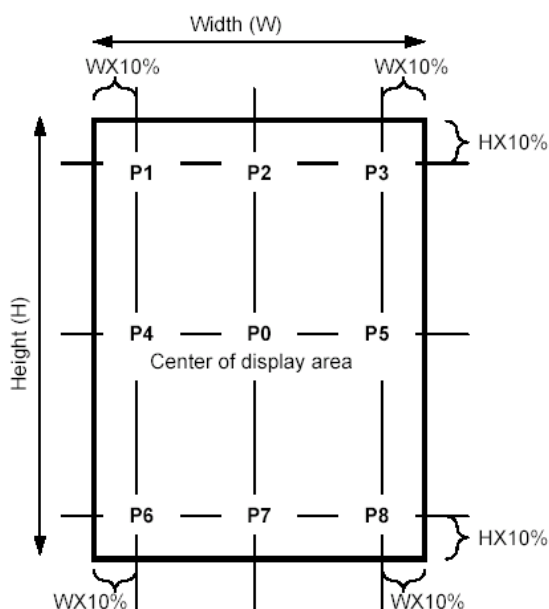
* Gmax : Luminance with all pixels white

* Gmin : Luminance with all pixels black

Note (3) Definition of Luminance of White : Luminance of white at the center point

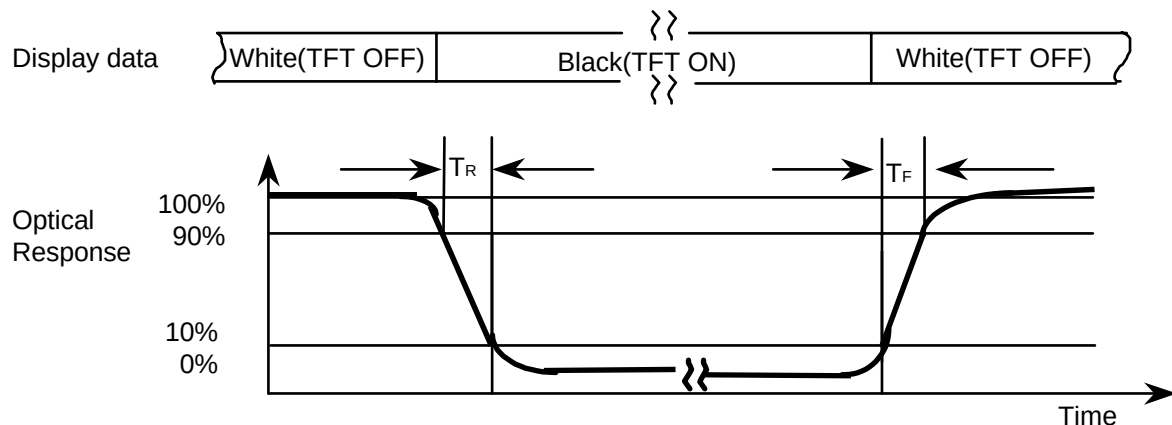
Note (4) Definition of brightness uniformity

Measure 9 point (P0~P8) and define the brightness uniformity using



$$\text{Brightness Uniformity} = \frac{\text{Minimum Brightness Among P0~P8}}{\text{Maximum Brightness Among P0~P8}} \times 100$$

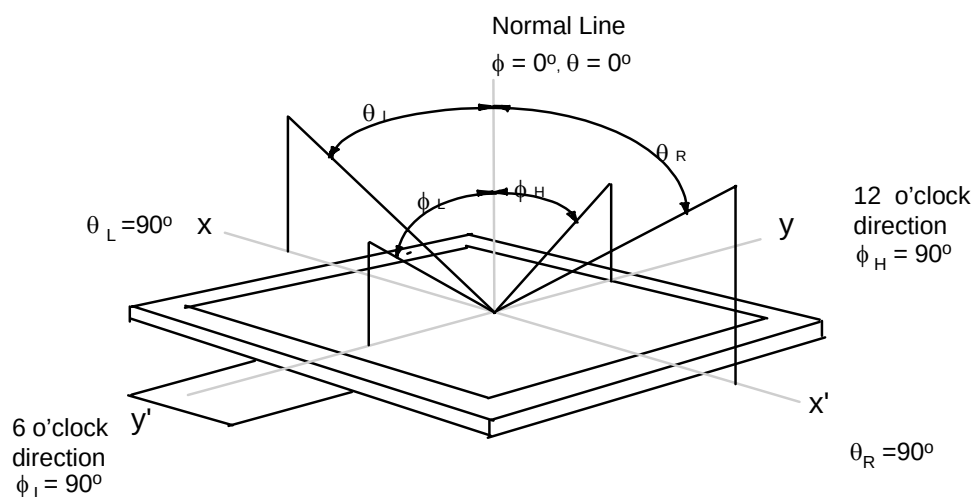
Note (5) Definition of Response time : Sum of T_R , T_F



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 ($CR \geq 10$)



3. Electrical Characteristics

3.1 TFT-LCD Module

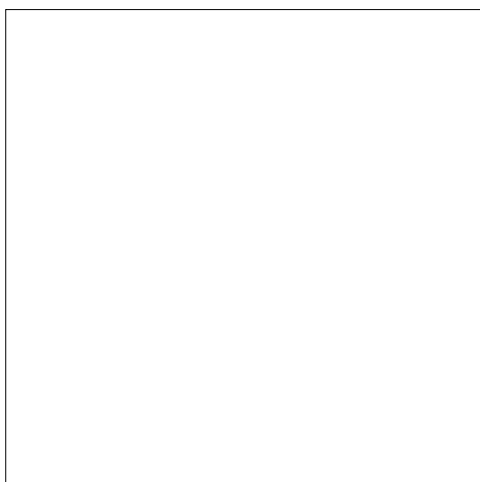
 $T_a = 25 \pm 2^\circ\text{C}$

Characteristics		Symbol	Min.	Typ.	Max.	Unit	Note
Power supply voltage		V _{CC}	3.0	3.3	3.6	V	-
IO Power supply voltage		V _{ci}	3.0	3.3	3.6	V	-
Power Dissipation	Black	P	-	33(30)	43(40)	mW	(1),(2)
	White	P _{FULL}		47(40)	56(50)		
Current Dissipation	Black	I	-	10(9)	13(12)	mA	
	White	I _{FULL}		14(12)	17(15)		
Frame frequency		f _{Frame}		75(60)	-	Hz	-
Dot Clock		DOTCLK		6.8(5.5)	-	MHz	-
Serial Clock		SCL	-	-	4.0	MHz	(3)

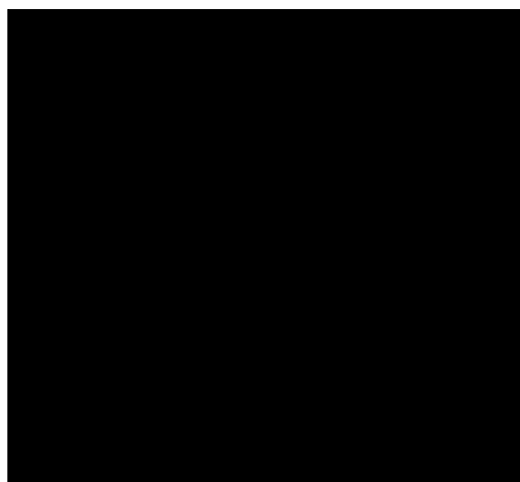
Note (1) $V_{CC} = 3.3\text{V}$, $f_{Frame} = 75(60)\text{Hz}$, DOTCLK = 6.8(5.5)MHz

(2) Dissipation current check pattern

► 255 Gray white pattern



► 0 Gray Black pattern



(3) $V_{ci} = 2.5\sim 3.3\text{V}$

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)

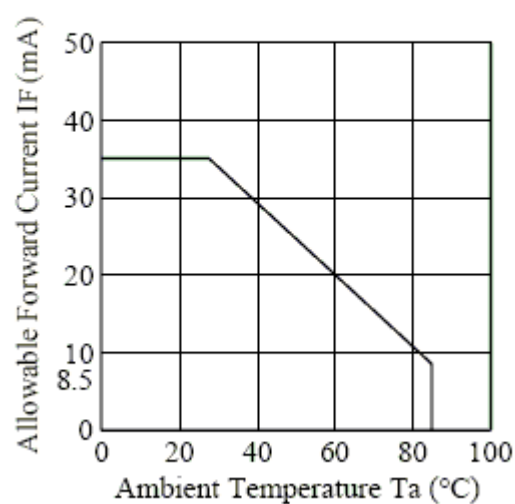
Item	Symbol	Min.	Typ.	Max.	Unit	Note
Current	I_B	-	20		mA	(1),(3)
Power Consumption	P_{BL}	-	400		mW	(2)

Note (1) Six LEDs serial type.

(2) Where $I_B = 20\text{mA}$, $V_B = P_{BL} / I_B$

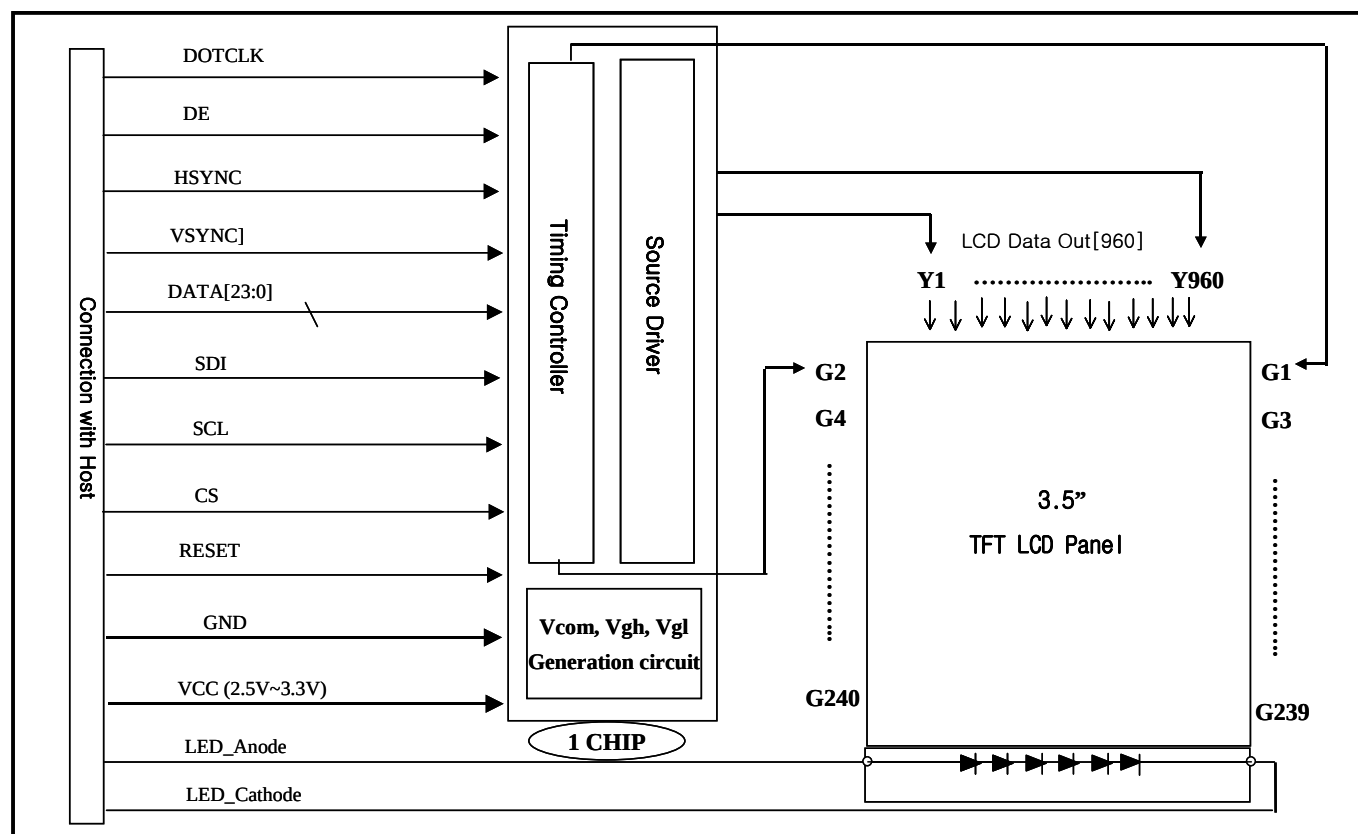
(3) Ambient Temperature vs. Allowable Forward current.

■ Ambient Temperature vs. Allowable Forward Current



4. Block Diagram

4.1 TFT-LCD Module (Interface System Structure) with Back Light Unit



5. Input Terminal Pin Assignment

5.1 Input Signal & Power (Connector : 60Pin FPC Connector type, 0.5mm pitch)

Pin NO	Pin Name	Discription	Pin NO	Pin Name	Discription
1	LED-	Led Anode pin	31	PD0~PD23	bi-directional data Port
2	LED+	Led Cathode pin	32		
3	GND	Ground	33		
4	X1	Touch Pnl' X1	34		
5	Y1	Touch Pnl' Y1	35		
6	X2	Touch Pnl' X2	36		
7	Y2	Touch Pnl' Y2	37		
8	GND	Ground	38		
9	CRTEST	Test pin	39		
10	VGL	A negative power output pin	40		
11	VGH	A positive power output pin	41		
12	IFSEL	Select RGB interface mode	42	DOTCLK	RGB Interface dot clock
13	GND	Ground	43	DE	Data enable signal
14	RESET	System Reset	44	HSYNC	Horizontal sync signal
15	CS	Chip selet	45	VSYNC	Vertical sync signal
16	SCL	serial clock signal	46	VCI	System Input signal
17	SDI	serial data signal	47	RVDD	Internal power Regulated output
18	PD0~PD23	bi-directional data Port	48	VCC	System power Supply
19			49	VDCI	Reference power Voltage
20			50	VCOMH	A Regulator output Vcom High level
21			51	VCOML	A Regulator output Vcom Low level
22			52	VGM	Gray Scale generate reference level
23			53	VS	Source driver generate reference level
24			54	VDD2	Power output pin
25			55	VCL	A negative power output
26			56	C32-	DC/DC Convert circuit3
27			57	C31-	DC/DC Convert circuit3
28			58	C31+	DC/DC Convert circuit3
29			59	C32+	DC/DC Convert circuit3
30			60	GND	

5.2 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	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	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	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	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	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	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	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	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	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	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	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	0	R2			
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3-R252			
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:				
	LIGHT ↓	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R253			
		0	1	1	1	1	1	1	1	0	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	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	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	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	0	G2			
		:			:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:	G3-G252			
		:			:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:				
	LIGHT ↓	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	G253			
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	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	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	0	B0			
	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	0	B1			
		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B2			
		:			:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:	B3-B252			
		:			:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:				
	LIGHT ↓	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	B253			
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	B254			
	BLUE	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	B255			

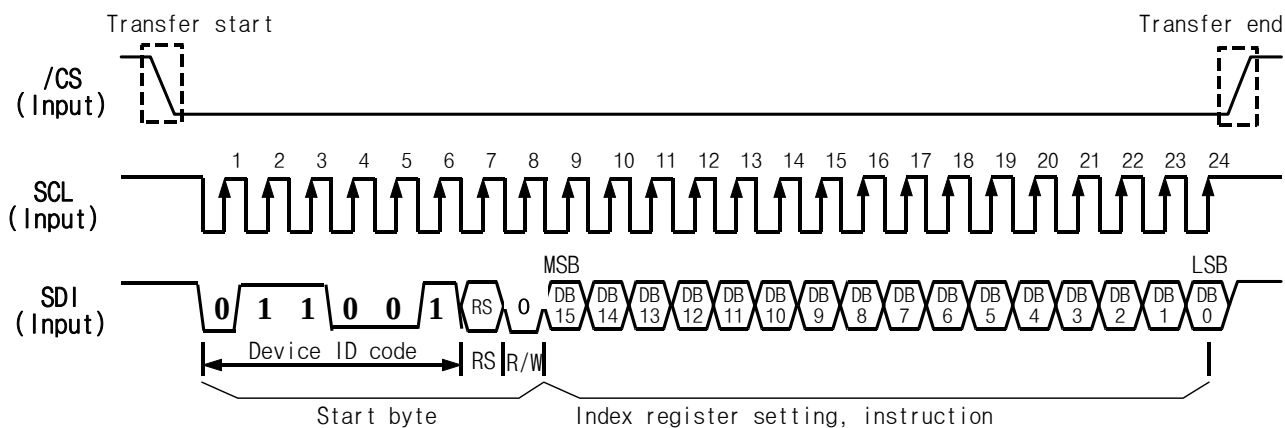
Note) Definition of Gray :

R_n : Red Gray, G_n : Green Gray, B_n : Blue Gray (n = Gray level)

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

6. Operation Specifications

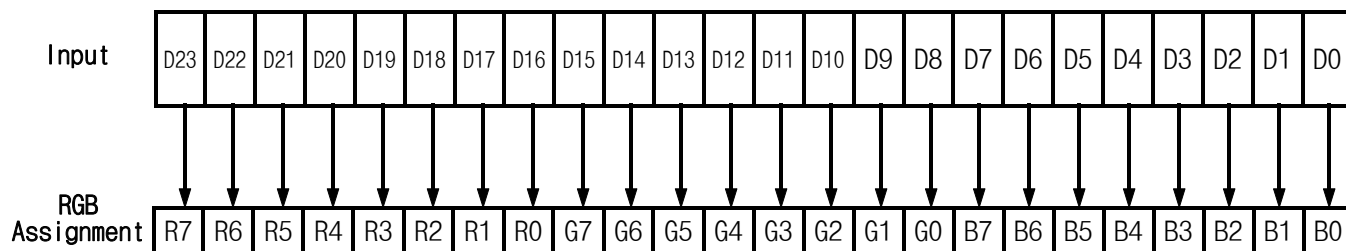
6.1 Serial Peripheral Interface



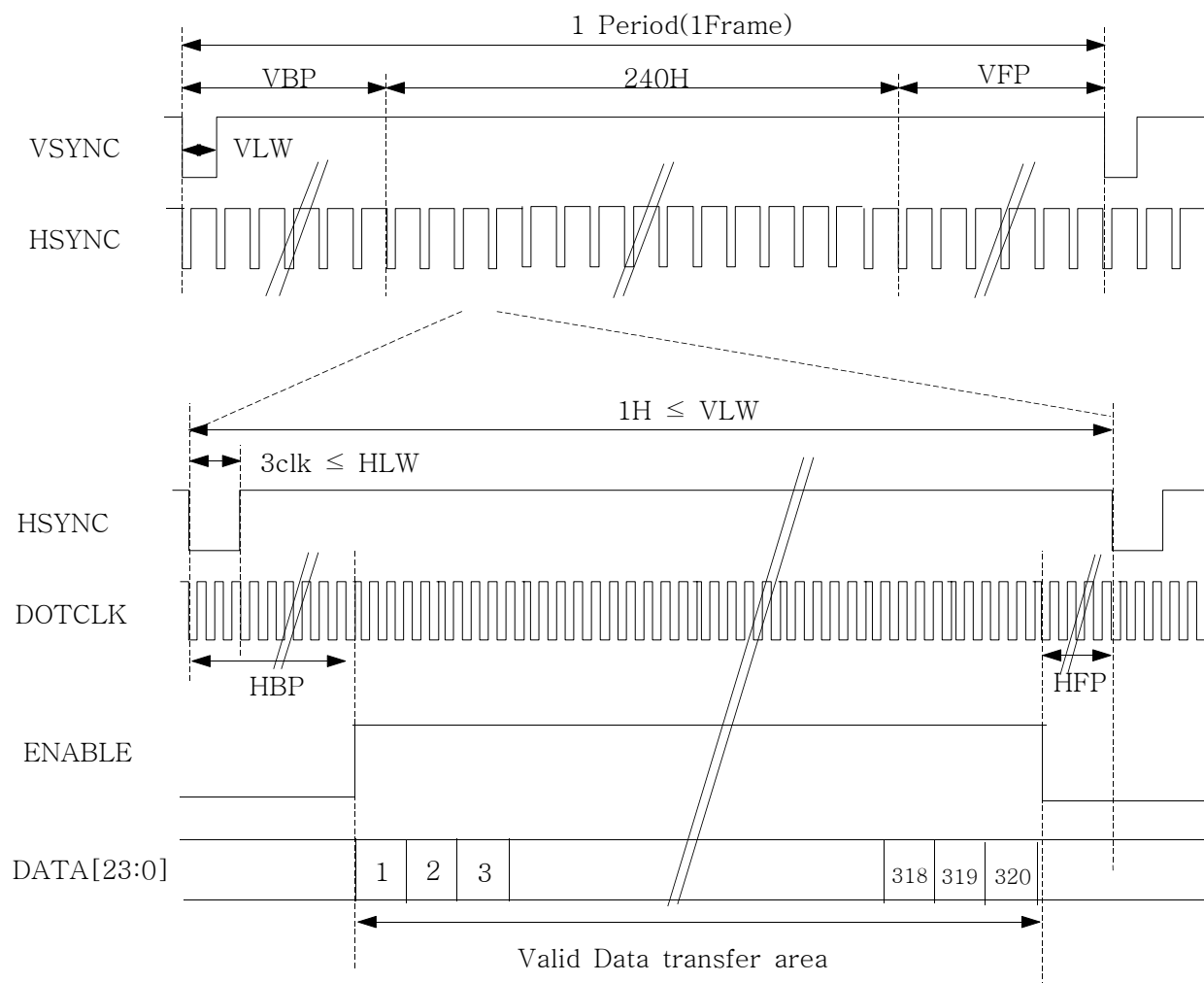
Note> RS = "0" : Index data.

RS = "1" : Instruction data

6.2 Data Format for 24bit RGB Interface



6.3 24bit RGB Interface Timing



$$\begin{aligned} \text{DOTCLK} &= f_{\text{frame}} \times (240 + \text{VBP} + \text{VFP}) \times (320 + \text{HBP} + \text{HFP}) \\ &= 60\text{Hz} \times (240 + \text{VBP} + \text{VFP}) \times (320 + \text{HBP} + \text{HFP}) \end{aligned}$$

* HBP : 8 ~ 511 clk, VBP : 1~255H

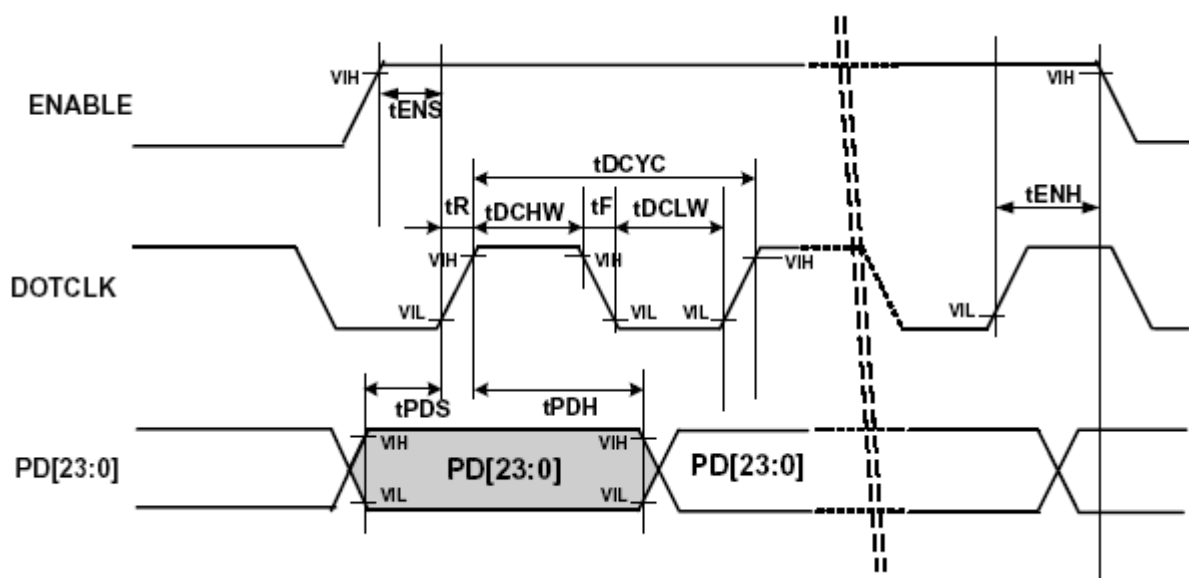
* HLW ≥ 3clk, VLW ≥ 1H

6.4 Electrical Specifications (when Vccio: 2.5 ~ 3.3V)

a. RGB Data Interface Characteristics

(T_A = -40 to +85 °C)

Characteristic	Symbol	24bit RGB Interface		Unit
		Min	Max	
DOTCLK cycle time	tDCYC	50	-	ns
DOTCLK rise/fall time	tR,tF	-	2	
DOTCLK Pulse width high	tDCHW	20	-	
DOTCLK Pulse width low	tDCLW	20	-	
ENABLE setup time	tENS	15	-	
ENABLE hold time	tENH	15	-	
PD data setup time	tPDS	15	-	
PD data hold time	tPDH	10	-	



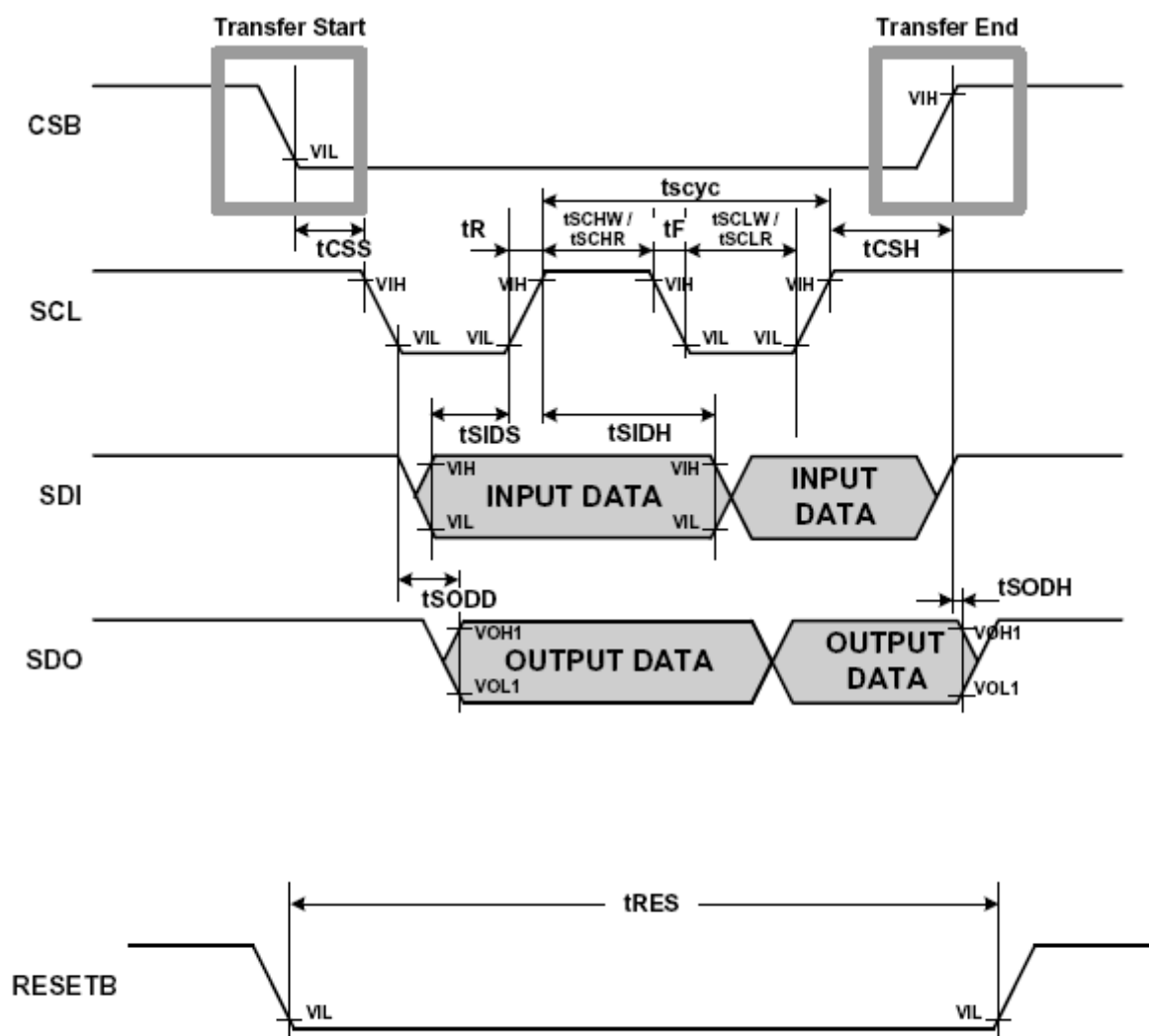
b. Clock Synchronized Serial Mode Characteristics(T_A = -40 to +85 °C)

Characteristic	Symbol	Min	Max	Unit
Serial clock cycle time	tscyc	250	-	ns
Serial clock rise/fall time	tR,tF	-	2	
Pulse width high for write	tSCHW	40	-	
Pulse width high for read	tSCHR	230	-	
Pulse width low for write	tSCLW	60	-	
Pulse width low for read	tSCLR	230	-	
Chip Select setup time	tCSS	20	-	
Chip Select hold time	tCSH	60	-	
Serial input data setup time	tSIDS	30	-	
Serial input data hold time	tSIDH	30	-	
Serial output data delay time	tSODD	-	130	
Serial output data hold time	tSODH	5	-	

c. Reset Timing Characteristics(T_A = -40 to +85 °C)

Characteristic	Symbol	Min	Max	Unit
Reset low pulse width	tRES	10	-	us

NOTE. Reset low pulse width shorter than 1us do not make reset. It means undesired short pulse such as glitch, bouncing noise or electorstatic discharge do not cause irregular system reset. Please refer to the table below.



7. Command List & Instruction Descriptions

7.1 Command List

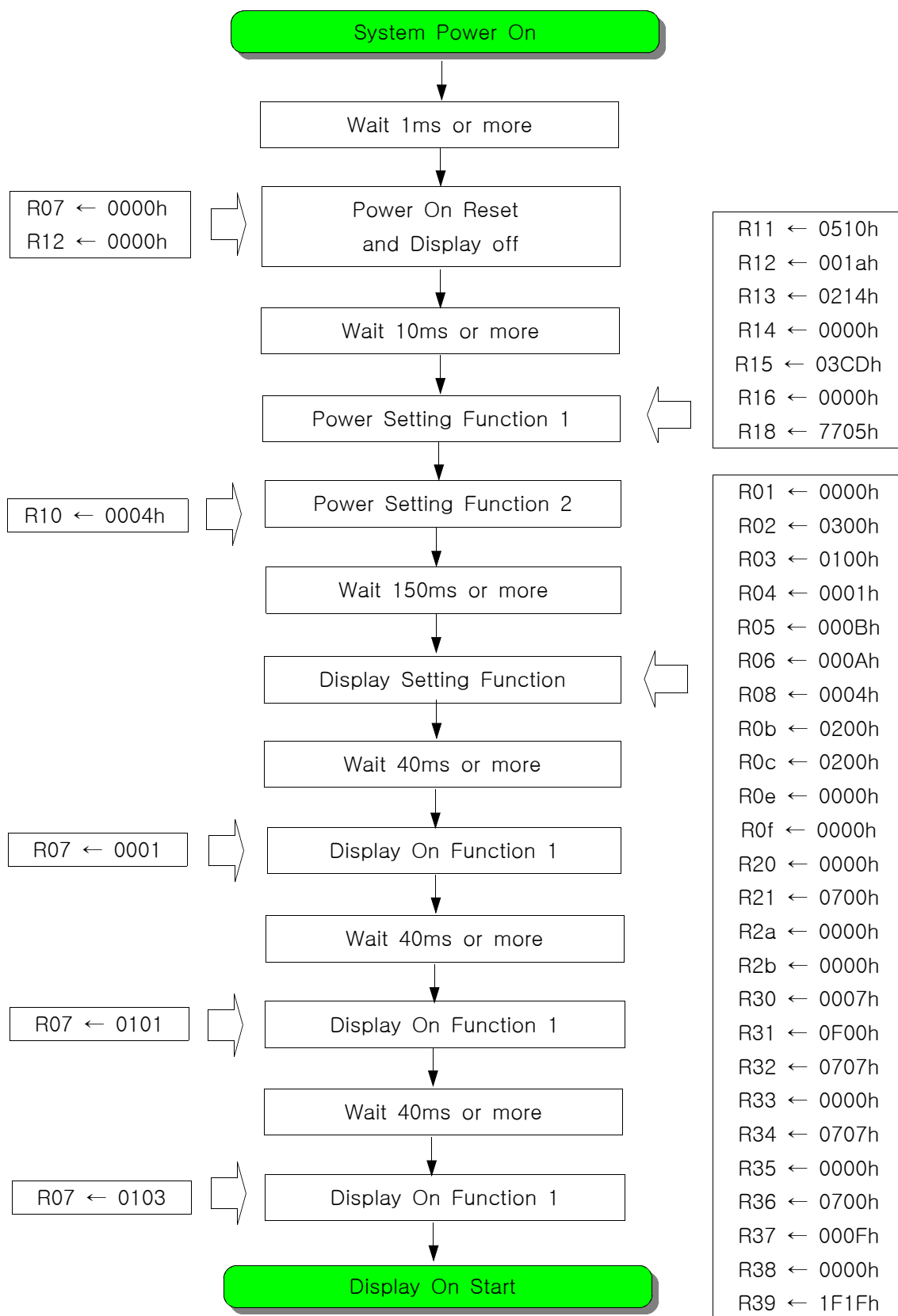
Refer to the Appendix 1: Driver IC Specification

7.2 Instruction Descriptions

Refer to the Appendix 1: Driver IC Specification

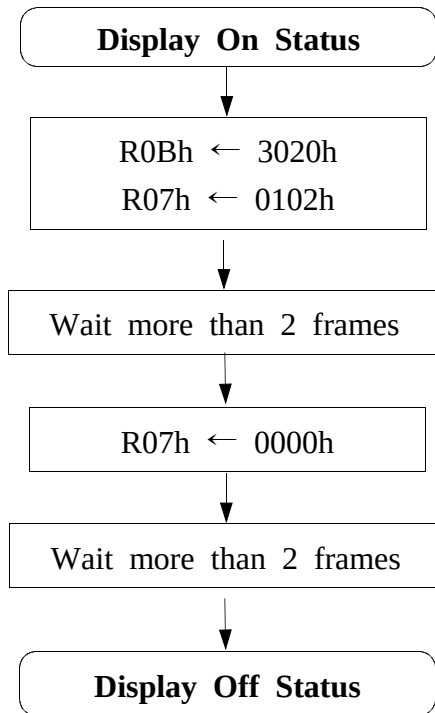
8. Power On/Off Sequence

8.1 Power On Sequence

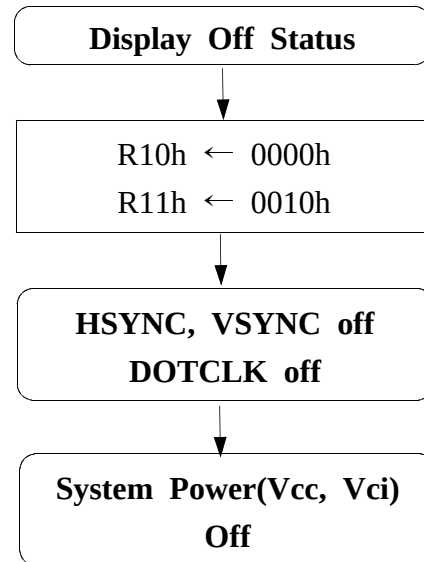


8.2 Power Off Sequence

< Display Off Sequence >

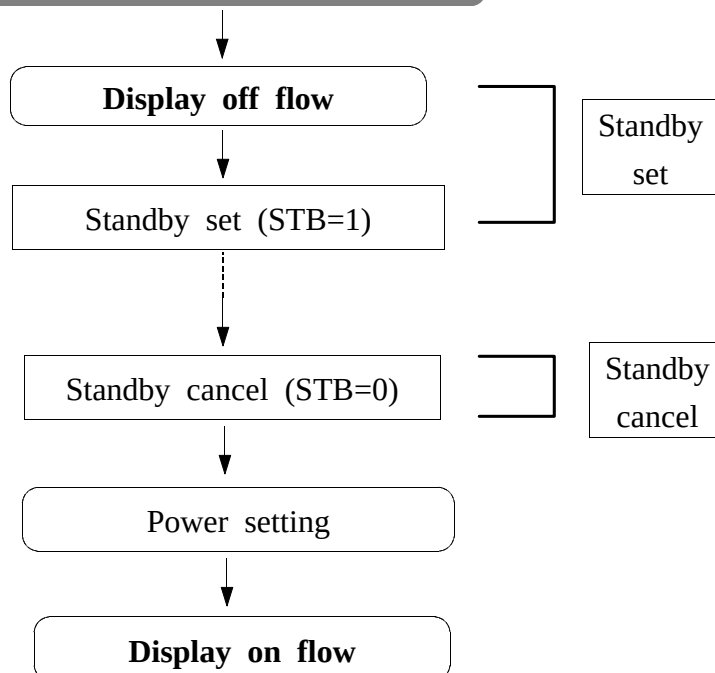


< Power Off Sequence >

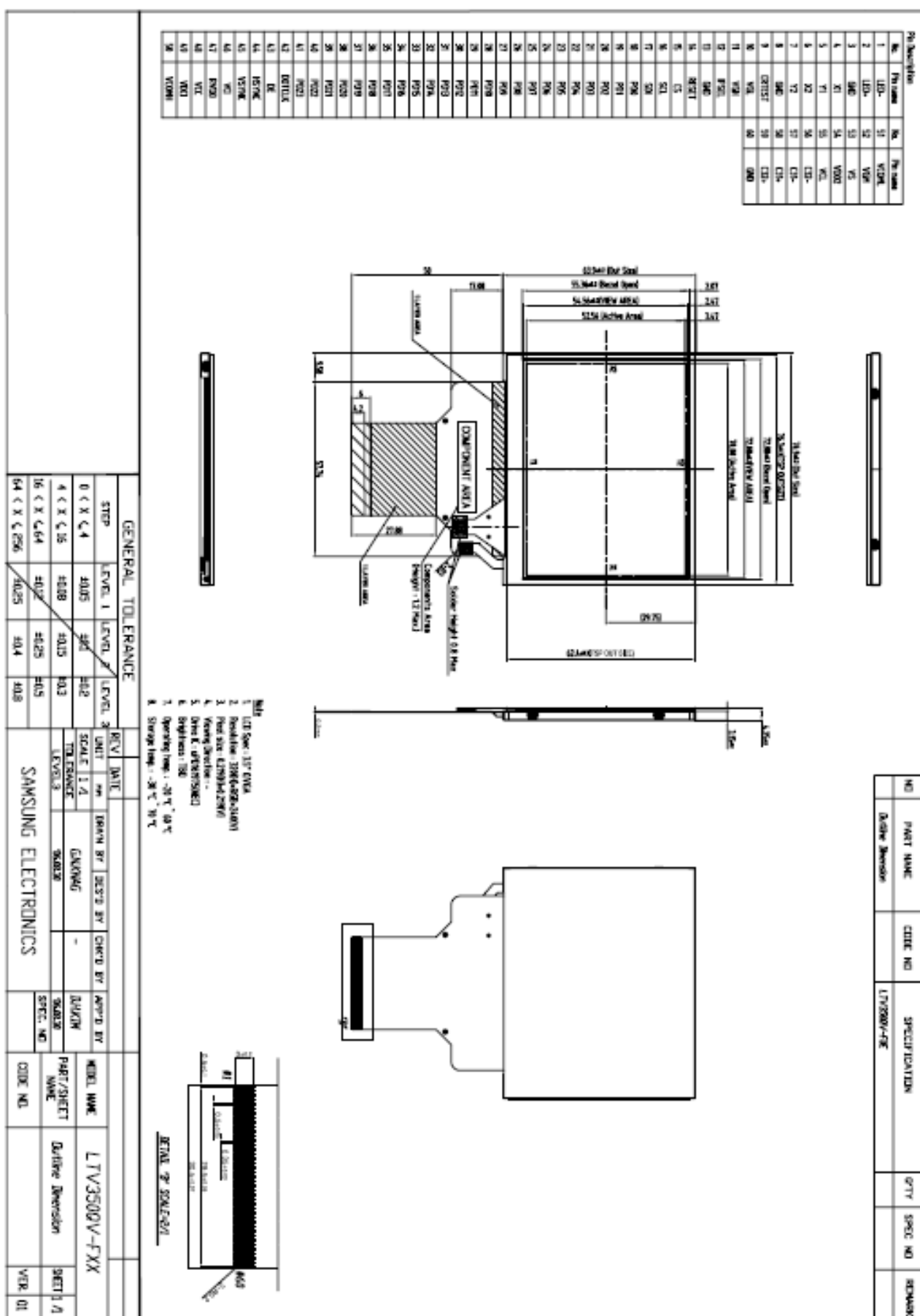


8.3 Standby Mode Sequence

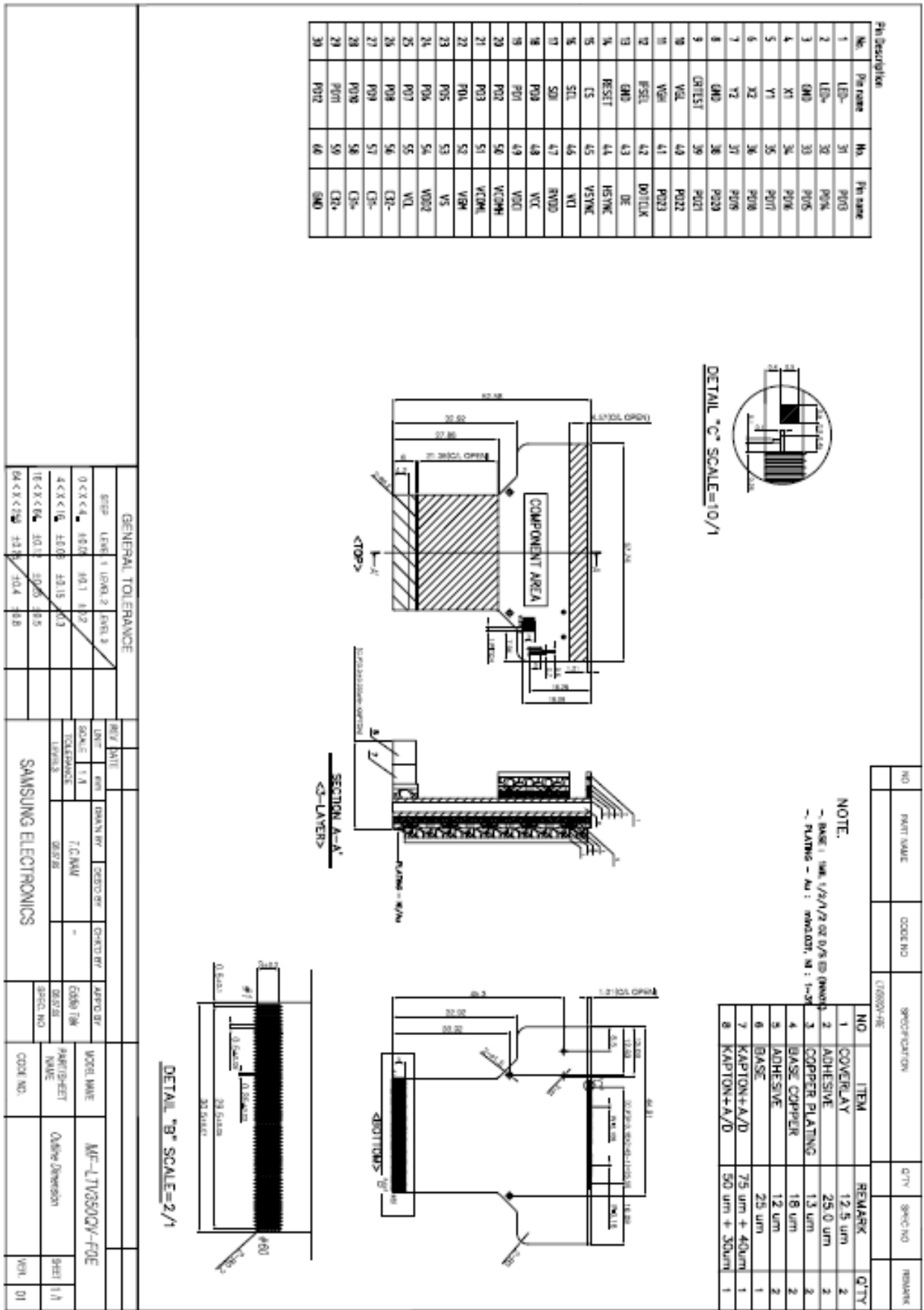
< Standby Mode Sequence >



9. Outline Dimension



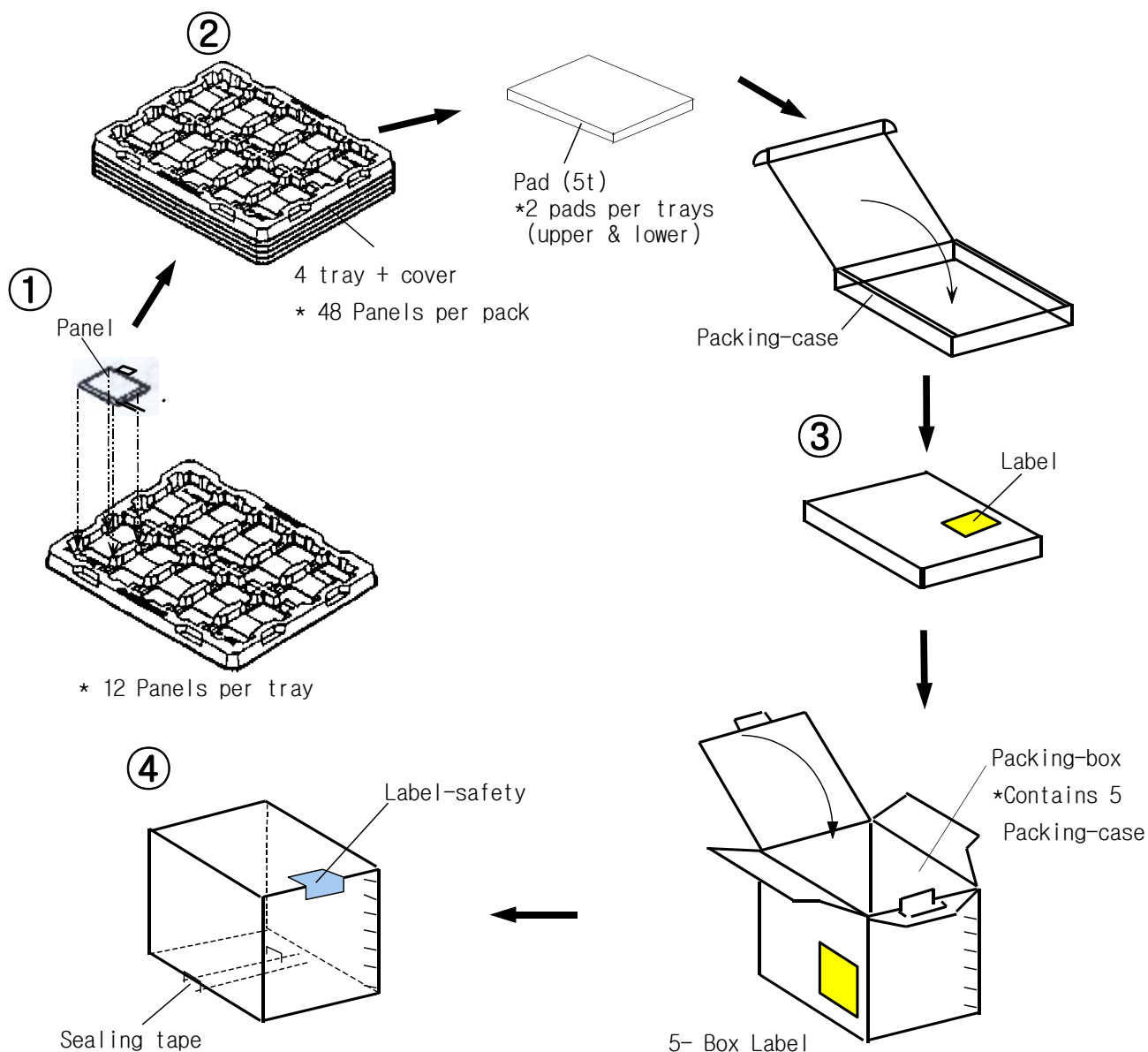
10. Fpcb Outline Dimension



10. Fpcb Partlist

No.	PART	SPECIFICATION	MAKER	SILK
1	Capacitor	4.7uF,6.3V,1608,X5R,20%	Murata Taiyo-Yuden TDK Kyocera	TBD
2	Capacitor	1uF,10V,1005,X5R,20%	Murata Taiyo-Yuden TDK Kyocera	TBD

12. Packing



Note (1) Total : Case: Approx. 2.56 Kg

Box: Approx. 13.4 Kg

(2) Size : Case: 490(W) x 342(D) x 58(H)

Box: 505(W) x 355(D) x 312(H)

(3) Place the panels in the tray facing the direction shown in the figure.

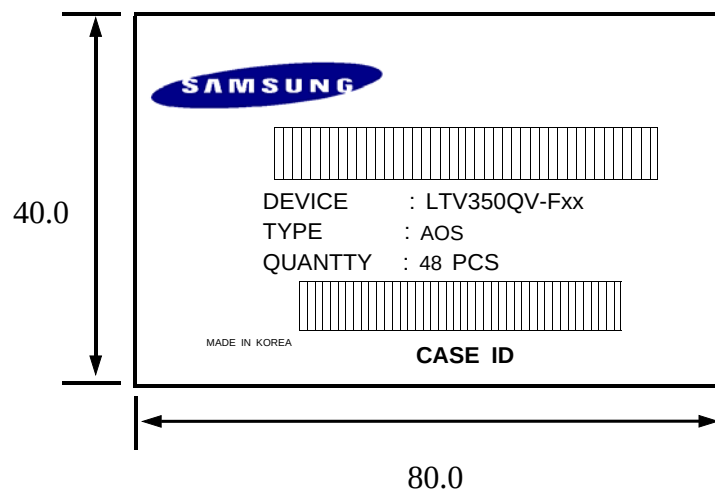
(4) Place 5 tray and cover(empty tray) and pads inside the packing-case.

(5) Place 5 packing-case inside the packing-box.(Affix the label)

(6) Seal the packing-box. Affix the label-safety.

13. Marking & Others

(1) Packing case attach



TYPE : AOS

CASE ID : DX 06 08 30 01

Box Number

Day

Month

Year

Site

14. General Precautions

14.1 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 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 Integrated Gate Circuit.
- (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

14.2 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.

14.3 Operation

- (a) Do not connect, disconnect the module in the "Power On" condition.
- (b) Power supply should always be turned on/off by the "Power on/off sequence"

14.4 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.